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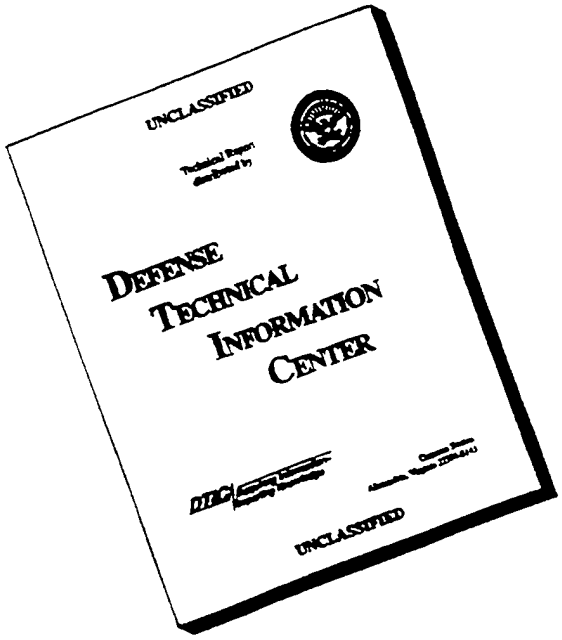
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**13. ABSTRACT** (Maximum 200 words) The Center for the Advancement of Science, Engineering, and Technology (CASET), of Huston-Tillotson College, a historically black college, conducted a multiyear research study to determine and test barriers and enhancements to the recruitment, retention, and performance of American Indians, Blacks, Hispanics and women as a means of alleviating a potential shortage of qualified American nationals in the scientific, engineering, and technological (SET) workforce. CASET organized a consortium of nineteen higher education institutions with enrollments primarily minority or female. Research strategies included quasi-experimental methodologies to collect and analyze data, the development and maintenance of the CASET database containing documents critical to the research purpose, conducting 62 interventions testing strategies designed to encourage women and minorities to engage in SET study and careers, and symposia held at Johnson Space Center focusing on intervention programs for minorities and women. The study results confirmed there is a problem with the teaching and learning of mathematics in the U.S. Science interventions enhanced science performance significantly at all educational levels. Science interventions enhanced mathematics performance and/or attitudes of college students. Interventions provide the kind of support enabling underrepresented minorities and women to succeed in non-traditional study and careers.

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Marin W. Kay 14 FEB. 97

PI - Signature Date

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## INTRODUCTION

The Center for the Advancement of Science, Engineering, and Technology (CASET) is a research arm of Huston-Tillotson College, an historically black college (HBCU) in Austin, Texas. In 1987, the Department of Defense (DoD), under Grant DAMD17-88-Z-8013, funded CASET's research project:

A Study to Determine and Test Factors
Impacting on the Supply of Minority and
Women Scientists, Engineers, and Technologists
Defense Industries and Installations

which suggested that one way to ensure an adequate supply and reserve of qualified American national scientists, engineers, and technologists (SETs) would be to increase the numbers of minorities and women pursuing quantitative study and careers (a non-traditional choice for them).

The main focus of the research was to gather data and develop insights concerning barriers and enhancements to the recruitment, retention, and performance of American Indians, Blacks, and Hispanics (the underrepresented minorities) and women in physical sciences, mathematical sciences, engineering, computer sciences, environmental sciences, and technology in general. CASET is committed to finding ways to increase the numbers of these groups in SET occupations. The DoD is a major stakeholder in enhancing the SET workforce, both civilian and military, in order to strengthen the human resource side of America's technology base for defense preparedness, economic security, and international competitiveness (for a discussion of this, see the paper "Research and Education in Economic Competitiveness: New Roles for Government, Industry and Universities," National Governors' Association Center for Policy Research and Analysis, 1987).

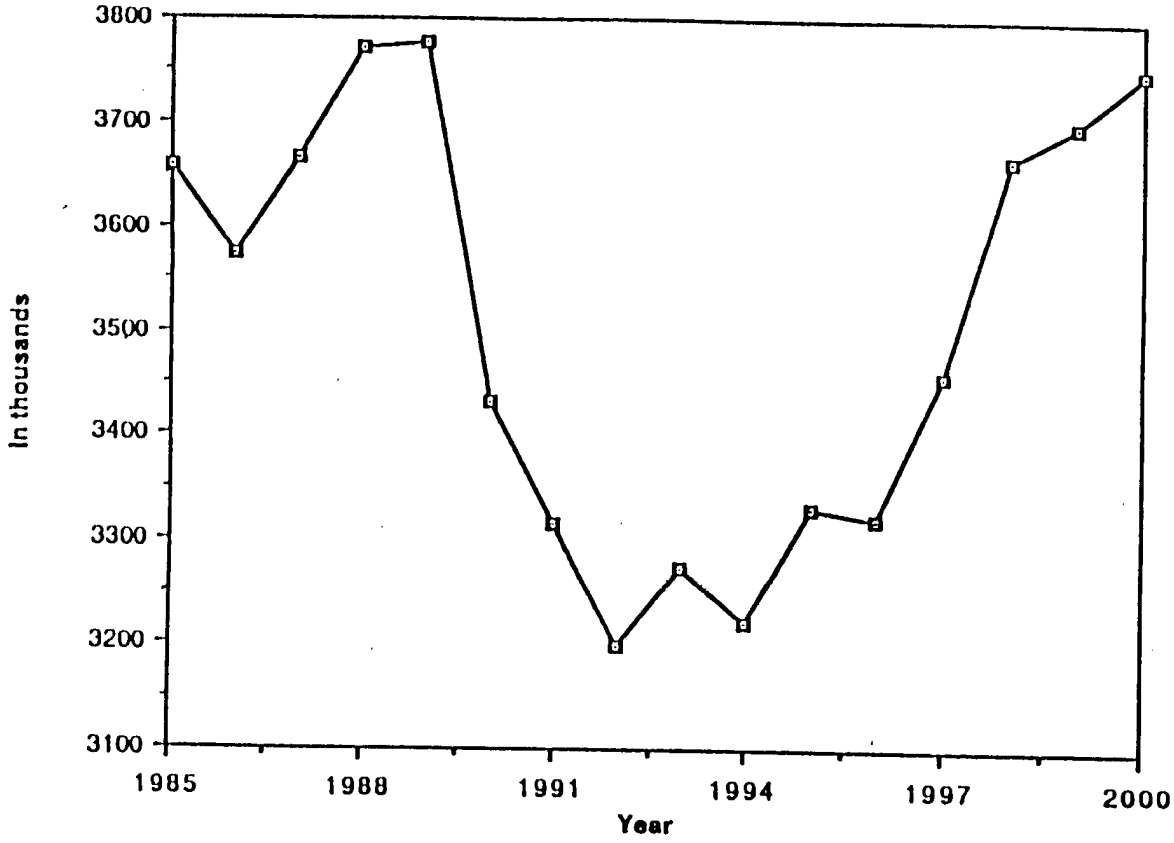
### Statement of the Problem

In the early 1980s, demographic trends and predictions began to suggest that the United States might experience a shortage of American national SETs (see Berryman, 1983). A combination of factors at work in America converged to create this potential shortage which could make the nation at risk for economic and military security as well as technological leadership:

- From 1983 to 1995 the number of college age students - 18 to 24 years old - would decline by 25% (see Chart 1 on Page 2) causing a decline in the number of Anglo males, the group from which SETs have traditionally been drawn.

- America was increasingly becoming a "high tech" society with concomitant demands for qualified, professional technical personnel. A shortage of SETs would magnify the "mismatch" between supply and demand, thus creating competition in the

**Chart 1. Projection of 18-Year Olds in U.S. Population**




Source: Department of Commerce, Bureau of the Census.

work place and the subsequent draining away of professionals from those sectors (such as education, the military, and government service) whose pay scale was not quickly responsive to market forces.

- o A potential shortage of SETs was of particular interest to the DoD because it depended on a continuing supply of technically trained personnel to accomplish its mission and yet was experiencing difficulty in hiring and retaining SETs (see the February, 1987 U.S. General Accounting Office Report submitted by the Chairman, Committee on Post Office and Civil Service, House of Representatives, entitled "Federal Workforce: Pay, Recruitment, and Retention of Federal Employees"). Thus the possibility existed that the DoD might need to increasingly rely on minorities and women to engage in the SET careers necessary for defense preparedness of the nation and for solutions to technological problems of the next decade and beyond.

- o In 1986, foreign nationals received nearly three times as many Ph.D.s in engineering, as ALL women and minorities combined - 1,441 foreign nationals against 535 women and minorities (see Chart 2 on Page 4). At the same time, American nationals were not choosing SET majors in increasing numbers.

In summary, the United States was facing a potential shortage in the SET labor pool in order to satisfy demand from all sectors - governmental, industrial, and academic. CASET's response was to suggest that the largest untapped pool of potential SETs was underrepresented minorities and women. The purpose of the present grant is the investigation of why these populations were underrepresented in quantitative fields and to determine ways in which barriers could be removed and participation enhanced, thus providing the DoD ways to alleviate shortages if necessary.

The Hudson Institute has documented in "Workforce 2000, Work and Workers for the Twenty-first Century" (1987) that by 2000, only 15 percent of the new entrants in the labor force will be native American national Anglo males as compared to 47 percent in 1987. The remaining 85 percent of workforce new entrants will be female, minority, or immigrant.

**Background**

The Sputnik launching in 1957 jump-started the United States into accelerating "production" of scientists and engineers, but by the 1970's the urgency of providing large numbers of American national SETs had begun to diminish. Concurrently, educators and other concerned persons began to question why so few minorities and women entered the quantitative fields. The National Science Foundation (NSF) sponsored a conference on the Participation of Women in Scientific Research, October 17-20, 1977. Among other grants, NSF

CHART 2

## ENGINEERING DEGREES BY LEVEL, SEX, RACE & CITIZENSHIP, 1985 AND 1986

| | BACHELOR'S | | MASTER'S* | | Ph.D. | |
|---|---|---|---|---|---|---|
| | 1985 | 1986 | 1985 | 1986 | 1985 | 1986 |
| **Total** | **77,892** | **78,178** | **22,502** | **23,025** | **3,383** | **3,686** |
| Women | 11,516 | 11,164 | 2,538 | 2,745 | 192 | 246 |
| Black | 2,045 | 2,114 | 311 | 345 | 32 | 17 |
| Hispanic° | 2,095 | 2,227 | 371 | 331 | 34 | 38 |
| Asian/Pacific | 4,302 | 4,826 | 1,529 | 1,712 | 246 | 229 |
| American Indian | 109 | 129 | 28 | 27 | 4 | 4 |
| Foreign National | 5,958 | 6,275 | 6,115 | 5,735 | 1,400 | 1,441 |

*Includes Engineer Degrees °Includes 363 BS and 9 MS each year at U. Puerto Rico

Data Source: Engineering Manpower Commission

also funded a study on Women's Choice of Science as a Career (Lantz, Carlberg, Eaton, 1982). In 1984, the National Action Council for Minorities in Engineering, Inc. (NACME) published a handbook of pre-engineering programs for minority youth. They were actively supportive of the report by Yale University Institution for Social and Policy Studies (Gordon et al, 1986) describing engineering programs for minorities.

Not all minorities were underrepresented in SET fields. American Indians, Blacks, and Hispanics definitely were, but the exception to this was the Asians. They were overrepresented in America in SET fields, in relation to their reported at that time two percent of the total population. Opinions in America were divided as to whether the large numbers of Southeast Asians in engineering school and in jobs in the U.S. were having a deleterious effect on the job market vis-a-vis American nationals (see letters published in the March 12, 1988 New York Times, next page). Women scientists were unemployed at a higher rate than males (NSF, 1978).

The Office of Technological Assessment (OTA), now defunct, published a 1985 report which documented at length, some of the points which CASET had made in its first proposal, "WORK-YOUR-WAY," to the DoD in 1983, later revised by CASET and funded as a research study contract through the Army Research Institute for the Behavioral and Social Sciences (ARI) in 1985, previous to the present grant.

In 1985, the Human Resources Subworking Group (C-2), a DoD/DOL team, under the Emergency Mobilization Preparedness Board (EMPB), produced several reports. The report for the Fourth Quarter, FY 1985, entitled **Emergency Mobilization Preparedness: Armed Forces Needs for Civilian Scientific, Engineering and Technical Workers, and Projected Shortages under Mobilization** set forth predicted shortages, under mobilization, for 33 civilian occupational titles important to the U.S. Military forces. For those occupations (such as engineers) the report also listed the occupations's critical suboccupations which would be in significant shortage under mobilization (see Chart 3 on Page 7). The report states that the Wartime Manpower Planning System (WARMAPS) and its civilian manpower subsystem in the DoD provided the data for analysis and for comparison with data from the DOL and the Federal Emergency Management Agency (FEMA).

Of the 33 important occupations, 19 can be considered SET occupations which are mission-critical or have high educational requirements, meaning a large, qualified supply of such professionals might not be quickly available. **For those 19 critical occupations, a total of 62,856 civilian hires would be needed in the first six months of an emergency mobilization.**

# Letters

## Scapegoatism or scam?

As an American-born engineering professor, I have my own suspicions when I hear statements about "an undercurrent of resentment" against foreign-born engineers working in the United States" ("U.S. engineering with a foreign accent," SN: 1/23/88, p.53). Frankly, I suspect a strong current of chauvinism behind such remarks.

Perhaps I have been lucky, but the only trouble I have ever had learning from a foreign-born professor or teaching assistant is when that person would have had trouble teaching even in his own language. Let us not forget that there is a strong motivation here toward scapegoatism on the part of students, and what is worse, there is also plain intolerance.

Let me add that many of these foreign engineers are able to come to the United States only because they are the elite students in their own countries. Although they are not inherently better than our own elite, I have found that they tend to work much harder than their American counterparts. Finally, many of them are among the finest people I have ever met. Instead of complaining about them, we should be doing everything we can to entice these people to live and work in our country.

The halls of higher education are as wide open to American students who choose to enter them as they are to foreigners. Americans are simply not choosing to do so. The sad fact is that in American culture higher education, and the hard work that entails, is no longer deemed to be of great value. Perhaps we are seeing in our current economic difficulties part of the consequences of that.

*Douglas G. Talley*
*Assistant Professor*
*Department of Mechanical Engineering and Applied Mechanics*
*University of Michigan*
*Ann Arbor, Michigan*

**We Americans should** get off our ethnocentric horse and welcome those highly able foreign graduate students in science, mathematics and engineering. I suggest the following:

1. Systematically recruit the best who can be found in all the world.
2. Require a high score — say, 600 — on the Test of English as a Foreign Language.
3. Have those who are accepted arrive, unaccompanied, early in the summer preceding their first graduate year here. Give them six to ten weeks of total immersion in the English language, stressing aural, oral and pedagogic aspects. Preferably, also provide each a roommate whose native language is U.S. English.
4. Urge the highest achievers to earn the Ph.D. degree.
5. Encourage any of the best who wish to remain in the United States and become citizens to do so.

To a great extent, our country became outstanding because of the continual arrival of eager, energetic immigrants. Initially, they have always done much of our menial labor — jobs that most Americans shunned as being too laborious, dangerous or poorly paid. I suspect that many bright American college graduates now consider doctoral study and the ensuing employment as risky, too intellectually demanding and not cost-effective even in the long run. So be it. Let's be grateful for the brilliant, highly motivated foreigners who consider it a great privilege to live as graduate students for many years on a pittance and then take jobs yuppies don't want. We didn't even have to pay for their kindergarten through 16th year pregraduate education!

*Julian C. Stanley*
*Director*
*Study of Mathematically Precocious Youth*
*Johns Hopkins University*
*Baltimore, Md.*

**It is true** that foreign engineers accept jobs at wages far below those offered to American engineers. It may be of interest to your readers to learn how this scam works.

All foreign students are required to sign a pledge stating that they will return home after graduation. Too few do. In the years from 1951 until 1981, Taiwan sent 67,000 foreign college students to this country. Only 9,000 of them returned home. Inelegantly put, the other 58,000 simply lied.

After graduation, what is needed for these foreign students to remain here is a job. The job, and not the salary, is all-important. Unethical employers take advantage of this situation by advertising (over the name of a State Job Service) for an engineer and offering a very low wage. The State Job Services know the going wage for a typist or a truck driver, but are ignorant of the going wage for a technical professional. Thus, they accept the word of the employer who pays for the ad.

The solution is to insist that all foreign graduates return home. In this way, we will encourage Americans to again pursue technical training.

*Irwin Feerst*
*Massapequa Park, N.Y.*

**In engineering, the** shortage is in jobs, not in workers. I doubt engineering is the only technical field for which general worker shortages are claimed where none exists.

By law, before you can import an alien worker you must show that "there are not sufficient workers who are able, willing and qualified, and who will be available at the time and place needed, to perform the labor or services involved" and that "the employment of the alien in such labor or services will not adversely affect the wages and working conditions of workers in the United States similarly employed" (USC 1186a).

I am an engineer with B.S. degrees in two different fields of engineering. I have now spent one-quarter of a year looking for employment. I have almost 10 years of experience and am chairman of three technical standards committees in two organizations. I have received awards for outstanding performance.

I am not alone. Engineers in other fields tell me work is tight or that they too are unemployed.

Foreign engineers and other technical employees are almost always imported for one reason: *cost!* At current levels they are depressing salaries and displacing many American workers.

Not addressed in your article is the reason why more Americans don't pursue advanced degrees. This is no deep dark secret. It is simple economics: It doesn't pay.

The large supply of foreign engineers eager and able to live and work in this country has pushed graduate-level salaries down. There are many companies anxious to hire these foreign engineers with doctor's degrees instead of Americans with bachelor's degrees, particularly for the same or less money. Why are more than half the assistant professors in our schools foreign? You can bet salary is a big part of the answer.

Many of us greatly fear that the trend of foreign domination of master's and doctor's degrees will also be repeated for bachelor's degrees.

What are the implications for this country of a national policy that results in near-total domination of all technical fields by foreign talent? Is there more than a coincidental relationship between our increasing use of foreign technical talent and our loss of competitiveness in world markets?

*Paul D. Cook*
*Palatine, Ill.*

Talley, D., Stanley, J. C., Cook, P. D., & Feerst, I. (1988, March 12). Scapegoatism or scam? [Letters to the editor]. Science News, 133(11), pp. 163, 169.

CHART 3

EMERGENCY MOBILIZATION, FIRST SIX MONTHS, DOD CIVILIAN HIRE REQUIREMENTS

SET SUBOCCUPATIONS CONSIDERED MISSION-CRITICAL OR HAVE HIGH EDUCATION REQUIREMENTS

| Suboccupation | IDOS Code | DOT Code | Shortage | Shortage/Demand Ratio |
|---|---|---|---|---|
| Civil Engineer | AC | | -7680 | 58% |
| Electronics Engineer | AC | 705 003061030 | -7240 | 30% |
| General Engineer | AC | | -6602 | 43% |
| Mechanical Engineer | AC | 705 007061014 | -3707 | 29% |
| Electrical Engineer | AC | 705 003061010 | -1655 | 48% |
| Aerospace Engineer | AC | (1622) | -1536 | 30% |
| Engineering Technician | GC | | -6499 | 34% |
| Industrial Eng. Tech. | | 705 012267010 | -1088 | 31% |
| Physics | AA | 705 023061014 | -744 | 20% |
| Chemistry | | 705 022061010 | -549 | 22% |
| Operations Research | CA | | -657 | 20% |
| Physical Science Tech. | GA | | -614 | 25% |
| Electronics Technician | GW | 705 003161014 | -4008 | 62% |
| Electronics Mechanic | PJ | | -8973 | 42% |
| Electronic Integrated Systems Mechanic | | | -1289 | 32% |
| Computer Specialist | GK | (171) | -5097 | 22% |
| Electrician | PB | | -3137 | 26% |
| Computer Operation | JK | | -1450 | 19% |
| Electronic Digital Computer Mechanic | PK | | -331 | 52% |

Excerpted from Part III (Tables T-1 through T-33) of Emergency Mobilization Preparedness: Armed Forces Needs for Civilian Scientific, Engineering and Technical Workers, and Projected Shortages Under Mobilization, Report for the Fourth Quarter, FY 1985, August, 1985.

In 1987, the NSF confirmed CASET's prediction that a serious shortage of SETs was looming and said that it would possibly be acute by 1995. Of course, the Cold War threat of the USSR was very much a reality when CASET began its research in 1985. By 1987, the NSF was decrying the decline of American citizens participating in science and engineering in the face of growing demand. In a 1987 talk before a joint meeting of the American Physical Society and the American Association of Physics Teachers, the then-NSF Director Erich Bloch deplored federal budget cutting. He also noted that women were still receiving less than 15 percent of graduate technical degrees, while Blacks and Hispanics (although approximately 20 percent of the total population) were still taking few Ph.D.s in the sciences - only 2 percent in physics, for example.

The DoD has traditionally supported its mission by encouraging education and training in those areas of science and technology which are crucial to civilian and military personnel and defense industries and installations. For example, the DoD has supported its Science and Engineering Apprenticeship Program for High School Students - providing for recruitment, screening, and placement of students as apprentices in DoD laboratories in the Washington, D.C. area. Also, DoD has supported the Air Force Fellowship Program - a specialized graduate program funding students in certain types of essential job categories in order to perform work for the Air Force or related industries.

The DoD was among the first (if not the first) government department to fund substantial empirical research investigating reasons why so few American Indians, Blacks, Hispanics entered quantitative careers. DoD Grant DAMD17-88-Z-8013 was Phase III of the multiyear CASET Research Study. Prior to being awarded the grant funding this Phase, CASET, in Phase I and Phase II (see page 8 for the announcement in the Austin American Statesman), had researched the quantitative aspects of the disproportionate participation of American Indians, Blacks and Hispanics and women in SET study and careers through two DoD contracts: MDA903-85-C-0342 and MDA903-86-C-0202, operating between September 2, 1985 and October 31, 1987. The ARI monitored both contracts, the latter eventually transferring and operating under the aegis of the U.S. Army Medical Research Acquisition Activity. The Department of Labor (DOL) Employment and Training Administration (ETA) supported MDA903-86-C-0202 through Interagency Agreement No. 99-6-3375-98-010-03 between the DOL and the DoD.

In 1985, only 13 percent of the nation's SET workforce was female, although women constituted over 40 percent of the total. Blacks represented 2.4 percent and Hispanics 2 percent of those employed in high technology jobs. American Indians, at 1/2 of 1 percent of the total population at that time, were also underrepresented in quantitative fields.

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Staff Photo by Tom Lankes

## Honorary doctorate

Ford B. Ford, left, undersecretary of labor, is given an honorary doctorate by Huston-Tillotson President John Q. Taylor King during ceremonies marking the school charter anniversary. Three others also received honorary degrees at the special convocation Friday.

# Huston-Tillotson to study minority roles in science

From Staff and Wire Reports

Huston-Tillotson College has been awarded a $287,205 contract to see why minorities and women hold relatively few scientific jobs.

John Q. Taylor King, president of the predominantly black school in East Austin, said Huston-Tillotson "has been concerned for some time with the reasons underlying the small participation of minorities and women in scientific fields, including the computer sciences and mathematics."

Currently, only 13 percent of the nation's high-technology work force is female, according to a statement from the college, and blacks hold only 2.4 percent and Hispanics 2 percent of such jobs.

Gov. Mark White praised the decision of the Army Research Institute for the Behavorial and Social Sciences to award the contract to Huston-Tillotson.

"We are understandably proud of Texas' gains in the areas of science and technology, but it is important that minorities and women share in the jobs created in the fields," White said.

The first contract resulted in two reports, "Pertinent Factors Which Affect the Representation of Women and Minorities in Scientific, Engineering and Technical Careers" (ARI Technical Report) (Kay, 1987) and "Database on Minorities and Women in Science, Engineering, and Technology" (ARI Research Product) (Kay, 1988). The second contract's deliverable was the report, "Mathematics Performance: A Meta-Analysis of Intervention Programs" (Kay, Ramirez, Ilegbodu, and Bahr, 1988).

Through this previous research, CASET found that the factors which underlie the underrepresentation are not sufficiently documented and analyzed, thus creating a data gap affecting the supply of qualified professionals available for civilian and uniformed positions with the U.S. armed forces and defense contractors. The research design of Phase III was formulated to gather more precise data on the reasons for the under- representation of minorities and women in SET study and careers and suggest and test methods for increasing this pool should the DoD find it necessary.

The concept and inspiration for the entire CASET Study came from Dr. John Q. Taylor King, second permanent president of Huston-Tillotson College (now Chancellor and President Emeritus), and Director and Chair of CASET. As a retired U.S. Major Lieutenant General and the holder of a Ph.D. in Applied Mathematics from the University of Texas-Austin, Dr. King recognized that the potential shortage of U.S. citizens in the SET work force could be alleviated by the recruitment and retention of underrepresented minorities and women in SET study and jobs.

Huston-Tillotson College has an impressive history as a quality, small HBCU. The present and third permanent president is Dr. Joseph T. McMillan, Jr., who is leading the College's new mission to achieve the "cutting edge" of academic excellence in the 1990's. Historically, Huston-Tillotson College represents a 1952 merger of two institutions: Samuel Huston College (originally founded in 1876 as the Andrews Normal School in Dallas, Texas) which moved to Austin in 1880 and Tillotson College, founded in Austin in 1875.

Beginning in 1986, CASET received support for the research Study from the National Aeronautics and Space Agency and the Lyndon B. Johnson Space Center (NASA/JSC) through a Memorandum of Understanding. CASET presently is funded by NASA/JSC for Grant NAG9-775, focusing on the maintenance and expansion of the CASET database. The database was started in Phase I as an CASET internal investigation of research, findings, and interventions which had been accomplished with regard to getting more underrepresented minorities and women into the SET workforce. The database is being expanded to include persons with disabilities, as well as the original groups of minorities and women.

## Approach

Government, academia, and industry/business have all expressed concern with the United States' economic, industrial, and educational abilities and capacities - given the demographic trends which show the increasing importance of women and minorities to the SET workforce.

Because of the complexity of the problem, CASET moved forward with research efforts in a multifaceted approach, allowing for conclusions to be drawn from a variety of data. Data were gathered from research efforts in several project areas individually described below.

### The CASET Consortium

The CASET Consortium was organized as the research mechanism for data gathering on the barriers and enhancements affecting the desires and abilities of women and minorities to pursue SET studies and careers. CASET wanted the Consortium to be a mixture of populations, locations, 2-year, 4-year, private, state institutions...in other words, diversity. CASET staff and consultants visited schools and selected 20 which had already exhibited interest and/or conducted some research on the problem. The resultant Consortium was a 20 institution organization whose purpose was to develop and conduct intervention projects for underrepresented groups (see pages 12, 13, 14, and 15 for members and page 16 for sites). Nineteen institutions actually conducted research and gathered data; one institution was unable to follow through from the planning stage to the implementation stage due to administrative conflicts.

Since this study was breaking new ground in conducting basic research, CASET set the criterion that each institution had to have a student enrollment which was primarily American Indian, Black, Hispanic, or female. Also, the interventions were to be conducted with "average and normal" students, not "creaming" the student population for the "gifted and talented."

CASET felt that if the pool of SETs were to be increased, then the research needed to find ways that the average student could be recruited and retained in quantitative fields.

The Consortium institutions received planning grants from CASET, usually for $5,000. Guidelines were issued for the preparation of proposals (Appendix A). See Appendix B for a chronology of the process of each institution from inception to implementation.

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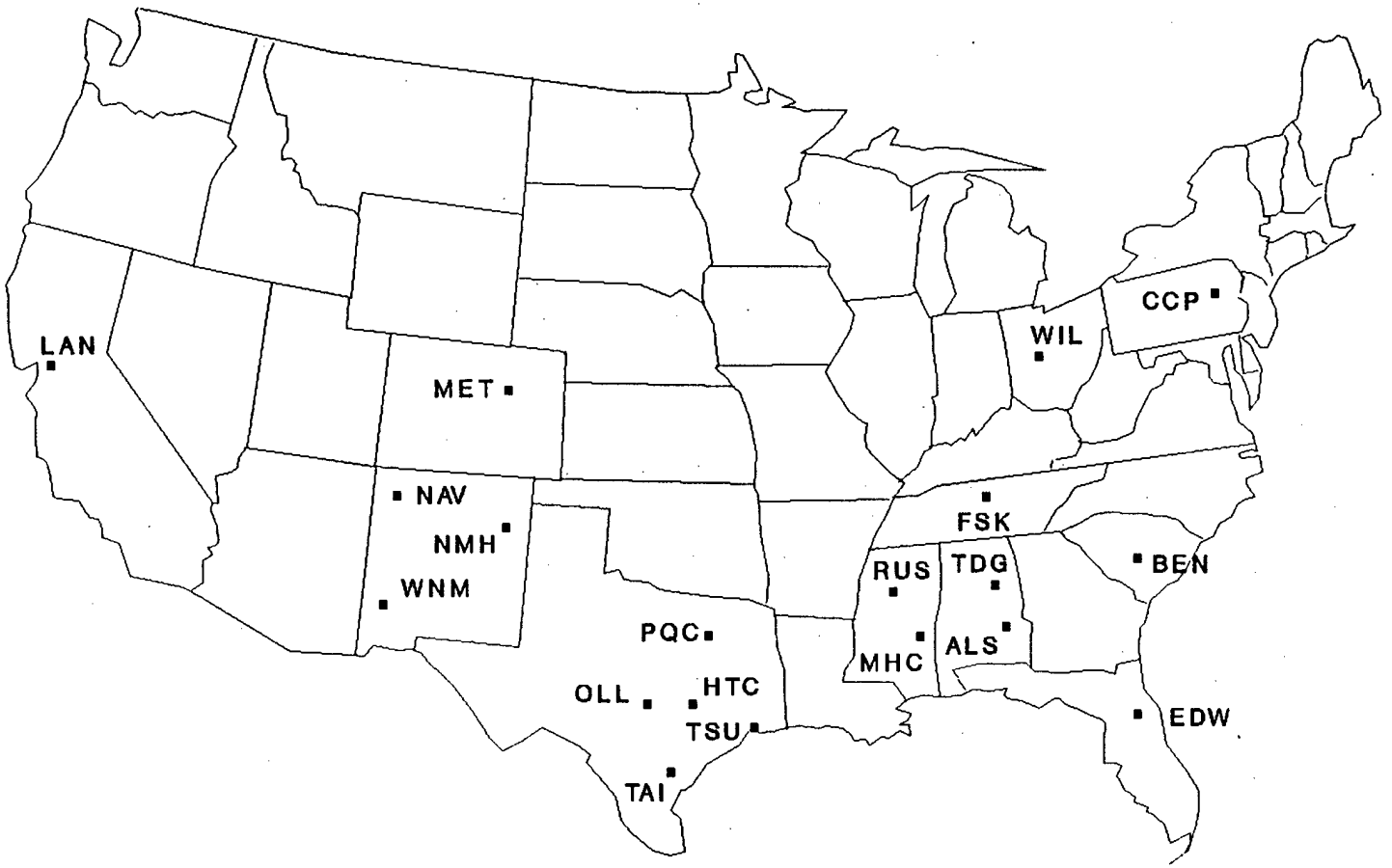
**********

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# CASET Consortium Intervention Sites




LEGEND

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EDW - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

After qualifying and acceptance of their proposals, a conference was convened at JSC, July 19-22, 1988, to acquaint Consortium members with experimental research methods and to meet with the CASET Research Team of consultants who would approve final research designs and provide expert technical assistance for any difficulties which might arise.

The Research Team of Consultants (and their professional affiliations at that time) were:

- Dr. Beatriz Cluwell, Research Scientist, Educational Testing Service, Princeton, NJ 08541
- Dr. Harris Cooper, Professor of Psychology and Research Associate, Department of Psychology, University of Missouri at Columbia, Columbia, MO 65211
- Dr. Suzanne Dancer, Department of Educational Psychology, University of Wisconsin, Milwaukee, WI 53201
- Dr. Larry Hedges, Chairman, Department of Education, University of Chicago, Chicago, IL 60637
- Dr. Cora Bagley Marrett, Professor of Sociology, Department of Sociology, University of Wisconsin, Madison, WI 53706
- Major Gilbert Ramirez, Ph.D., Academy of Health Sciences, Brook Army Medical Center, Fort Sam Houston, San Antonio, TX 78234
- Dr. Nestor Rodriguez, Department of Sociology, University of Houston, Houston, TX 77004

## The Interventions

Between 1988 and 1991, the 19 CASET Consortium institutions conducted interventions designed to encourage American Indian, Black, Hispanic, and female students to pursue SET study and careers. "Intervention" is defined as a research strategy for projects designed to change behaviors and/or attitudes and to produce measurable outcomes. A total of 62 semesters of interventions were conducted, for a total of 3032 students' data. Of these 1650 were intervention-group students and 1382 were control-group students.

A total of 53 of the interventions generated experimental data suitable for project reports, involving 1535 intervention-group students and 1260 control-group students. At the analysis stage, eligibility was determined by a combination of the student's sex, ethnicity/race, and citizenship. All non-U.S. citizens were eliminated, as well as Anglo males, and all Asians. Two data sets were later eliminated because they lacked sufficient information

for effective size calculation, leaving a total of 51 data sets to contribute to the quantitative synthesis of the data, providing data on 1377 intervention-group students and 1129 control-group students.

With the assistance of CASET staff and the Research Team of consultants, each institution developed its own approach to increasing the "pool" of minorities and women in SET study and careers. Each conducted several interventions, each one generally one semester in length; each collected data to measure the effects of those interventions. Data collected come from the institutions' outcome measures developed by them, from CASET protocols (can be found in each of the appendices of the 21 CASET Intervention Reports, Appendix C) and from background information on students, such as transcripts and test scores. All measures were taken on the intervention-group students, as well as on a control-group of students identified by each institution for comparison purposes.

Intervention methods tested by individual institutions included study teams, tutoring, role modeling, group discussions, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats. For example, some established Saturday Academies, some offered Summer Residential Programs, and others chose to incorporate their methods into existing courses and semester schedules.

Student participants ranged from middle school students to college level and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields - American Indian, Black, Hispanic, and women students - were studied in these interventions, with the goal of developing interventions to increase their participation in SET areas.

Informed consent forms were signed by all intervention and control group members (by parent or guardian when the student was below the age of consent in her or his state of residence at the time of the signing).

Institutions were encouraged to develop and improve their consortium interventions in the light of their on-going experiences. In addition to the first July 19-22, 1988 meeting, three project director meetings were held at NASA/JSC: October 31-November 1, 1988; August 2-4, 1989; and August 16-17, 1989. The foci in the meetings were 1) instruction in experimental and/or quasi-experimental research methods, 2) fine-tuning research design through consultation with the CASET research team, and 3) interacting and profiting from each other's experiences.

One semester (in most cases, the first semester) is described in

the CASET Intervention Reports (Appendix C) combined with a summary of findings from the other interventions which the college conducted. Some colleges conducted two different interventions. A financial limit of $25,000 was placed on each individual intervention, with a limit of four interventions per institution. An exception to this was a residential program for two summers - each intervention having a budget of $50,000. (See Appendix D for a summary of all interventions' populations, components and goals.)

**The CASET Database**

The database was started during Phase I as an inhouse tool to help CASET discover what interventions were being conducted and what was known about the problem of the underrepresentation of women and minorities in SET study and careers. Under a Memorandum of Understanding between CASET and NASA, the CASET database is now part of the NASA RECON II system, available to RECON subscribers.

The National Security Agency also supported the maintenance and development of the database. NASA/JSC has demonstrated extensive interest in the database and has supported it and the other research. The Department of Labor provided funds to purchase several hundred dissertations on the subjects of minorities, women, and SET study and careers.

The original work on the database in Phases I and II did not include indexing abstracts of the database entries. Producing abstracts for all early entries is part of the on-going development of the database (see Appendix E for the Abstract Indexing Form).

Description of the database:

- All documents relate to minorities, women and people with disabilities
- All documents relate to quantitative fields
- Focus is on documents which help policy-makers, employers, researchers, foundations, and common concern organizations address the issues and questions of the underrepresentation of minorities and women in engineering, physics, chemistry, mathematics, environmental sciences, earth sciences, computer sciences, and various technologies such as biotechnology
- Focus is on recruitment, retention, performance, and attitudes
- Database contains approximately 3,000 documents including approximately 700 interventions

- Database is mounted on the NASA/RECON national online system and is available to its subscribers

- When complete, it is estimated the database will contain approximately 5,000 documents, including over 1,000 past and current interventions

**Symposia**

As part of its mission, CASET sought to bring together and facilitate networking between people who were already conducting interventions or running programs to encourage the targeted groups.

The strategy for this data-gathering and experience-sharing was a series of six symposia, collaboratively sponsored by CASET and Johnson Space Center. Each symposia was for a specific minority, i.e. two dedicated to American Indians, two to Blacks, one to Hispanics, and one to women. Only one symposium was held exclusively for Hispanic interventions because an Hispanic engineering organization copied the CASET format and NASA collaboration, and held a symposium at JSC in 1989.

The symposia were:

1. The First American Indian Symposium on Science, Engineering, and Technology Careers, May 25-27, 1988

2. The First Hispanic Symposium on Increasing Participation in Science, Engineering, and Technology Careers, August 10-12, 1988

3. The First Annual Black Symposium on Science, Engineering, and Technology Careers, October 12-14, 1988

4. The Second American Indian Symposium on Science, Engineering, and Technology Careers, April 12-14, 1989

5. The Second Black Symposium on Science, Engineering, and Technology and Careers, October 18-20, 1989

6. The Women's Symposium on Science, Engineering, and Technology, October 15-17, 1990

CASET also collaborated with The National Technical Association (NTA) and NASA/JSC to arrange a seventh symposium on April 17, 1993, in Houston, Texas. The NTA works to promote careers for Blacks in science and technology. The agenda included panels, science projects from high school and college students, and corporate displays.

Interviews (see Appendix F for schedule) were conducted with

students to see if the same concerns were reflected as were found through the presentations of the intervention project and research directors who spoke at the symposia.

**On-going Programs**

Through its research prior to this grant, CASET learned of two very successful interventions which were being conducted on a large scale. One was the program of the National Action Council for Minorities in Engineering, Inc. (NACME), and the other was San Antonio Precollege Engineering Program (PREP), initiated and conducted by Dr. Manuel Berriozábal, Professor of Mathematics, The University of Texas-San Antonio.

Analysis of the NACME-scholars data was part of the multifaceted research effort. Investigation of the database revealed that there was no recent data on the factors influencing retention and graduation of minority engineering students. CASET determined that a cost-effective method of gathering this data was to use NACME's networking capability to gain access to minority engineering students.

NACME emerged as a thriving leadership organization when the three organizations with minority engineering concerns consolidated in 1980. NACME has been collecting information for several years on NACME-supported students who receive its incentive grants. The NACME organization had the capability to collect and analyze data, including performance and perceptions, of its student-scholars and graduates - providing another data source for CASET on the barriers and enhancements for minority engineering students.

The research objectives were to gather data on minority engineering students' perceptions of their college experiences and future professional development. CASET and NACME collaborated on these two research objectives 1988 through 1990.

NACME had produced a Pre-College Program Directory of interventions in 1984. NACME updated the Directory, under a CASET subcontract, to provide new intervention data for the CASET database and information for minority students (Appendix G, "Educating Tomorrow's Engineers, a Guide to Precollege Minority Engineering Programs").

San Antonio PREP and CASET collaborated on developing a protocol which PREP program assistants administered to students who dropped out of the summer program, which has been expanded to other Texas cities - becoming known as TEXPREP. Some of the data from the last summer data gathered has been found unreadable thus making the analysis incomplete. The Principal Investigator is trying to recover the diskettes' lost data so that it can be analyzed and a supplemental report prepared.

## BODY

### Method

The methodology of the CASET research project was designed to be appropriate to each of the research areas. Where possible quantitative methods were used as in the analysis of the interventions, the meta-analysis, and the analysis of the on-going programs.

The Consortium colleges and universities sent intervention data to CASET for analysis which was then checked for errors, validity and consistency, and then evaluated. This process was called "greening the data." After analysis, data were compiled individually for each institution in the Intervention Reports. CASET also conducted quantitative syntheses where appropriate.

Meta-analysis, as a technique for quantitatively synthesizing the results of scientific studies which have related outcomes or objectives, is continuing to be more widely used. "Meta-analysis refers to a set of statistical procedures used to integrate the quantitative results of studies that have the same or similar hypotheses. It allows for more precise comparisons between the relative effects of interventions than does a traditional literature review" (Kay, Ramirez, Ilegbodu, and Bahr, 1988).

All students were administered standard Demographic and pre- and post-Opinion Protocols, developed by CASET staff and the Research Team, to measure opinions and attitudes. A meta-analysis was done from data judged to have data evaluated as absolutely valid by the greening process. Based on the factor analyses of over 600 students' responses, five new opinion measures were derived from the original 55 item protocol, reducing the protocol to 40 items. This meant that students were able to complete the protocol faster, and as far as CASET was concerned, the results were the same as with the longer protocol. One of the concerns with collecting the data was that many teachers and project directors objected to the time that the data collection took away from the actual classroom or intervention activities.

The five new opinion/attitude measures were: science attitude, math attitude, academic anxiety, academic motivation, and SET values.

The science attitude was made up of nine items that assessed interest in science careers and classes. The mathematics attitude scale was composed of five items that assessed students' opinions of math courses and assignments.

The academic anxiety scale contained six items that assessed the

level of nervousness, tension, dread, worry, or fear that students had in relation to mathematics (three items), tests (two items), and science (one item).

The academic motivation scale included 11 items that concerned students' perseverance in general (two items), study habits (two items), general interest in studies or school (three items), support from others, e.g. family and counselors (three items), and interest in improved math skills (one item).

The SET values scale included nine items about science and scientists (five items), mathematics (three items), and the relationship between success and ability (one item).

The 15 items removed from the original Opinion Protocol either did not add anything to the scales' internal validity or did not correlate greater than .3 with any of the five factors.

This meta-analysis focused only on adjusted data which allowed the use of post-intervention performance relative to the pre-intervention performance, thereby controlling for pre-existing differences. The modal research design was the quasi-experimental nonequivalent control group design with pre-tests and post-tests for intervention and control groups; the groups were comparable prior to the intervention. The performance measures were selected so as to be appropriate to each intervention's goals. The demographic measures included parental involvement, educational support in the home, and prior involvement in math and science activities. The opinion measures included math attitude, science attitude, academic anxiety, academic motivation, and the value of SET fields and careers. CASET staff analyzed the results of the interventions with valid data and the results were synthesized via meta-analysis. Meta-analysis uses an effect size statistic which has been defined by Cohen (1977) as the degree to which a phenomenon is present in the population. The measure of effect size summarized the advantage of the intervention in standard units - the proportion of one standard deviation; as a rule of thumb, small effects were .2, medium effects were .5, and large effects were .8 (ibid).

The interventions were separated by academic level (middle school, high school, and college), and within each level, the mean effect size was determined for math and science performance and the five attitude measures, adjusting for pre-intervention scores.

The mean weighted effect size was determined based on procedures described by Hedges and Olkin (1985) and implemented in DSTAT software (Johnson, 1989). If the set of effect sizes was heterogeneous, the largest effect size was reached. If the homogeneous, weighted mean effects size was significantly different from zero at $p = .05$, it is indicated by an asterisk.

The mean effect sizes of 32 college interventions, adjusting for pre-intervention scores, were:

| | | |
|---|---|---|
| Math performance | = | .01 (based on 22 of 29 effect sizes) |
| Science performance | = | .40* (based on 8 of 10 effect sizes) |
| Math attitude | = | - .04 |
| Science attitude | = | - .07 |
| Academic anxiety | = | - .03 |
| Academic motivation | = | - .06 |
| SET value | = | .04 |

The mean effect sizes of the five high-school interventions, adjusting for pre-intervention scores, were:

| | | |
|---|---|---|
| Math performance | = | - .54 (based on 1 of 2 effect sizes) |
| Science performance | = | 1.22* (based on 3 of 3 effect sizes) |
| Math attitude | = | .11 |
| Science attitude | = | .18 |
| Academic anxiety | = | .12 |
| Academic motivation | = | .26* |
| SET value | = | .03 |

The mean effect sizes of the 10 middle-school interventions, adjusting for pre-intervention scores, were

| | | |
|---|---|---|
| Math performance | = | .70* (based on 7 of 9 effect sizes) |
| Science performance | = | .92* (based on 4 of 7 effect sizes) |
| Math attitude | = | .12 |
| Science attitude | = | .23* |
| Academic anxiety | = | - .01 |
| Academic motivation | = | - .05 |
| SET value | = | .07 |

Methodology for transferring the PC software, "INMAGIC," which CASET used to index documents for the database, to the NASA RECON system was jointly developed by CASET and the NASA Scientific and Technical Information (STI) branch. A program was written which "translated" INMAGIC into RECON-compatible language.

The methodology for the symposia planning was to organize symposia that focused on interventions for only one minority group, rather than lumping all groups together in a symposium under the rubric "minority." Given that caveat, all participants in each symposia represented interventions on all educational levels (academic and vocational).

The methodology for the NACME data gathering was a collaborative effort between CASET, NACME, and Minority Engineering Program (MEP) Directors of universities participating in the NACME incentive

grants program. The data collection protocol was designed by NACME and the MEP personnel and approved by CASET. A representative sample of 25 colleges and universities receiving NACME incentive grants was invited to participate with CASET and NACME, in a meeting held at JSC on March 24, 1988. A detailed discussion of the research plans and a critique and revision of draft protocols were the agenda for the meeting. Thereafter, NACME was responsible for drafts sent to all participants for suggested changes and approvals by all involved.

The institutions' MEPs distributed 3,070 protocols. 1,312 protocols were returned, and 1,206 usable ones from 64 institutions were included in the analysis. All respondents were enrolled full-time in engineering B.S. programs accredited by the Accreditation Board for Engineering and Technology (ABET).

**Results**

The CASET study strengthens the DoD capacity to recruit and retain minorities and women for SET occupations....through providing knowledge and tested interventions on barriers to success.

Each semester of usable data from the interventions provided a project report. A full case study was prepared from the first intervention (in most cases), and all each institution's interventions were included in the CASET Intervention Report - a summary of the findings of all its research. In two instances, a university had two different interventions, therefore Wilberforce University and Western New Mexico University each have two project reports (see Appendix C for 21 Intervention Reports).

Western New Mexico University conducted one of the most successful programs, "Science in the Field" for high school students. CASET prepared a handbook so this intervention can be replicated by others (see Appendix H for "CASET FIELD-TESTED MODULE: Science in the Field").

"Tips for Project Directors" is another module (Appendix I) which covers information and insights learned from project directors' verbal reports at Consortium meetings. Texas A&I University (now renamed Texas A&M University-Kingsville) produced the module, "Fun d'mental Physics Laboratory Manual" (Hewett and Schruben, 1990) (Appendix J).

In the meta-analysis, because the college interventions had not enhanced math performance or math attitude when considered all together, the interventions were separated to examine the relative success at enhancing math attitude or math interventions compared to the science interventions or the math-science combination. For the interventions with only mathematics as the focus, the mean effect size for math attitude was -.06; for interventions with math and another focus, the mean effect size was -.08; but for

interventions with no math focus, i.e., primarily science and engineering content, the mean effect size for math attitude was .23! This positive effect on math attitude was important; in models such as Eccles' (1983), the value of math for students was the best predictor of their intention to take more mathematics.

One result of the CASET database research effort was the handbook jointly developed by NASA/STI and CASET to be sent to RECON subscribers, describing the contents of the database and how to access them (Appendix K). Several hard copies of the entire database were distributed (1988, 1990); the latest, 1995, can be found in Appendix L.

The CASET database, through INMAGIC software, has the capability to be sorted into particular areas of interest, suitable for specialized bibliographies. Prior to working with the Consortium institutions on their intervention design, CASET prepared an analysis of the 289 interventions then on the database to use as an internal guide (Appendix M). Of the interventions, recruitment was the most common purpose (25 percent), followed by performance and information or awareness (14 percent each).

Two other specialized bibliographies were produced:

- A bibliography of intervention programs, sorted by population groups (American Indians, Anglos, Blacks, Females, Hispanic, and Mixed Ethnic Groups); by subject areas (basic skills, biotechnology, chemistry, computer science, engineering, environmental science, geology, mathematics, non-traditional careers, physics, science, technology); and by educational level (below 9th grade, graduate school, high school, professional, undergraduate, and vocational/technical) (Appendix N). Many interventions will of course be listed under several headings.

- A bibliography of gender-differentiated research, "Gender Differences in Mathematics and Science Performance: A Bibliography" (Appendix O).

The results of the jointly-sponsored CASET/NASA symposia were proceedings. The format allowed each presenter to describe their intervention or research. Most speakers mention difficulties encountered as well as giving their findings. Many of the presenters were the actual directors of interventions. One of the benefits of the symposia was the exchange of expertise between people with "hands-on" direct impact on minority and female students. Symposia proceedings can be found in Appendix P.

The interviews were only intended to confirm to CASET researchers that they were on track, and some eventually will be transformed into case studies for the database.

The results of the NACME data collection, as analyzed and interpreted by Friedman and Kay (1990) showed that student commitment to the university has a significant influence on academic performance. Minority presence on campus - either students or faculty - also contributed significantly to student success. The analysis also found that non-minority faculty can have a positive influence on student performance when they are perceived as helpful. High school grades, SAT-mathematical scores, perceived precollege preparation, and clear understanding of what is expected in college are all related to student success. Previous to this research, perceived and actual academic performance have been related to student success in engineering programs, but not specifically with minority groups. Additionally, the impact of the major support system for maintaining minority students in engineering, the MEPs, has not been widely investigated.

## Discussion

In the meta-analysis, the science interventions enhanced performance significantly at all three academic levels. These enhancements ranged from medium effects at the college level to large effects at the middle school and high school level. The other successes of the interventions were to enhance mathematics performance and science attitude at the middle school level. Based on these results, one would conclude that both mathematics and science interventions at the middle school level have the greatest positive effects on performance and attitudes; high school interventions enhance science performance and some opinions (to a smaller degree); but at the college level science interventions are more successful than mathematics interventions and their success is enhancing science performance and mathematics attitudes.

Consistent with prior research studying non-minority samples (Kay et al., 1988), college level mathematics interventions failed to enhance math performance and math attitudes. This finding suggests that college teachers are more effective at enhancing science performance than at enhancing either mathematics performance or mathematics attitudes. Fortunately, the most surprising finding was that science interventions enhanced the mathematics performance or mathematics attitudes of college students. Speculatively, these science interventions seemed to have justified the importance of mathematics for these students, and interventions that teach applied mathematics via science seem promising for attracting students to quantitative fields.

These results indicate that something is dramatically and critically wrong with the teaching of mathematics. Either the teachers are incompetent or, and this seems more likely, they are uninterested in the subject. The data suggest that what is wrong with American students who cannot seem to learn mathematics is not their ability, but the inability of some teachers to motivate

students into learning.

Meta-analytic findings raise important questions which could be answered by a long-term follow-up of the students from the CASET interventions:

1. What is the relationship (statistically speaking) between the ability of the student to learn mathematics and the attitude/skill/personality/knowledge of the teacher?

2. What are the long-term effects of these interventions, especially those interventions at the middle school level that seem most promising?

3. What are the long-term performance implications of the short-term attitude changes? If a science intervention enhances mathematics attitude, will the person behave differently, e.g., choose more quantitative courses later in her/his academic career?

There is no doubt that mathematics is the greatest barrier to pursuing SET study in an academic setting. Sells (1973) has called mathematics the "critical filter." Although we did not study vocational institutions, it is suggested by our research that more "hands-on" learning such as that provided in vocational programs might benefit students in a more academic setting. Mathematics is viewed more positively and performance sometimes improves when combined with science. Science may give a rationale to students for studying mathematics whereas abstract formulae and calculations seem to have no real life application.

The same support mechanisms for minorities and women are needed both in school and in the career. Because of the non-traditional aspect at this point of SET careers for most minorities and women, they do not have the self-esteem, self-confidence, or persistence that it takes to continue to push against the barriers which do exist. Most professors of SET subjects in universities are either Anglo males or Southeast Asian males. There is much anecdotal and interview information about their negative attitudes toward women in general spilling over into the classroom, teaching assistantships, research assistantships and counseling. The minority women seem less able to cope with both teachers' negative attitudes and the difficulty of the curricula without some strong support systems in place.

The more the students learn in middle school and high school about what is required to perform well in a SET subject, the more comfortable they are with college. Programs such as the PREP (Berriozabal, 1988) programs or MESA (University of California, 1986) do work. A strong system is where a university or college works with schools from kindergarten on up, helping to locate sources of financial aid for the student as well as providing

academic support for mathematics and science. This kind of advance planning gives the student a confidence that if in fact they do well, there will be money later for college. Minority students tend to be more disadvantaged financially than Anglo students, so families are not able to help as much as they would like. The interviews found that, particularly with Hispanic parents, the desire is for their children to "be happy" and "do what they want to do," but they do not actively push them in the direction of higher education, particularly if it means leaving the family home.

The financial side of education needs to be emphasized by counselors in a positive and documented way, instead of just saying "scholarships are available." The advantage of the on-going summer programs such as the MESA programs is that financial planning for college is built into most of them.

The CASET database produced by this Study can provide knowledge and strategies to strengthen the present programs of the DoD to support students in their study of SET subjects. Additionally, the database documents can provide greater understanding of educational and career choices which can be of benefit to future applied research programs involving minorities and women. School counselors need to learn how to access the database.

Not surprisingly, program directors of interventions have a lot to do with the success and effectiveness of programs. One criterion of program success frequently was having a direct channel to higher authority in order to control resources and facilities. Successful programs also tended to have directors who were directly involved with the program rather than delegating day-to-day control to subordinate personnel who might be less motivated and enthusiastic as well as understanding program objectives less well.

## CONCLUSIONS

Solutions must do five things: change choices, remove barriers, increase persistence, expand participation, and eliminate stereotypes and stereotypical thinking.

The "pipeline" should become a system. A useful metaphor is that of the transportation system in America. A destination has many ways to be reached: interstate highways, state highways, state roads, county roads, city freeways, city streets/boulevards/ avenues, sidewalks, rail mass transit, railroads, airlines, waterways, hiking and biking trails - and any combination thereof. On top of that, there are all the different methods of using the system: cars, busses, recreational vehicles, bicycles, walking, private rail cars, private planes, a variety of boats and ships, and many, many other and more creative ways. The list could go on and on.

In education and training, the destination is a job - <u>not</u> just a

degree or certificate or license. Those are the means of reaching the destination. The methods of using the using the system are the varieties of educational institutions - from kindergarten through community college and vocational training schools through four-year colleges and graduate institutions to places for post-post-graduate specialized training, internships and apprenticeships.

In a system, there can be more than one pathway and many connections, whereas a pipeline implies moving along a rigid assembly line. No wonder there is such a high dropout rate from the SET "pipeline" for women and minorities. The less financially secure a student is, the more "detours" he or she may have to make on the way to the destination. However, that need not mean that the person never reaches the destination if the detour can be turned into a positive experience and not a dropout disaster.

The institutions and faculty who prefer the "pipeline" method are not flexible in their thinking nor their "standards," nor supportive of students who are not able to "fit" into the pipeline time frame. Conventional wisdom says American education is in trouble, particularly when measured against the performance of other developed nations' students and particularly in mathematics and science. Instead of looking at education as a rigid kind of production line, policy makers should insist that educators take a metaview focusing on the end result of education. Policy makers should institutional the kind of cultural changes which allow for individual and creative paths to jobs in the workforce. Certainly, one prime destination for America's minorities and women should and can be SET jobs and careers with a potential for advancement.

Minorities and women who have such high dropout rates from the "pipeline" need "enablers", i.e. strategies which allow them to proceed towards the job market in a manner which fits their situation - taking into account their sex, age, race/ethnicity, culture, family including children, and anything else which is a structural part of their lifestyle. Faculties and administrative staff (particularly in majority institutions) could benefit from cultural training programs where they are exposed to mind- and attitude-stretching knowledge about the values, traditions, and behaviors of other cultures, races, and ethnicities.

The CASET solution would provide the needed qualified professional SETs without resorting to an increased dependency on foreign nationals. By 1996, this unrecognized threat to American employment had become very real. It is a point of discussion whether or not there is a shortage of engineers and other scientific and technical personnel, there is no doubt that there remains a shortage of women, American Indians, Blacks, and Hispanics in the American SET workforce - as compared to their percentages of representation in the total national population and labor pool. Their underrepresentation has become a critical

national issue which affects the supply and demand of labor as America passes into the 21st century.

Demographics are driving the culture change which is restructuring the American workforce. Priorities have to be reset as it becomes increasing apparent that schools are not educating youth (particularly minority youth) for the future occupational demands. Is the role of public education to provide a technologically, scientific, numerically literate population? If the answer is yes, then what are the implications of and for an increasingly diverse and immigrant population?

The human resources of the United States are a primary asset; and arguably, the most important of these resources is the SET workforce. The development of these human resources is needed to ensure that every available segment of the American population can become a part of the "high tech" society - if not by achieving the amount of education and training necessary to perform a SET job, then at least by receiving the lesser amount necessary to become scientifically literate and mathematically numerate.

The responsibility of business and industry cannot be overemphasized. Since they will be among the primary beneficiaries through being able to draw on a highly trained and scientifically and technologically competent workforce, they should contribute accordingly. "Partnership" is currently the hot concept for cooperation between the sectors of government, education, business, and industry. Yes, forming partnerships can help all sectors to achieve national educational excellence with concomitant high productivity and low unemployment. However, the incentives for industry need to be bottom-line ones so that companies have the sufficient financial resources to be active partners.

Since the jobs will be coming from industry and business, they are perhaps the most qualified sector to conduct learning and training interventions for that part of the SET workforce and potential SET workforce who most need support and encouragement - minorities and women.

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Baseline reports; research proposals; catalogs; bulletins

**Bibliography of all publications and meeting abstracts:**


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# APPENDIX A

# CONSORTIUM PROPOSAL GUIDELINES

# CASET

Center for the Advancement of Science, Engineering, and Technology
of Huston-Tillotson College

Dr. John Q. Taylor King, Chair
Major-General, AUS-Ret.

Dr. Nina W. Kay
Principal Investigator
Research Professor

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## GUIDELINES FOR PROPOSALS TO CASET

### PURPOSE OF GUIDELINES

The Center for the Advancement of Science, Engineering and Technology (CASET) has requested proposals for intervention projects designed to increase the pool of American Indians, Blacks, Hispanics and women in science, engineering and technological (SET) studies and careers. This request is consistent with the CASET's grant from the Department of Defense to conduct research related to the underrepresentation of the above mentioned minorities and women in the SET areas.

Participants of the CASET consortium, all of which are two or four year higher education institutions, have agreed to assist CASET in the collection of data for the research. The areas of interest are the quantitative sciences, including mathematics, chemistry, physics, computer science, bio-technology, environmental sciences, and engineering.

The following guidelines are provided in order to assist the consortium participants in the preparation of their proposals. Participants are requested to follow the format provided in the Table of Contents. Interventions are to be implemented for a two-year period. The two-year period will consist of four semesters or a combination of summer, fall, and spring semesters. All projects must be completed by December 31, 1990.

Deadline for submission of proposal: October 1, 1988

Contact: Ms. Muriel C. Vaughn (Phone) 713-483-9313
Assistant for Field Test Research

Mail Proposals to: CASET c/o NASA/Johnson Space Center
2101 NASA Road One, Bldg. 7A, #323
Houston, TX 77058

DEFINITIONS

1. Baseline Report

The Baseline Report was requested from each institution as one phase of the planning activities. It outlines relevant accomplishments of the institution which are related to CASET purposes and goals, including the numbers of students who go into SET majors. Details to be included may be found in the memo: Schedule of Planning Activities for Consortium Participants.

2. Concept Paper

The Concept Paper, also requested as part of the planning activity, summarizes the proposed intervention indicating its conformity with the institution's past, current, and future initiatives and philosophy as reflected in the baseline report.

3. Focus

Focus is the area of concentration of the intervention, i.e., recruitment, improvement of performances, retention.

4. Objectives

Objectives are concrete expectations related to the focus or foci of the program. They reflect the expected changes in the specific target population.

5. Sources of Data

Sources of data include students, parents, faculty, counselors, program staff, institutional officers, individuals associated with program operation, and institutional records, e.g., transcripts, test scores, and attendance records.

6. Identification

Identification refers to the identification of students with potential for achieving in SET fields and is considered a prior activity to recruitment, retention, and improvement of performance.

7. Recruitment

Recruitment consists of motivating, attracting, encouraging and influencing students to go into SET fields. Recruitment can be passive or active, ranging from mass mail-outs to individual personalized contact.

8. Retention

Retention involves keeping students in SET fields.

9. Improvement of Performance

Improvement of performance refers to measurable improvement of academic achievement or abilities.

10. Outcomes

Outcomes of the intervention are results stated in measurable terms, whether academic or non-academic, e.g., attitudes, expectations, aspirations, and/or self-concept.

TABLE OF CONTENTS FOR PROPOSAL

1. Introduction and Background Information on Institution

2. Summary

3. Focus

4. Objectives

5. Population

6. Components of the Program

7. Intervention Design

8. Monitoring

9. Outcomes

10. Evaluation

11. Personnel

12. Budget

## INTRODUCTION AND BACKGROUND INFORMATION ON INSTITUTION

Consult your baseline report for information to be included here. This information should include a description of the institution's student body, its location and its status as related to SET studies and careers.

Provide a brief historical review of the institution and state what its objectives and philosophy are with regard to SET programs.

SUMMARY

Prepare an abstract or executive summary of the intervention. Include a statement of the problem the intervention is intended to address and identify how it is consistent with policies and goals of your institution. State concisely the need for your program on your campus. Comment on the reasons for the selection of this intervention as opposed to others which might have been undertaken.

FOCUS

Specify what the focus of the intervention will be. Is it recruitment, retention or improved performance? (Bear in mind that identification of students with potential for SET fields will be considered a prior activity for all three foci.) Within these broad foci, state the educational level, e.g., (precollege, college) and subject area as appropriate. Consideration should be given to the possibility of work study and internship programs. The focus should be consistent with the stated goals and philosophy of the institution.

Confine subject areas to the quantitative sciences: mathematics, chemistry, computer science, physics, biotechnology, environmental sciences, and engineering.

If the CASET intervention is to be a component of a larger project which has been proposed by the institution or is currently underway, identify the aspect of the program which is to be isolated for funding, monitoring, evaluation, and data collection by CASET.

POPULATION

State the number of persons to be served each semester or summer session, broken down by age, sex, ethnicity, and educational level. Note if they are academically disadvantaged students, "second tier" students, high ability students, dropouts, etc. Indicate what portion of the total eligible population is being served. Refer to your baseline report for relevant statistics which should be included here.

Note whether or not the population to be served remains the same during the two year period. If not, indicate how the population will change. State the rationale for the change.

If the intervention subjects are teachers, counselors, or other employees, indicate the grade level taught by the teacher or the level of the employee in the company's organizational structure.

OBJECTIVES

Outline the concrete expectations as related to the focus or foci of the program. These objectives should reflect the expected changes in the specific target population and should include the field of study. Below are examples of objectives stated in measurable terms:

1) Recruitment

a) Precollege:

To motivate American Indian students to take more and higher level science and math courses

To encourage female students who are proficient in math to take higher level math courses

b) College:

To get minority students who have undecided or non-SET majors into SET majors

To increase the number of Hispanics women selecting physical science majors.

The following objectives reflect the initial stages of recruitment:

* To heighten students' awareness of opportunities in nontraditional careers
* To favorably change students' attitudes toward math and science

2) Improvement of performance

a) Precollege:

To improve the science grades of minority and female students in middle school

To reduce math anxiety and enhance math achievement in female students.

b) College:

To provide Black students with skills in working with personal computers

To employ an audio-tutorial system of learning to prepare academically disadvantaged college students for the study of chemistry.

3) Retention

a) Precollege:

To keep minority and female students in the math and science academic track

b) College:

To keep minority students and women in SET majors

To increase the number of women and minority engineering graduates

PROGRAM COMPONENTS

Identify and describe the activities through which the objectives of the program will be accomplished. The following examples do not constitute an exhaustive list:

Role modeling:

A talk given by a female engineer to high school female students relating her personal experiences and explaining opportunities for women in engineering

Counseling:

Academic guidance for minority students encouraging them to complete high school courses required for entry into a school of engineering

Program to reduce math anxiety in females

Instruction/Tutoring:

Precollege physics course to prepare students for the first year of college

A six-week tutorial in college algebra to supplement regular classes

Information:

Career day presentations, workshop lectures, and handouts to increase students' awareness of opportunities and requirements for SET careers

Support group:

Assistance from peers such as tutoring, motivating, counseling, and helping with studies

INTERVENTION DESIGN

State the criteria for selecting the sample from the target population that will be participating in the intervention. Such criteria might include socioeconomic status, GPA, financial needs, and so on. Describe specifically the comparison/control group, including detailed information about ethnicity, sex, and educational level. Discuss how the comparison/control group is similar to and different from the group receiving the intervention. Explain how you will decide who will be in each group.

MONITORING

Design a timeline which includes deadlines for the intervention activities and for the collection of data. The timeline should relate directly to the intervention design.

This section should be completed for at least one semester to the extent possible. (The details will be included in the services agreement and coordinated with the payment schedule.)

State the concrete indicators which will show that the program is proceeding as planned. For example, if the program is to select students and enroll them in a remedial mathematics course as preparation for a science course, then concrete indicators might be a list of students selected; evidence they have enrolled in the Math course, and evidence they had enrolled in a subsequent science course.

At a minimum, there should be 3 indicators - one at the beginning, one in the middle, and one at the end. CASET will be sending baseline instruments to obtain the students' background and demographic information and will indicate the date by which data needs to be received.

OUTCOMES

Define the expected results of your intervention and indicate how these results will be measured. Identify both long-term and short-term outcomes. List outcomes beyond student-related variables, such as modification of institutional policies, and changes in professors', counselors', and parents' attitudes.

Send along with the proposal any instrument you have to measure your intended outcomes, and justify the selection of this instrument. If you do not have any valid measurement instrument, CASET will provide an appropriate one according to the specification of your intervention.

Examples of measurable outcomes:

Middle school: Enrollment in an academic track
Improvement of grades in math and science
Changing attitudes towards math

High school: Improvement of grades in math and science
Number of advanced courses taken in math and science

College: Enrollment in SET majors
Graduation in SET majors
Improvement of grades in SET courses
Matriculation from two-year college to four-year college in SET majors

## EVALUATION

CASET is developing an evaluation plan for each program and for the consortium as a whole. As soon as this plan is developed, it will be shared with you. In the meantime, if you have a plan for evaluation, please include this in your proposal.

PERSONNEL

Give the name, title, and a brief statement of the pertinent experience of the principal project director and any other key personnel. Include resumes in an appendix.

State briefly what the role of each staff person will be and the portion of his or her time that will be devoted to the intervention project. Justify the portion of times allocated.

BUDGET

Itemize the budget per semester or summer session. The maximum amount available for any intervention per semester is $25,000. Payments to the institution will be made in installments tied to the timeline. The service agreement negotiated with each institution will spell out the payment schedule.

Unallowable costs as mandated by the Department of Defense are (1) the purchase of equipment and (2) the payment of stipends to students for participation in the intervention project.

List all position titles such as director, assistants, secretary, consultants, etc. with salary and percentage of time spent on the intervention project.

Itemize operating expenses; list essential travel, services, and other items as necessary. Include an item for travel to CASET offices at least once during each semester.

While it is not a Department of Defense mandate, it is desirable and in the best interest of students that staff filling key positions be familiar with the institution, its goals and philosophy, and its students.

# CASET

Center for the Advancement of Science, Engineering, and Technology
of Huston-Tillotson College

Dr. John Q. Taylor King, Chair
Major-General, AUS-Ret.

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TO: Consortium Participants

FROM: Nina W. Kay, Ph.D.

SUBJECT: Schedule of Planning Activities for Consortium Participants

CASET is inviting your participation in a research project to determine and test the factors which influence minorities and women in their choice of quantitatively-based careers such as computer science, mathematics, engineering, physics, chemistry, and the environmental sciences.

A significant aspect of this research involves designing, implementing, and evaluating intervention programs in these high tech areas for underrepresented minority groups of Blacks, American Indians, and Hispanics.

Following is a planning schedule overview of preliminary activities for Consortium colleges and universities:

1. Preparation of a Baseline Report, giving:

   (a) past and present programs of the institution regarding recruitment, selection, performance, and retention;

   (b) numbers of students with majors in the quantitative subjects of interest (by sex, ethnicity, race and citizenship) for the past two years or longer if the information is available;

   (c) research projects, grants, or other funded programs which relate in any way (past and present);

   (d) plans for the future or objectives and goals which are relevant in any way;

   (e) any other pertinent information you would like to give us.

Upon receipt of this report, CASET will forward a check for $1,500.00 to the college or university.

2. Subsequent to a telephone discussion or visit with a CASET representative, the institution will write a Concept Paper describing an intervention program they would like to conduct, with a focus relevant to the overall research questions addressed by CASET (attached). An overall budget figure should be included, on a one-semester (or one quarter) cost estimate basis.

   Upon receipt of this Concept Paper, CASET will forward a check for $1,500.00 to the institution.

3. Subsequent to a telephone discussion or visit with a CASET representative, the university or college will prepare a Proposal describing in detail how the intervention will be conducted. The Proposal should contain a time line or schedule and a detailed budget. The intervention would first be implemented in the fall of 1988. Consortium members would then have two interventions per year funded, for a total of 4 semesters. Interventions may remain the same or change. Summer programs can be implemented but if the cost includes residence (meals and lodging) it may be necessary to fund one summer program rather than 2 semesters.

   Data will be collected according to CASET specifications and CASET will supply all data collection instruments. CASET will analyze the data and provide Consortium members with research results and reports.

   Upon receipt of the proposal, CASET will forward to the institution a check for $2,000.00, five hundred of which is meant to cover the cost of attending a Consortium Conference at NASA/Johnson Space Center July 20, 21, and 22, 1988. The agenda will cover research design, goals and objectives, and allow for the exchange of information and ideas.

If you have any questions, please contact CASET at Johnson Space Center (713) 483-9313. Thank you.

NWK/lt

Attachment

# APPENDIX B

# CONSORTIUM MEMBER CHRONOLOGIES

**ALABAMA STATE UNIVERSITY**
915 South Jackson Street
Montgomery, Alabama 36195
Telephone: 205-293-4100

**PRESIDENT:** Dr. Leon Howard
**PROJECT DIRECTOR:**
Dr. Wallace Maryland, Chair
Department of Mathematics and
Physical Sciences

**FOCUS:**
The foci of this intervention are recruitment, retention, and improved performance. It will take place during the spring semester and summer session of 1989 and will serve 25 high-ability freshmen enrolled in the institution.

**VISIT:**
**4-8-88**

The initial visit was made by Ms. Muriel C. Vaughn. She met with the following:
Dr. Shiva P. Singh, Professor/Director of the Science Center;
Dr. Susanta K. Ghoria, Professor of Physics;
Dr. Washington L. Taylor, Associate Professor of Mathematics;
Dr. K.H. Kim, Professor of Mathematics;
Dr. Vera K. Varner, Associate Professor of Biology;
Dr. Robert Polk Thomson, Dean, College of Arts and Sciences;
Dr. Roosevelt Steptoe, Vice President for Academic Affairs;

Prior to the visit, a letter dated March 9, 1988 was sent by Dr. King to Dr. Howard requesting the appointment and briefly describing CASET. Calls were were made by Ms. Vaughn following the meeting in order to answer questions raised by Dr. Steptoe.

**LETTER OF INTENT:**
**4-8-88**

The Letter of Intent, indicating the President's willingness to participate in the Consortium, was signed by the President on April 8, 1988.

**CONSORTIUM MEETING LETTER:**
**6-27-88**

A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to the Project Director.

**BASELINE REPORT:**
**7-1-88**

The Baseline Report was received in the CASET office on July 1, 1988.

**BASELINE REPORT CHECK:**
**7-5-88**

A check in the amount of $1,500 for the Baseline Report was sent to the Project Director on July 1, 1988.

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| **CONCEPT PAPER:**<br>**7-22-88** | The Concept Paper was received in the CASET office on July 22, 1988. |
| **CONCEPT PAPER CHECK:**<br>**8--16-88** | A check in the amount of $1,500 for the Concept Paper was sent to the Project Director on August 16, 1988. |
| **CONSORTIUM MEETING:**<br>**7-20-22-88** | The Consortium Meeting was held at Johnson Space Center on July 20-22, 1989. The institution's representative was Dr. Chai-Fu Pan. |
| **PROPOSAL:**<br>**8-16-88** | The Proposal was received in the CASET office on August 16, 1988. |
| **PROPOSAL CHECK:**<br>**8-30-88** | A check in the amount of $2,000 for the Proposal and travel to the Consortium Meeting was sent to the Project Director on August 30, 1988. |
| **PROPOSAL COMMENTS:**<br>**8-23-88** | The Proposal was reviewed by CASET staff (Ms. Linda Chappell, Dr. Adesua Ilegbodu, Ms. Muriel Vaughn) and CASET consultants, Dr. Larry Hedges and Dr. Harris Cooper. Comments were consolidated by Ms. Vaughn and sent to the Project Director for purposes of revision on August 23, 1988 after review and approval by Dr. Nina Kay, the Principal Investigator. |
| **REVISED PROPOSAL:**<br>**9-13-88** | The revised Proposal was received in the CASET office on September 13, 1988. |
| **REVISED PROPOSAL COMMENTS:**<br>**12-2-88**<br><br>**12-16-88** | The revised Proposal was reviewed by Ms. Chappell, Dr. Ilegbodu, Ms. Mary Ochoa, and Ms. Vaughn on December 2, 1988. The comments were consolitated by Ms. Vaughn. They were mailed to the Project Director on December 16, 1988 upon the review and approval of Dr. Kay. |
| **PROPOSAL ADDENDUM:**<br>**12-28-88** | The Addendum to the Proposal was received in the CASET office on December 28, 1988. |
| **SERVICES AGREEMENT:**<br>**1-18-89** | The Addendum was incorporated into the Services Agreement and two originals were sent to the Project Director on January 18, 1989. |

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| **FUNDING LETTER:**<br>**1-19-89** | A letter dated January 19, 1989 indicating that CASET funding had been approved and clarifying the Consortium funding process was sent to the Project Director by the Principal Investigator. |
| **SIGNED SERVICES AGREEMENT:**<br>**1-30-89**<br>**2-7-89** | The Services Agreements were signed by the President, Dr.Leon Howard, and Project Director January 30, 1989 and received in the CASET office on February 7, 1989. |
| **FINAL SERVICES AGREEMENT:**<br>**6-5-89**<br>**6-21-89** | The Final Services Agreements with the Addendum for the Spring Semester were signed by the President and the Project Director on June 5, 1989. They were signed by Dr. Kay on June 21, 1989. One original was sent to the Project Director and the other was filed in the CASET office. |
| **INITIAL PAYMENT:**<br>**6-26-89** | A check in the amount of $25,000 for Initial Payment for the institution's Summer 1989 CASET Research Project, was sent to the Project Director on June 26, 1989, pursuant to the terms of the Services Agreement. |
| **PRE-BASELINE DATA INSTRUMENTS:**<br>**7-17-89** | The Pre-Baseline Data Instruments were sent to the Project Director on July 17, 1989. Included in the packet were the following: Pre-Baseline Data Instruments Consent Forms for the Intervention and Comparison Groups, Standardized Test Scores Reporting Forms, Instructions for the Project Director and the Project Director Protocol. |

**BENEDICT COLLEGE***
Harden and Blanding Streets
Columbia, South Carolina, 29204
Telephone: 803-253-5199

**PRESIDENT:**
Dr. Marshall C. Grigsby
**PROJECT DIRECTOR:**
Dr. Kenneth Alston
Director, Center for
Mathematics and Science

**FOCUS:** The focus of the intervention is retention. The intervention will be the implementation of a computerized program, Mathematics and Science On-Line Network (MASON) in college algebra, a required course for SET majors during the freshman or sophomore year. The first semester (September-December, 1988) will be start-up. The full scale intervention will take place in Summer, 1989.

**VISIT:**
**4-6-88**

The initial visit was made by Ms. Muriel C. Vaughn. She met with the following people on April 4, 1989:
Dr. Robbie Bateman-Chandler, Director of Grants and Research;
General Robert B. Solomon, Vice-President for Institutional Advancement;
Mr. Wayne Sumpter, Director of Financial Aid;
Dr. Juanita Scott, Director of Summer Science Enrichment Programs
Dr. Kenneth Alston, Director C-MAS

Prior to the visit, a letter dated March 9, 1988 was sent by Dr. King to Dr. Grigsby asking for an appointment and briefly describing CASET. Calls were made by Ms. Vaughn following the meeting to answer questions raised by Dr. Alston and Dr. Bateman-Chandler.

**LETTER OF INTENT:**
**4-15-88**

The Letter of Intent, indicating the President's willingness to participate in the Consortium, was signed by the President on April 15, 1988.

**CONSORTIUM MEETING LETTER:**
**6-27-89**

A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to Dr. Alston.

**BASELINE REPORT:**
**16-88**

The Baseline Report was received in the **5-**CASET office on May 16, 1988.

**BASELINE REPORT CHECK:**
**5-25-88**

A check in the amount of $1500.00 for the Baseline Report was sent to the Project Director on May 25, 1988.

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| **PROPOSAL:**<br>**6-5-88** | The Proposal was received in the CASET office on June 5, 1988. |
| **CONCEPT PAPER:**<br>**6-13-88** | The Concept Paper was received in the CASET office on June 13, 1988. |
| **CONCEPT PAPER CHECK:**<br>**6-22-88** | A check in the amount of $1500.00 for the Concept Paper was sent to the Project Director on June 22, 1988. |
| **PROPOSAL CHECK:**<br>**7-8-88** | A check in the amount of $2000.00 for the proposal and travel to the Consortium Meeting was sent to the Project Director on July 8, 1988. |
| **CONSORTIUM MEETING:**<br>**7-20-22-88** | The Consortium Meeting was held on July 20-22, 1988. The institution's representative was Dr. Kenneth Alston. |
| **PROPOSAL COMMENTS:**<br>**8-23-88** | The Proposal was reviewed by CASET staff (Ms. Linda Chappell, Dr. Adesua Ilegbodu, Ms. Muriel Vaughn), CASET consultants, Dr. Harris Cooper and Dr. Larry Hedges. Comments were consolidated by Ms. Vaughn and sent to the Project Director for purposes of revision on August 23, 1988, after review and approval by the Principal Investigator, Dr. Nina Kay. |
| **REVISED PROPOSAL:**<br>**9-6-88** | The Revised Proposal was received in the CASET office on September 6, 1988. |
| **PRE-BASELINE DATA INSTRUMENTS:**<br>**10-21-88** | The Pre-Baseline Data Instruments were sent to the Project Director on October 21, 1988. However, subsequent changes agreed to by CASET and Benedict College waived the requirement of Pre-Baseline Data for this phase of the intervention. |
| **REVISED PROPOSAL COMMENTS:**<br>**11-2-88** | The Revised Proposal was reviewed by Ms. Chappell, Dr. Ilegbodu, Ms. Ochoa and Ms. Vaughn and CASET consultants Drs. Hedges and Cooper. The comments were consolidated by Ms. Vaughn and sent to the Project Director on November 2, 1988. |
| **PROPOSAL ADDENDUM:**<br>**11-11-88** | The Proposal Addendum was received in the CASET office on November 11, 1988. |

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| **SERVICES AGREEMENT:**<br>**11-15-88** | The Proposal Addendum and the Proposal were incorporated into the Services Agreement and signed by the President, Dr. Grigsby, the Project Director, Dr. Alston and the Principal Investigator, Dr. Nina Kay on November 15, 1988. |
| **INITIAL PAYMENT:**<br>**11-22-88** | A check for the Initial Payment in the amount of $12,332.00, pursuant to the terms of the Services Agreement, was sent to the Project Director on November 22, 1988. |
| **ALTERED SCHEDULE:**<br>**3-7-89** | A letter dated March 7, 1989 was sent to the Project Director by the CASET P.I. A new Services Agreement was requested to cover the Summer 1989 semester when the actual intervention will occur. |
| **FUNDING LETTER:**<br>**3-10-89** | A letter dated March 10, 1989 was sent to the Project Director by the Principal Investigator. It indicated that CASET funding had been approved and provided clarification of the Consortium funding process. |

* Originally was a pilot project; purchased software for intervention program in Fall, 1988; had pilot status in Fall, 1988 and Spring, 1989. Will be a full scale intervention in Summer, 1989.

**COMMUNITY COLLEGE OF PHILADELPHIA**
1700 Spring Garden Street
Philadelphia, PA 19130
215-751-8000

**PRESIDENT:** Dr. Judith Eaton
**PROJECT DIRECTOR:**
Mr. Geoffrey Schulz
Instructor, Mathematics

**FOCUS:** The foci of this intervention are recruitment and retention. During the summer and academic year there will be a three week workshop designed to review mathematics and direct students towards further study of mathematics. Participants will be entering CCP students.

**VISIT:**
**3-29-88**

The initial visit was made by Dr. John Q. Taylor, Dr. Nina W. Kay and Ms. Muriel C. Vaughn on March 29. 1988. They met with the following:

Dr. Thomas Hawk, Vice President for Finance and Planning
Dr. Judith Eaton, President.

They also met with representatives of the Development Office who had knowledge of what CCP was doing in CASET's area of concern or in the way of interventions in other disciplines.
Prior to the visit, a letter dated March 7, 1988 was sent to Dr. Judith Eaton by Dr. King requesting an appointment and briefly describing CASET.

**LETTER OF INTENT:**
**6-3-88**

The Letter of Intent, indicating that CCP would participate in the Consortium, was signed by Mr. Stanley G.Sunderwirth, Vice President for Academic Affairs, on June 3, 1988.

**CONSORTIUM MEETING LETTER:**
**6-27-88**

A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to Dr. Hawk and Dr. Eaton.

**BASELINE DATA REPORT:**
**7-12-88**

The Baseline Data Report was received in the CASET office on July 12, 1988.

**BASELINE REPORT CHECK:**
**7-14-88**

A check in the amount of $1,500.00 for the Baseline Report was sent to Dr. Judith Toman, Dean Mathematics, Science and Engineering Technologies on July 14, 1988.

**CONSORTIUM MEETING:**
**7-20-22-88**

The Consortium Meeting was held on July 20-22, 1988. The institution's representative was Wayne Obetz, Office of Finance and Planning.

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| **PROPOSAL:**<br>**10-3-88** | The Proposal was received in the CASET office on October 3, 1988. |
| **PROPOSAL CHECK:**<br>**10-7-88** | A check in the amount of $2,000.00 for the Proposal and travel to the Consortium Meeting was sent to Dr. Judith Toman on October 7, 1988. |
| **PROPOSAL COMMENTS:**<br>**11-23-88**<br>**1-25-89**<br>**2-29-89** | The Proposal was reviewed by Ms. Muriel Vaughn, Ms. Mary Ochoa, Dr. Adesua Ilegbodu and Ms. Linda Chappell. The comments were consolidated by Ms. Vaughn and discussed over the phone with Dr. Toman. After review and approval by Dr. Kay, they were sent to Dr. Toman on November 23, 1988. Additional phone calls were made by Dr. Ilegbodu and after consultation with CASET consultant, Dr. Larry Hedges, Dr. Toman was asked to provide an addendum to the original proposal. |
| **PROPOSAL ADDENDA:**<br>**1-3-89**<br>**3-16-89** | A Proposal Addendum was received in the CASET office on January 3, 1989. The final Proposal Addendum was received in the CASET office on March 16, 1989. |
| **SERVICES AGREEMENT:**<br>**4-28-89** | The Addenda and the Proposal were incorporated into the Services Agreement. Two originals were sent to the Project Director, Geoffrey Schultz, on April 28, 1989. |
| **SIGNED SERVICES AGREEMENT:**<br>**5-10-89** | The Services Agreements were signed by the President and the Project Director on May 18,1989 and May 10, 1989 respectively. |
| **FINAL SERVICES AGREEMENT:**<br>**7-13-89** | The Final Services Agreement was signed by the Principal Investigator, Dr. N. Kay on July 13, 1989. One original was sent to the Project Director. The other was filed in the CASET office. |
| **INITIAL PAYMENT:** | A check pursuant to the terms of the Services Agreement was sent to the Project Director. |
| **PRE-BASELINE DATA:**<br>**5-3-89** | The pre-Baseline Data Instruments were sent to the Project Director on May 3, 1989. |

**EDWARD WATERS COLLEGE**
1658 Kings Road
Jacksonville, Florida 32209
904-355-3030

**PRESIDENT:**
Dr. Robert Mitchell
**PROJECT DIRECTOR:**
Dr. James Kerr
Associate Professor
of Education

**FOCUS:** The foci of this intervention are recruitment and improved performance. The intervention will take place during the spring semester (January-May, 1989), the summer of 1989, and the fall semester (September-December, 1989) and serve one hundred sixty (160) students in the 7th and 8th grades.

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| **VISIT:**<br>**6-1-88** | There was no preliminary site visit. Telephone conversations were held between Dr. Cone, the former President of EWC, and Dr. King, as well as between Dr. Cone and Professor Wiersma. A letter dated June 1, 1988 was sent to Dr. Cone enclosing the information necessary for him to proceed. |
| **LETTER OF INTENT:**<br>**6-6-88** | The Letter of Intent, indicating the President's willingness to participate in the Consortium, was signed by President Cone on June 6, 1988. |
| **CONSORTIUM MEETING LETTER:**<br>**6-27-88** | A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to the Project Director. |
| **BASELINE REPORT:**<br>**7-6-88** | The Baseline Report was received in the CASET office on July 6, 1988. |
| **BASELINE REPORT CHECK:**<br>**7-11-88** | A check in the amount of $1500.00 for the Baseline Report was sent to the Project Director on July 11, 1988. |
| **CONCEPT PAPER:**<br>**7-14-88** | The Concept Paper was received in the CASET office on July 14, 1988. |
| **PROPOSAL:**<br>**7-18-88** | A tentative Proposal was received in the CASET office on July 18, 1988. |
| **CONCEPT PAPER AND PROPOSAL CHECKS:**<br>**8-1-88** | A check in the amount of $3500.00 for the Concept Paper and the Proposal and to cover costs of travel to the Consortium Meeting was sent to the Project Director on August 1, 1988. |

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| **PROPOSAL COMMENTS:**<br>**8-29-88** | The Proposal was reviewed by CASET staff(Ms. Linda Chappell, Dr. Adesua Ilegbodu, Ms. Muriel Vaughn) and CASET consultants, Drs. Larry Hedges and Harris Cooper. Comments were consolidated by Ms. Vaughn, approved by Dr. Nina Kay and sent to the Project Director, Dr. James Kerr, for revision of the Proposal on August 29, 1988. |
| **REVISED PROPOSAL:**<br>**9-30-88** | The Revised Proposal was received in the CASET office on September 30, 1988. |
| **PROPOSAL COMMENTS:**<br>**12-2-88**<br>**12-16-88** | The Revised Proposal was reviewed by Ms. Chappell, Dr. Ilegbodu, Ms. Vaughn and Ms. Ochoa on December 2, 1988. The comments were consolidated by Ms. Vaughn. Upon the review and approval of Dr. Kay, they were sent to the Project Director on December 16, 1988. |
| **PROPOSAL ADDENDUM:**<br>**10-3-88**<br>**12-27-88** | The Addendum to the Proposal was received in the CASET office on October 3, 1988. The Final Addendum to the Proposal was received in the CASET office on December 27, 1988. |
| **SERVICES AGREEMENT:**<br>**1-19-89** | The Final Addendum and Proposal were incorporated into the Services Agreement. Two originals of the Services Agreement were sent to the Project Director on January 19, 1989. |
| **SIGNED SERVICES AGREEMENT:**<br>**2-2-90**<br>**2-13-89**<br>**2-16-89** | The Services Agreements were signed by the President, Dr. Robert Mitchell, on February 13, 1989 and the Project Director, Dr. James Kerr, on February 2, 1989 and received in the CASET office on February 16, 1989. |
| **FINAL SERVICES AGREEMENT:**<br>**2-17-89** | The Services Agreements were signed by the Principal Investigator, Dr. Nina Kay on February 17, 1989. One original was sent to the Project Director. The other was filed in the CASET office. |
| **INITIAL PAYMENT:** | No payment was due. |
| **PRE-BASELINE DATA INSTRUMENTS:**<br>**1-19-89** | The Pre-Baseline Data Instruments were sent to the Project Director on January 19, 1989. |

**FISK UNIVERSITY**
1000 17th Street N.
Nashville, Tennessee 37203
Telephone: 615-329-8500

**PRESIDENT:** Dr. Henry Ponder
**PROJECT DIRECTOR:**
Dr. George Neely, Jr.
Executive Vice President

**FOCUS:** The focus of this intervention is improved performance in SET related subjects by Black students in grades 4-6 by the implementation of the Fisk Saturday-Summer Academy in Computers, Mathematics and Science. The term of the intervention is June 1, to July 31, 1990.

**VISIT:**
**3-31-88**

The initial visit was made by Dr. King and Ms. Vaughn on March 31, 1988. They met with the following:

- Dr. George Neely, Jr., Executive Vice President;
- Dr. Reavis Mitchell, Executive Assistant to the President;
- Mr. George Carpenter, Associate Director of Development.

Prior to the visit, a letter dated March 18, 1988 was sent by Dr. King to Dr. Ponder requesting the appointment and briefly describing CASET. Calls were made by Ms. Vaughn following the meeting in order to answer questions raised by Dr. Neely. A letter was sent to Dr. Reavis Mitchell on June 23, 1988 to clarify procedures.

**6-23-88**

**LETTER OF INTENT:**
**4-11-88**

The Letter of Intent, indicating the President's willingness to participate in the Consortium, was signed by President Ponder on April 11, 1988.

**CONSORTIUM MEETING LETTER:**
**6-27-88**

A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to the Project Director.

**BASELINE REPORT:**
**7-6-88**

The Baseline Report was received in the CASET office on July 6, 1988.

**BASELINE REPORT CHECK:**
**8-88**

A check in the amount of $1500 for 7-the Baseline Report was sent to the Project Director.

**CONCEPT PAPER:**

Concept Paper received after this report.

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| **PROPOSAL GUIDELINES:**<br>**8-26-88** | A copy of the Guidelines for the Proposal was sent to the Project Director on August 26, 1988. |
| **PROPOSAL:**<br>**10-4-88** | The Proposal was received in the CASET office on October 4, 1988. |
| **PROPOSAL CHECK:**<br>**10-7-88** | A check in the amount of $2000 was sent to the Project Director on October 7, 1988 for the Proposal and for travel to the Consortium meeting. |
| **PROPOSAL COMMENTS:**<br>**12-2-88**<br><br>**12-5-88**<br><br>**12-16-88** | The Proposal was reviewed by Ms. Chappell, Dr. Ilegbodu, Ms. Vaughn and Ms. Ochoa on December 2, 1988. The comments were consolidated by Ms. Vaughn and given to Dr. Kay for her approval and review. They were mailed to the Project Director on December 16, 1988. |
| **PROPOSAL ADDENDUM:**<br>**3-2-89** | The Addendum to the Proposal was received in the CASET office on March 2, 1989. |
| **REVISED ADDENDUM:**<br>**3-15-89** | In a letter dated March 15, 1989, the P.I. requested pre-tests more appropriate for grade level of participants and suggested copying software in order to cut expenses, if it is not against policy of software company. |
| **SERVICES AGREEMENT:**<br><br>the | After several telephone conversations between Ms. Vaughn and Project Director, the Addendum was incorporated into the Services Agreement. Two originals were sent to the Project Director on |
| **SIGNED SERVICES AGREEMENT:** | The Services Agreement was signed by the President and the Project Director on<br>and received in the CASET office on |
| **FINAL SERVICES AGREEMENT:** | The Services Agreements were signed by Dr. Kay. One original was sent to the Project Director on<br>. The other was filed in the CASET office. |

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| **INITIAL PAYMENT:** | A check for the Initial Payment pursuant to the terms of the Services Agreement, was sent to the Project Director. |
| **PRE-BASELINE DATA INSTRUMENTS** | Pre-Baseline Data Instruments were not required. |

**HUSTON-TILLOTSON COLLEGE**
1820 East 8th Street
Austin, Texas 78702
512-476-7421

**PRESIDENT:** Dr. Joseph T. McMillan
**PROJECT DIRECTOR:**
Dr. Charles E. Urdy
Professor of Chemistry

**FOCUS:** The foci of this intervention are retention and improved performance. Twenty high school students in grades 10 through 12 will participate in a Saturday Academy.

**VISIT:**
**7-7-88**

The initial visit to the new president was made by Muriel C. Vaughn on July 7, 1988. She met with the following people:

Dr. Joseph T. McMillan, President
Dr. Lenora Waters, Vice President Academic Affairs
Ms. Renette B. Echols, Associate Professor of Physics
Ms. Ora B. Wilson, Title III Coordinator

Arrangements were made for the meeting by Muriel Vaughn upon the direction of Dr. King and Dr. Kay.

**LETTER OF INTENT:**
**7-7-88**

The Letter of Intent, indicating the President's willingness to participate in the Consortium, was signed by the President on July 7, 1988.

**BASELINE REPORT:**
**7-18-88**

The Baseline Data Report was received in the CASET office on July 18, 1988.

**PROPOSAL:**
**7-19-88**

The Proposal was received in the CASET office on July 19, 1988.

**CHECKS: PROPOSAL, BASE-LINE REPORT:**
**8-1-88**

A check in the amount of $3500.00 was sent to the Vice President for Academic Affairs on August 1, 1988 for the Baseline Report, the Proposal and to cover costs of travel to the Consortium Meeting.

**CONCEPT PAPER:**

The requirement for a Concept Paper was waived because Huston-Tillotson College was late appointing Dr. Urdy.

**CONSORTIUM MEETING:**
**7-20-22-88**

The Consortium Meeting was held on July 20-22, 1988. The institution's representatives were Ms. Rennette Echols and Ms. Ora Wilson.

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| **PROPOSAL GUIDELINES:**<br>**8-29-88** | A copy of the Guidelines for Proposals was sent to Dr. Waters on August 29, 1988. She was asked to revise the proposal as required. |
| **REVISED PROPOSAL:**<br>**12-1-88** | The Revised Proposal was received in the CASET office on December 1, 1988. |
| **PROPOSAL COMMENTS:**<br>**12-16-88** | The Proposal was reviewed by Caset staff (Muriel Vaughn, Mary Ochoa, Adesua Ilegbodu, and Linda Chappell.) The comments were consolidated and,upon review and approval of the Principal Investigator, were sent to the Project Director on December 16, 1988. |
| **PROPOSAL ADDENDUM:**<br>**1-26-89** | The Proposal Addendum was received in the CASET office on January 26, 1989. |
| **PRE-BASELINE DATA INSTRUMENTS:**<br>**2-21-89** | The Pre-Baseline Data Instruments were sent to the Project Director on February 21, 1989. |
| **SERVICES AGREEMENT:**<br>**3-10-89**<br>**3-17-89** | The Proposal and the Proposal Addendum were incorporated into the Services Agreement. Originals signed by the President and the Project Director were received in the CASET office on March 10, 1989. They were signed by the Principal Investigator. One original was sent to the Project Director on March 17, 1989. The other was filed in the CASET office. |
| **INITIAL PAYMENT:** | No payment was due. |

**LANEY COLLEGE***
900 Fallon Street
Oakland, CA 94607
415-464-3226

**PRESIDENT:** Mr. Odell Johnson
**PROJECT COORDINATOR:**
Mr. Blas Guerrero
**PROJECT DIRECTOR:**
Dr. Eugene Long, Asst. Dean
Mathematics, Science, and
Related Technologies

**FOCUS:** The foci of this intervention are retention and improved performance. The program, Achievement in Science, Engineering and Technology (ASET) will be implemented during the Spring semester, 1989 and Summer, 1989 and will serve 25 10th graders.

**VISIT:**
**2-28-88**

The Initial Visit was made by Dr. John Q. Taylor King on February 28, 1988. He met with the following people:

Dr. Armen Sarafin, Interim Chancellor, Peralta Community College District.

Dr. Eugene S. Long, Assistant Dean, Mathematics , Science and Related Technologies, and Director of Oakland Schools' Mathematics In-service Consortium.

Mr. Ron Moore, Director of Transfer Opportunities Program

**LETTER OF INTENT:**
**5-27-88**

The Letter of Intent, indicating willingness to participate in the Consortium was signed by Dr. Wise E. Allen, the Interim Vice Chancellor of the Peralta Community College District on May 27, 1988.

**CONSORTIUM MEETING:**
**6-27-88**

A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to Dr. Eugene Long and Dr. Wise Allen.

**BASELINE DATA REPORT:**

Waived because of innovation of this project for Laney Community College.

**CONSORTIUM MEETING:**
**7-20-22-88**

The Consortium Meeting was held from July 20-22, 1988. The institution's representative was Mr. Blas Guerrero.

**PROPOSAL:**
**7-22-88**

The Proposal was received in the CASET office on July 22, 1988.

**PROPOSAL CHECK:**
**8-1-88**

A check in the amount of $2000.00 for the Proposal and to cover travel costs

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| | to the Consortium Meeting was sent to the President, Mr. Odell Johnson on August 1, 1988. |
| **CONCEPT PAPER:** **8-22-88** | The Concept Paper was received in the CASET office on August 22, 1988. |
| **CONCEPT PAPER CHECK:** **8-30-88** | A check in the amount of $1500.00 for the Concept Paper was sent to the Project Director on August 30, 1988. |
| **PROPOSAL COMMENTS:** **8-30-88** | The Proposal was reviewed by CASET staff, Ms. Muriel Vaughn, Ms.Linda Chappell and Dr. Adesua Ilegbodu. The comments were consolidated and upon review and approval of the Principal Investigator, were sent to the Project Director. |
| **REVISED PROPOSAL:** **10-21-88** | The Revised Proposal was received in the CASET office on October 21, 1988. |
| **PROPOSAL ADDENDUM:** **11-1-88** | The Proposal Addendum was received in the CASET office on November 1, 1988. |
| **SERVICES AGREEMENT:** **10-28-88** **11-1-88** | The Revised Proposal and the Proposal Addendum were incorporated into the Services Agreement. It was signed by Mr. Odell Johnson, President of Laney College and Dr. Eugene Long, Project Director on October 28, 1988. It was received in the CASET office on November 1, 1988. |
| **FINAL SERVICES AGREEMENT:** **11-1-88** | The Final Services Agreement was signed by Principal Investigator, Dr. Nina W. Kay, on November 1, 1989. One original was sent to the Project Director and the other was filed in the CASET office. |
| **PILOT PROJECT INITIAL PAYMENT:** **11-1-88** | A check in the amount of $15,000.00 was sent to Laney College on November 1, 1988 pursuant to the terms of the Services Agreement to serve as start up funds. |
| **PRE-BASELINE DATA INSTRUMENTS:** **11-8-88** | The Baseline Data Instruments were sent to the Project Director on November 8, 1988. |

* Originally a Pilot Project, but was converted to and "A" semester project, Spring, 1989 and will continue until August, 1989.

**MARY HOLMES COLLEGE**
P.O. Drawer 1257
West Point, Mississippi 39773
Telephone: 601-494-6820

**PRESIDENT:***
Dr. Sammie Potts
**PROJECT DIRECTORS:**
Dr. JoAnn Vicks, Dean
Mathematics and Natural Sciences
Ms. Fannie Gibson, Dean
Business and Computer Science

**FOCUS:** The foci of this intervention are recruitment and retention. Forty (40) freshmen and sophomores will take part in a Saturday College during the academic year through 1990.

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| **VISIT:**<br>**2-9-88** | The initial visit was made by Mr. Niles White on February 9, 1988. He met with the following:<br>Dr. Alvin Anderson, Sr., President<br>Key members of faculty.<br>Prior to the visit, a letter was sent on February 1, 1988 from Dr. King to Dr. Anderson advising him of Mr. White's visit, requesting an appointment, and briefly describing CASET. |
| **LETTER OF INTENT:**<br>**2-18-88** | The Letter of Intent, indicating the President's willingness to participate in the Consortium, was signed by then President Alvin Anderson, Sr. on February 18, 1988. |
| **BASELINE REPORT:**<br>**5-16-88** | The Baseline Report was received in the CASET office on May 16, 1988. |
| **BASELINE REPORT CHECK:**<br>**5-26-88** | A check in the amount of $1500 for the Baseline Report was sent to the Project Director on May 26, 1988. |
| **CONSORTIUM MEETING LETTER:**<br>**6-27-88** | A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to the Project Director on June 27, 1988. |
| **CONCEPT PAPER:**<br>**7-5-88** | The Concept Paper was reviewed in the CASET office on July 5, 1988. |
| **CONCEPT PAPER CHECK:**<br>**7-8-88** | A check for the Concept Paper in the amount of $1500 was sent to the Project Director on July 8, 1988. |
| **PROPOSAL:**<br>**7-18-88** | The Proposal was received in the CASET office on July 18, 1988. |

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| **CONSORTIUM MEETING:**<br>**7-20-22-88** | The Consortium Meeting was held on July 20-22, 1988. The institution's representatives were Ms. Hellena Terrell, the original Project Director, and Mr. Malik Khokhar. |
| **PROPOSAL CHECK:**<br>**7-26-88** | A check in the amount of $2,000.00 was sent to the Project Director on July 26, 1988 for the Proposal and to cover costs of attending the Consortium Meeting. |
| **PROPOSAL COMMENTS:**<br>**8-29-88** | The Proposal was reviewed by CASET staff (Ms. Linda Chappell, Dr. Adesua Ilegbodu, Ms. Muriel Vaughn) and CASET consultants, Drs. Larry Hedges and Harris Cooper. The comments were consolidated by Ms. Vaughn and sent to the Project Director on August 29, 1988 after review and approval by Dr. Kay. |
| **REVISED PROPOSAL:**<br>**11-3-88** | The Revised Proposal was received in the CASET office on November 3, 1988. |
| **REVISED PROPOSAL COMMENTS:**<br>**12-2-88**<br><br>**12-16-88** | The Revised Proposal was reviewed by Ms. Chappell, Dr. Ilegbodu, Ms. Vaughn, and Ms. Ochoa on December 2, 1988. The comments were consolidated by Ms. Vaughn and given to Dr. Kay for her review and approval. They were sent to the Project Director on December 16, 1988. |
| **FUNDING LETTERS:**<br>**1-9-89**<br>**3-10-89** | In response to requests for information, a letter was sent to the President, Dr. Sammie Potts, on January 9, 1988 explaining the funding process. A similar letter was sent to the Project Director on March 10, 1989. |
| **PROPOSAL ADDENDUM:**<br>**1-17-89** | The Addendum to the Proposal was received in the CASET office on January 17, 1989. |
| **PRE-BASELINE DATA INSTRUMENTS:**<br>**2-1-89** | The Pre-Baseline Data Instruments were sent to the Project Director on February 1, 1989. Included in the packet were the Services Agreement, Instructions to the Project Director, Intervention and Comparison Group Consent Forms, Project Director Protocol, Standardized Test Scores Reporting Form, College Student Protocol, and the Opinion Protocol. |

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| **SERVICES AGREEMENT:**<br>**2-1-89** | The Addendum was incorporated into the Services Agreement and two originals of the latter were sent to the Project Director on February 1, 1989. |
| **SIGNED SERVICES AGREEMENT:**<br>**2-3-89**<br>**2-7-89** | The Services Agreements were signed by the President and the Project Director on February 3, 1989 and received in the CASET office on February 7, 1989. |
| **FINAL SERVICES AGREEMENT:**<br>**2-7-89** | The Services Agreements were signed by Dr. Kay on February 7, 1989. One original was returned to the Project Director; the other was filed in the CASET office. |
| **INITIAL PAYMENT:** | A check for the Initial Payment in the amount of $17,500.oo was sent to the Project Director. |

**METROPOLITAN STATE COLLEGE**
1006 11th Street
Denver, Colorado 80204
Telephone: 303-556-4270

**PRESIDENT:** Dr. Thomas B.Brewer
**PROJECT DIRECTOR:**
Dr. Gwendolyn Thomas
Assistant Vice President for
Student Affairs

**FOCUS:**
The foci of this intervention are the recruitment, retention and improved performance in science and mathematics of sixth grade minority and female students.

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| **VISIT:**<br>**3-11-88** | The Initial Visit was made on March 11, 1988 by Dr. Nina W. Kay. |
| **LETTER OF INTENT:**<br>**3-11-88** | The Letter of Intent, indicating the President's willingness to participate in the Consortium, was signed by then President, Dr. Tobin Barrozo, on March 11, 1988. |
| **CONSORTIUM MEETING LETTER:**<br>**6-27-88** | A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to Dr. Barrozo and to Dr. Magelli. |
| **UPDATE LETTER:**<br>**6-29-88** | During a telephone conversation with Ms. Sandra Rexroat, Director of Grants and Sponsored Projects, she indicated that there had been administrative changes at the institution. The packet which she requested was sent to her on June 29, 1988: CASET Executive Summary, Schedule of Planning Activities, Draft Agenda for the Consortium Meeting, and Guidelines for Preparing the Proposal. |
| **CONSORTIUM MEETING:**<br>**7-20-22-88** | The Consortium Meeting was held on July 20-22, 1988. The institution's representative was Dr. Joan Foster, Associate Dean, Letters, Arts, and Sciences. |
| **CONCEPT PAPER:**<br>**7-19-88** | The Concept Paper was received in the CASET office on July 19, 1988. |
| **CONCEPT PAPER CHECK:**<br>**8-1-88** | A check in the amount of $1500 was sent to then President, Dr. Paul Magelli, on August 1, 1988. |
| **BASELINE REPORT:**<br>**7-20-88**<br><br>**9-6-88** | The Baseline Report was received in CASET office on July 20, 1988.<br>Additional data was received in the CASET office on September 6, 1988. |

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| **REVISED GUIDELINES FOR PROPOSAL:**<br>**8-26-88** | The Revised Guidelines for writing the proposal were sent to the Interim Project Director on August 26, 1988 for use in revising the institution's proposal. |
| **BASELINE REPORT CHECK:**<br>**8-30-88** | A check in the amount of $1500 was sent for the Baseline Data Report to the Interim Project Director, Dr. Dorothy Snozek. |
| **PROPOSAL:**<br>**10-31-88** | The Proposal was received in the CASET office on October 31, 1988. |
| **PROPOSAL CHECK:**<br>**11-4-88** | A check in the amount of $2000 was sent to Sandra L. Rexroat,Director of Grants and Sponsored Projects on November 4, 1988 for the Proposal and to cover expenses for travel to the Consortium Meeting. |
| **PROPOSAL COMMENTS:**<br>**12-2-88**<br><br><br><br><br>**12-16-88** | The Proposal was reviewed by CASET staff, Ms. Linda Chappell, Ms. Muriel Vaughn, Dr. Adesua Ilegbodu, and Ms. Mary Ochoa on December 2, 1988. Comments were consolidated by Ms. Vaughn. Upon the review and approval of Dr. Kay, they were and sent to the Interim Project Director for further revisions on December 16, 1988. |
| **PROPOSAL ADDENDUM:**<br>**2-22-89** | The Addendum to the Proposal was received in the CASET office on February 22, 1989. |
| **WELCOME LETTER:**<br>**2-10-89** | A letter welcoming Dr. Gwendolyn Thomas as Project Director was sent to Dr. Thomas on February 10, 1989. |
| **SERVICES AGREEMENT:** | The Addendum was incorporated into the Services Agreement and two originals were sent to the Project Director. |
| **SIGNED SERVICES AGREEMENT:**<br>**6-9-89**<br>**6-7-89**<br>**6-12-89** | The Services Agreements were signed by the President of the institution and the Project Director on June 9, 1989 and June 7, 1989 respectively. It was received in the CASET office on June 12, 1989. |

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| **FINAL SERVICES AGREEMENT: 6-12-89** | The Services Agreements were signed by Dr. Kay on June 12, 1989. One of the originals was sent to the Project Director. The other was filed in the CASET office. |
| **INITIAL PAYMENT:** | A check in the amount of $12,814.00, pursuant to the terms of the Services Agreement, was sent to the Project Director. |
| **PRE-BASELINE DATA INSTRUMENTS:** | The Pre-Baseline Data Instruments were sent to the Project Director. |

**MOREHOUSE COLLEGE**
830 Westview Drive, S.W.
Atlanta, Georgia 30314
Telephone: 404-681-2800 Ext 288

**PRESIDENT:** Dr. Leroy Keith, Jr.
**PROJECT DIRECTOR:**
Dr. Arthur M. Jones, Director
Software Group

**FOCUS:** The foci of the intervention are retention and improved performance of Morehouse freshmen students enrolled in the Dual-Degree Engineering Program. The intervention will be implemented during the school year and will serve 25 students.

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| **VISIT:**<br>**2-5-88** | The initial visit was made by Dr. Nina Kay and Mr. Niles White. They met with Mr. Oliver Delk, Director, Government and Corporate Relations on February 5, 1988. |
| **2-6-88** | On February 6, 1988, Mr. White made a formal presentation to the faculty at a workshop sponsored by the College. Prior to the visit, a letter was sent to Dr. Keith from Dr. King on February 1, 1988 confirming the appointment and briefly describing CASET. |
| **LETTER OF INTENT:**<br>**2-12-88** | The Letter of Intent, indicating the President's willingness to participate in the CASET Consortium, was signed by President Keith on February 12, 1988. |
| **CONSORTIUM MEETING LETTER:**<br>**6-27-88** | A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to the Project Director. |
| **BASELINE REPORT:**<br>**CONCEPT PAPER:**<br>**6-15-88** | The Baseline Report and the Concept Paper were received in the CASET office on June 15, 1988. |
| **BASELINE REPORT, CONCEPT PAPER CHECKS:**<br>**6-29-88** | A check in the amount of $3,000 was sent to the Project Director for the Baseline Report and the Concept Paper on June 29, 1988. |
| **CONSORTIUM MEETING:**<br>**7-20-22-88** | The Consortium Meeting was held on July 20-22, 1988 at the Johnson Space Center. The institution's representative was Dr. Arthur Jones, the Project Director. |
| **GUIDELINES FOR PROPOSAL:**<br>**8-26-88** | The Guidelines for the Proposal were sent to the Project Director on August 26, 1988. |

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| **PROPOSAL:**<br>**10-4-88** | The Proposal was received in the CASET office on October 4, 1988. |
| **PROPOSAL CHECK:**<br>**10-7-88** | A check in the amount of $2,000 was sent to the Project Director on October 7, 1988 for the Proposal and to cover costs of travel to the Consortium Meeting. |
| **PROPOSAL COMMENTS:**<br>**12-16-88** | The Proposal was reviewed by CASET staff(Ms. Chappell, Dr. Ilegbodu, Ms. Ochoa, Ms. Vaughn) and CASET consultants, Drs. Harris Cooper and Larry Hedges. Comments were consolidated by Ms. Vaughn. They were sent to the Project Director for purposes of revision on December 12, 1988 upon the review and approval of Dr. Kay. |
| **REVISED BUDGET:**<br>**12-20-88** | After a telephone discussion of the comments, the Project Director sent a Revised Budget which was received in the CASET office on December 20, 1988. |
| **PROPOSAL ADDENDUM:**<br>**2-19-89** | The Addendum to the Proposal was received in the CASET office on February 19, 1989. |
| **SERVICES AGREEMENTS:**<br>**2-20-89** | The Addendum was incorporated into the Services Agreement and two originals were sent to the Project Director on February 20, 1989. |
| **PRE-BASELINE DATA INSTRUMENTS:**<br>**2-20-89** | The Pre-Baseline Data Instruments were sent to the Project Director on February, 20, 1989. Included in the packet were the following: Instructions to the Project Director, Services Agreement, Consent forms for both intervention and comparison groups, Standardized Test Scores Reporting Forms for both groups, College Student Protocol, and the Opinion Protocol. |
| **SIGNED SERVICES AGREEMENTS:** | The Services Agreements were never implemented because of time and administrative situations prevailing then at Morehouse. |

**NAVAJO COMMUNITY COLLEGE**
P.O. Box 580
Shiprock, Navajo Nation
New Mexico 87420
Telephone: 505-368-5164

**ACTING PRESIDENT:**
Mr. MacArthur Norton
**PROJECT DIRECTOR:** Dr. Mark C. Bauer
Chair, Math/Science Department

**FOCUS:** The foci of this intervention are recruitment and improved performance. The intervention will run for the summers of 1989 and 1990 and will serve one hundred and sixty (160) Navajo students in grades 4 through 8.

**VISIT:**
**4-21-88**

The initial visit was made by Dr. Nina Kay. She met with the following:
- Mr. Steven C. Semken, Instructor
- Mr. James M. Tutt, Vice President for Administrative Affairs,
- Dr. James K. McNeley, Dean of Instruction,
- Dr. Mark Bauer, Chair, Math/Sciences
- Dr. Lora Shields, Project Director, MBRS, March of Dimes.

**LETTER OF INTENT:**
**4-22-88**

The Letter of Intent, indicating the the President's willingness to participate in the Consortium, was signed by James Tutt for then President, Mr. Dean C. Jackson.

**AMERICAN INDIAN SYMPOSIUM:**
**4-25-88**

A letter dated April 25, 1989, thanking those present for meeting with her, was sent to Mr. Tutt by Dr. Kay. She also invited him to be a presenter at a joint CASET/JSC American Indian Symposium.

**WELCOME LETTER:**
**5-25-88**

A letter dated May 25, 1988 welcoming Navajo Community College to the Consortium was sent to Mr. Dean C. Jackson by Dr. King. He also reminded Mr. Jackson of the Baseline Report requirement.

**BASELINE REPORT:**
**6-18-88**

The Baseline Report was received in the CASET office on June 18, 1988.

**CONSORTIUM MEETING LETTER:**
**6-27-88**

A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting, was sent to the Project Director.

**BASELINE REPORT CHECK:**
**6-28-88**

A check in the amount of $1,500 was sent to Mr. Dean Jackson for the Baseline Report on June 28, 1988.

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| **CONSORTIUM MEETING:**<br>**7-20-22-88** | The Consortium Meeting was held on July 20-22-88 at the Johnson Space Center. The representative for the institution was Dr. Mark Bauer, the Project Director. |
| **GUIDELINES FOR FOR THE PROPOSAL:**<br>**8-26-88** | The Guidelines for the Proposal were sent to the Project Director on August 26, 1988. |
| **CONCEPT PAPER:**<br>**10-27-88** | The Concept Paper was received in the CASET office on October 27, 1988. |
| **PROPOSAL:**<br>**10-28-88** | The Proposal was received in the CASET office on October 28, 1988. |
| **PROPOSAL CHECK:**<br>**11-4-88** | A check in the amount of $2,000 was sent to the Project Director on November 4, 1988 for the Proposal and to cover the cost of travel to the Consortium Meeting. |
| **CONCEPT PAPER CHECK:**<br>**11-9-88** | A check in the amount of $1,500 was sent to the Project Director for the Concept Paper on November 9, 1988. |
| **PROPOSAL COMMENTS:**<br>**12-2-88**<br><br>**12-16-88** | The Proposal was reviewed by CASET staff (Dr. Ilegbodu, Ms. Chappell, Ms. Vaughn and Ms. Ochoa) on December 2, 1988. The comments were consolidated by Ms. Vaughn. They were mailed to the Project Director on December 16, 1988 upon the review and approval of Dr. Kay. |
| **PROPOSAL ADDENDUM:**<br>**4-3-89** | The Proposal Addendum was received in the CASET office on April 3, 1989. |
| **SERVICES AGREEMENTS:**<br>**4-21-89** | The Addendum was incorporated into the Services Agreement and two originals were sent to the Project Director on April 21, 1989. |
| **SIGNED SERVICES AGREEMENTS:**<br>**5-3-89** | The Services Agreements were signed by the Project Director, Dr. Mark Bauer, and the acting president, Mr.MacArthur Norton, on May 1, 1989. They were received in the CASET office on May 3, 1989. |

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| **FINAL SERVICES AGREEMENT: 5-4-89** | The Services Agreements were signed by Dr. Kay on May 4, 1989. One original was sent to the Project Director and the other was filed at CASET. |
| **INITIAL PAYMENT:** | A check for the Initial Payment in the amount of $ 24,999.00, pursuant to the terms of the Services Agreements, was sent to the Project Director. |
| **PRE-BASELINE DATA INSTRUMENTS: 3-6-89** | Pre-Baseline Data Instruments were sent to the Project Director on March 6, 1989. |

**NEW MEXICO HIGHLANDS UNIVERSITY**
Las Vegas, New Mexico 87701
Telephone: 505-425-7511

**PRESIDENT:** Dr.Gilbert Sanchez
**PROJECT DIRECTOR:**
Dr. Gilbert D. Rivera
Vice President for
Academic Affairs

**FOCUS:** The foci of this intervention are recruitment and retention. The intervention will serve 25 high ability high school students in grades 11 and 12. This is a summer residential program for the summers of 1989 and 1990. The spring semester of 1989 is used for recruitment and start-up.

**VISIT:**
**4-20-88**

The initial visit was made by Dr. Nina Kay and Consultant Cesar Trimble, of the Hispanic Association of Colleges and Universities (HACU) on April 20, 1988. They met with The following:

- Dr. Peggy Poling,Director, Grants, Contracts, and Extramural Funding
- Dr. Gilbert Sanchez, President
- Dr. Edwin LeMaster, Dean, School of Science and Technology
- Dr. Gabino Rendon, Prof.of Sociology
- Dr. C. Howerton, Assoc. Prof., Computer Science
- Dr. Calvin Thomas, Assoc. Prof., Engineering Technology
- Dr.George Sprenger, Professor of Chemistry

**LETTER OF INTENT:**
**4-20-88**

The Letter of Intent, indicating the President's willingness to participate in the Consortium, was signed by the President Gilbert Sanchez on April 20, 1988.

**THANK YOU LETTER:**
**4-25-88**

A letter dated April 25, 1988 was sent to Dr. Sanchez by Dr. Kay thanking him for meeting with her and having arrangements made for the meetings with others.

**BASELINE REPORT:**
**5-15-88**

The Baseline Report was received in the CASET office on May 15, 1988.

**BASELINE REPORT CHECK:**
**5-17-88**

A check in the amount of $1,500 was sent to the President on May 17, 1988 for the Baseline Report.

**CONCEPT PAPER:**
**6-1-88**

The Concept Paper was received in the CASET office on June 1, 1988.

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| **CONCEPT PAPER CHECK:**<br>**6-10-88** | A check in the amount of $1,500 was sent to the President for the Concept Paper on June 10, 1989. |
| **CONSORTIUM MEETING LETTER:**<br>**6-27-88** | A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to the Project Director. |
| **CONSORTIUM MEETING:**<br>**7-20-22-88** | The Consortium Meeting was held on July 20-22, 1988 at Johnson Space Center. The representative for the institution was Dr. Gilbert Rivera, the Project Director. |
| **GUIDELINES FOR THE PROPOSAL:**<br>**8-26-88** | The Guidelines for the Proposal were sent to the Project Director on August 26, 1988. |
| **PROPOSAL:**<br>**9-27-88** | The Proposal was received in the CASET office on September 27, 1988. |
| **PROPOSAL CHECK:**<br>**10-5-88** | A check in the amount of $2,000 was sent to the Project Director for the Proposal and to cover costs of travel to the Consortium Meeting. |
| **PROPOSAL COMMENTS:**<br>**11-14-88** | The Proposal was reviewed by CASET staff (Dr. Adesua Ilegbodu, Ms. Linda Chappell, Ms. Mary Ochoa and Ms. Muriel Vaughn.) The comments were consolidated by Ms. Vaughn and mailed to the Project Director on November 14, 1988 upon the review and approval of Dr. Kay. In a telephone conversation between Dr. Rivera and Ms. Vaughn on January 3, 1989, several points were clarified and included in a letter from Dr. Kay to Dr. Rivera dated January 5, 1989.<br>**1-3-89**<br>**1-5-89** |
| **PROPOSAL ADDENDUM:**<br>**1-20-89** | The Proposal Addendum was received in the CASET office on January 20, 1989. |
| **SERVICES AGREEMENT:**<br>**2-24-89** | The Addendum was incorporated into the Services Agreement. Two originals were sent to the Project Director on February 22, 1989. |
| **FUNDING LETTER:**<br>**4-10-89** | A letter explaining the funding process was sent to Dr. Gilbert Rivera on April 10, 1989 by Dr. Kay. |

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| **SIGNED SERVICES AGREEMENT:**<br>**6-5-89**<br>**6-20-89** | The Services Agreements were signed by the President and the Project Director on June 5, 1989. They were received in the CASET office on June 20, 1989. |
| **FINAL SERVICES AGREEMENT:**<br>**6-21-89** | The Services Agreements were signed by Dr. Kay on June 21, 1989. One original was sent to the Project Director; the other was filed in the CASET office. |
| **INITIAL PAYMENT:** | A check in the amount of $ 15,000.00, pursuant to the terms of the Services Agreement, was sent to the Project Director. |
| **PRE-BASELINE DATA INSTRUMENTS:**<br>**2-24-89** | The Pre-Baseline Data Instruments were sent to the Project Director on February 24, 1989. |

**OUR LADY OF THE LAKE UNIVERSITY***
411 S.W. 24th Street
San Antonio, Texas 78285
Telephone: 512-434-6711

**PRESIDENT:** Sister Elizabeth Anne Sueltenfuss
**PROJECT DIRECTOR:**
Sister Isabel Ball, Dean
College of Arts & Sciences
Professor of Chemistry

**FOCUS:** The foci of this intervention are retention and improved performance. The participants are freshmen students in the pre-calculus class who are assigned to study teams. The term of the intervention is September, 1988 through December, 1990.

**VISIT:**
**2-25-87**

The initial visit was made by Dr. Nina Kay and Professor John Wiersma on February 25, 1987. They met with the following:

- Dr. Antonio Rigual, Vice President for Institutional Advancement
- Mr. Cesar M. Trimble, Director of Development and Research, HACU
- Dr. Lorece Porter Williams, Professor of Social Work

Prior to the visit, arrangements were made by Dr. Kay, by telephone, to hold the meeting on the campus. In a letter dated February 19, 1987, the time, date and place were confirmed.

**LETTER OF INTENT:**
**2-25-87**

The written Letter was waived in favor of the verbal commitment made at the meeting.

**BASELINE REPORT:**
**3-16-88**

The Baseline Report was received in the CASET office on March 16, 1988.

**BASELINE REPORT CHECK:**
**4-30-88**

A check in the amount of $1,500 was sent to the Project Director for the Baseline Report on April 30, 1988.

**CONCEPT PAPER:**
**6-9-88**

The Concept Paper was received in the CASET office on June 9, 1988.

**CONSORTIUM MEETING LETTER:**
**6-27-88**

A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to the Project Director.

**PROPOSAL:**
**6-27-88**

The Proposal was received in the CASET office on June 27, 1988.

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| **CONCEPT PAPER CHECK:**<br>**6-29-88** | A check in the amount of $1,500 was sent to the Project Director for the Concept Paper on June 29, 1988. |
| **PROPOSAL CHECK:**<br>**7-5-88** | A check in the amount of $2,000 was sent to the Project Director on July 5, 1988 for the proposal and to cover the costs of travel to the Consortium Meeting. |
| **CONSORTIUM MEETING:**<br>**7-20-22-88** | The Consortium Meeting was held at Johnson Space Center on July 20-22, 1988. The institution's representative was Sister Isabel, the Project Director. |
| **PROPOSAL COMMENTS:**<br>**8-23-88** | The Proposal was reviewed by CASET staff (Ms. Linda Chappell, Ms. Muriel Vaughn and Dr. Adesua Ilegbodu) and by CASET consultants, Drs. Harris Cooper and Larry Hedges. The comments were consolidated and sent to the Project Director on August 23, 1988 after review and approval by Dr. Kay. A copy of the revised Guidelines for the Proposal was enclosed with the comments. |
| **REVISED PROPOSAL:**<br>**9-1-88** | The revised Proposal was received in the CASET office on September 1, 1988. |
| **SERVICES AGREEMENT:**<br>**10-20-88** | The revised Proposal was incorporated into the Services Agreement and two originals signed by Dr. Kay were sent to the Project Director on October 20, 1988 for her signature. |
| **PILOT PROJECT MEETING LETTER:**<br>**10-20-88** | In the letter dated October 20, 1988 which included the Services Agreements, the Project Director was advised of the Pilot Project Meeting to be held October 31-November 1, 1988 at CASET with Consultants Drs. Harris Cooper, Larry Hedges, and Beatriz Cluwell along with CASET staff. |
| **BASELINE DATA INSTRUMENTS:**<br>**10-21-88** | The Baseline Data Instruments were sent to the Project Director on October 21, 1988. Included in the packet were the following: Instructions for the Project Director, Consent Forms, College Student Protocol, Opinion Protocol, Standardized Test Scores Form, and Project Director Protocol. |

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| **FINAL SERVICES AGREEMENT: 10-27-88** | The Services Agreement with the appropriate signatures was received in the CASET office on October 27, 1988. |
| **PILOT PROJECT MEETING: 10-31-88 to-11-1-88** | The Pilot Project Meeting was held at Johnson Space Center on October 31, 1988-November 1, 1988. Discussions centered around issues of data collection and the preparation of the evaluation instruments. |
| **INITIAL PAYMENT: 11-1-88** | A check in the amount of $15,000 was sent to the Project Director on November 1, 1988 pursuant to the terms of the Services Agreement. |

* A pilot project

**PAUL QUINN COLLEGE**
1020 Elm Street
Waco, Texas 76704
Telephone: 817-753-6415 ext. 258

**PRESIDENT:** Dr. Warren W. Morgan
**PROJECT DIRECTOR:** Dr. Dennis Strete
Chairperson, Natural Sciences

**FOCUS:** The focus of this intervention is improved performance in science and mathematics. There will be a six week summer session in 1989 followed by additional academic enrichment classes in the fall and spring of school year 1989-1990.

**VISIT:**
**3-4-87**

The initial visit was made by Professor Wiersma and Dr. King on March 3, 1987. They met with the following:

- Dr. Terrance Johnson, Associate Professor Microbiology
- Dr. Norman Ashford, Professor Biology
- Dr. Weldon Walton
- Dr. Warren W. Morgan, President

**CASET MEETING:**
**3-9-87**
**3-17-87**

In a letter dated March 9, 1987, Dr. Kay confirmed final arrangements for Dr. Johnson and Dr. Ashford to come to Johnson Space Center for a CASET meeting on March 17, 1987.

**ACCEPTANCE LETTER:**
**3-11-87**

In a letter dated March 11, 1987, Dr. Morgan thanked Dr. King for his visit to Paul Quinn College and accepted his invitation to join the consortium. On the same day, a letter was mailed to Drs. Ashford and Johnson with directions for arriving at the meeting.

**REIMBURSEMENT:**
**4-8-87**

A check in the amount of $400.00 was sent to Dr. Morgan on April 8, 1987 to reimburse Paul Quinn College for expenses incurred in sending Drs. Ashford and Johnson to the CASET meeting.

**PROJECT PLAN:**
**4-28-87**

In a letter dated April 28, 1987, Professor Wiersma thanked Dr. Johnson for the cooperative research plan which he had submitted for Paul Quinn College, "The Effect of Science Teacher Enrichment on Science, Engineering, and Technology Students".

**MODIFICATION:**
**7-2-87**

A modification to the project plan was received in the CASET office on July 13, 1987.

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| **INTERVENTION PLANNING:**<br>**3-18-88** | A check in the amount of $3,000.00 was sent to the President on March 18, 1988 for Intervention Planning. This covered the receipt of the Proposal and Concept Paper. The Letter of Intent and the Schedule of Planning Activities were included in the envelope with the check and a letter addressed to President Morgan from Dr. Kay. |
| **LETTER OF INTENT:**<br>**3-21-88** | The Letter of Intent, reiterating the President's willingness to participate in the Consortium was signed by President Morgan on March 21, 1988. |
| **BASELINE REPORT:**<br>**5-24-88**<br><br><br><br><br>**7-12-88** | In a letter dated May 24, 1988, Dr. Kay advised Dr. Ashford that the Baseline Report was still due and that upon its receipt, she would forward a check for $2,000.00 to cover travel expenses to the CASET Consortium Meeting and for the Baseline Report. The Baseline Report was received in the CASET office on July 12, 1988. |
| **CONSORTIUM MEETING LETTER:**<br>**6-27-88** | A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to Dr. Norman Ashford and Dr. Morgan. The letter also advised Dr. Ashford that the guidelines for writing the proposal were being sent under separate cover. |
| **CONSORTIUM MEETING:**<br>**7-20-22-88** | The Consortium Meeting was held on July 20-22, 1988. The institution's representative was Dr. Van S. Allen. |
| **BASELINE REPORT CHECK:**<br>**8-1-88**<br><br>**8-12-88** | A check in the amount of $1,500.00 was sent to the President for the Baseline Report on August 1, 1988. An additional check for $500.00 was sent on August 12, 1988 to reach the total of $5,000.00 for each institution's planning expenses. |
| **INTERVENTION PLAN COMMENTS:**<br>**8-29-88** | The Proposal was reviewed by CASET staff (Ms. Linda Chappell, Dr. Adesua Ilegbodu, Ms. Muriel Vaughn and CASET consultants Drs. Larry Hedges and Harris Cooper.) Comments were consolidated by Ms. Vaughn and sent to the President for purposes of revision on August 29, 1988 |

after review and approval by Dr. Nina W. Kay, the Principal Investigator.

**REVISED PROPOSAL: 10-31-88**

The Revised Proposal was received in the CASET office on October 31, 1988.

**PROJECT COORDINATOR: 10-31-88**

In the cover letter with the Revised Proposal, President Morgan indicated that the new Project Coordinator would be Dr. Dennis Strete.

**REVISED PROPOSAL 12-2-88**

The Revised Proposal was reviewed by Ms. Chappell, Dr. Illegbodu, Ms. Mary Ochoa (staff) and Ms. Vaughn on December 2, 1988. The comments were consolidated by Ms. Vaughn. They were mailed to the Project Director, Dr. Dennis Strete, on December 16, 1988 upon the review and approval of Dr. Kay.

**FUNDING LETTER: 1-27-89**

On January 24, 1989, a letter was written to Dr. Strete by Dr. Kay advising that the funds received from CASET are restricted to the use of CASET related activities. It was also pointed out that funds may be carried over to the next semester, but must be itemized on the budget submitted for the subsequent semester. He was assured that once DOD funds reach the CASET office, they will be disbursed to each of the Project Directors.

**PROPOSAL ADDENDUM: 3-3-89**

The Addendum to the Proposal was received in the CASET office on March 3, 1989.

**FUNDING LETTER: 4-3-89**

In a letter dated April 3, 1989, the Principal Investigator advised the Project Director of the funding process and indicated approval of the institution's CASET intervention.

**ADVANCE PAYMENT: 4-4-89**

A check in the amount of $500.00 was sent to the Project Director on April 4, 1989 as an advance to cover printing expenses.

**SERVICES AGREEMENT:**

The Addendum was incorporated into the Services Agreement and two originals were sent to the Project Director.

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| **SIGNED SERVICES AGREEMENT:**<br>**5-16-89**<br>**5-23-89** | The Services Agreements were signed by President and the Project Director on May 16, 1989 and reeceived in the CASET office on May 23, 1989. |
| **FINAL SERVICES AGREEMENT:**<br>**5-25-89** | The Final Services Agreements were signed by Dr. Kay on May 25, 1989. One original was sent to the Project Director, and the other was filed in the CASET office. |
| **INITIAL PAYMENT:**<br>**5-31-89** | A check for the Initial Payment for the intervention in the amount of $24,500.00 |

**RUST COLLEGE***
One Rust Avenue
Holly Springs, MS 38635
601-252-4661 Ext. 356

**PRESIDENT:** Dr. William A. McMillan
**PROJECT DIRECTOR:**
Ms.Cheryl Ann Richards, Instructor
Computer Science
**PROJECT COORDINATOR:** Dr. M.I.Shafi
Chair, Division of Science and Mathematics

**FOCUS:** The foci of this intervention are retention and improved performance. There will be a Saturday Academy which will take place during the academic year (starting during the spring semester, 1989) and serve 20 10th and 11th grade high school students.

**VISIT:**
**2-10-88**

The Initial Visit was made by Mr. Niles White on February 10, 1988. He met with the following:

Dr. M.I. Shafi, Chairman, Division of Science and Mathematics
Dr. William A. McMillan, President

Prior to the visit, a letter, dated February 1, 1988, was sent by Dr. King to Dr. McMillan requesting the appointment and briefly describing CASET.

**LETTER OF INTENT:**
**2-10-88**

The Letter of Intent, indicating the President's willingness to participate in the Consortium, was signed by President McMillan on February 10, 1988.

**BASELINE REPORT:**
**4-13-88**

The Baseline Report was received in the CASET office on April 13, 1988.

**BASELINE REPORT CHECK:**
**5-3-88**

A check in the amount of $1,500.00 was sent to the Project Director for the Baseline Report on May 3, 1988.

**CONCEPT PAPER:**
**6-9-88**

The Concept Paper was received in the CASET office on June 9, 1988.

**CONSORTIUM MEETING LETTER:**
**6-27-88**

A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to the Project Director.

**CONCEPT PAPER CHECK:**
**6-29-88**

A check in the amount of $1,500.00 was sent to Dr. Shafi for the Concept Paper on June 29, 1988.

**INFORMATION LETTER:**
**7-1-88**

In a letter dated July 1, 1988, Ms. Vaughn advised Dr. Shafi of national Black organizations which are able to help him in planning and implementing

test preparation sessions.

**CONSORTIUM MEETING:**
**7-20-22-88**

The Consortium Meeting was held on July 20-22, 1988. The institution's representative was Dr. M.I. Shafi. It was agreed that the first semester of the Rust intervention would be a Pilot Project.

**PROPOSAL:**
**8-18-88**

The Proposal was received in the CASET office on August 18, 1988.

**PROPOSAL CHECK:**
**8-30-88**

A check in the amount of $2,000.00 was sent to the Dr. Shafi for the Proposal on August 24, 1988.

**PROPOSAL COMMENTS:**
**8-23-88**

The Proposal was reviewed by CASET staff (Ms. Linda Chappell, Dr. Adesua Ilegbodu, Ms. Muriel Vaughn) and CASET consultants, Dr. Harris Cooper and Dr. Larry Hedges. Comments were consolidated by Ms. Vaughn and sent to the Project Director for purposes of revision on August 3, 1988 after review and approval by Dr. Nina Kay, the Principal Investigator.

**REVISED PROPOSAL:**
**9-23-88**

The Revised Proposal was received in the CASET office on September 23, 1988.

**SITE VISIT:**
**10-26-27-88**

It was decided that it would be helpful for Muriel Vaughn to make a site visit. The current Project Director, Cheryl Richards, was not the one who attended the Consortium Meeting. In addition, it became apparent that there would not be enough time left in the semester to recruit students and to implement an intervention long enough to collect data. It was agreed that the Pilot Project for Rust would consist of the recruitment of students for the Saturday Academy and the final development of the proposal for the Saturday Academy. Ms. Vaughn brought the revised Pilot Project Proposal back with her to the CASET office.

**PILOT PROJECT MEETING:**
**10-31-11-1-88**

A meeting with CASET staff, consultants, and Pilot Project Directors was held on on October 31, 1988 through November 1, 1988. Ms. Cheryl A. Richards represented

Rust College.

**PILOT PROJECT SERVICES AGREEMENT:**
**11-15-88**
**11-16-88**

The Services Agreement for the Pilot Project was finalized with the signature of the Principal Investigator, Dr. Kay, on November 15, 1988 and the signature of Dr. McMilllan, the President of Rust College and Ms. Cheryl Ann Richards the Project Director, on November 16, 1988.

**FUNDING LETTER:**
**11-18-88**

A letter dated November 18, 1988 explaining the funding process was sent to Dr. Shafi, the Project Coordinator.

**PRE-BASELINE DATA INSTRUMENTS:**
**11-18-88**

The Pre-Baseline Data Instruments were sent to the Project Director on November 18, 1988.

**INITIAL PAYMENT:**
**11-22-88**

The Initial Payment, in the amount of $4,000.00 for the first semester planning phase of the intervention project was sent to the Project Director on November 22, 1988.

**SITE VISIT:**
**12-13-88**

Dr. King made a site visit to Rust to provide technical assistance in finalizing the proposal on December 13, 1988. He reviewed the comments prepared by staff and returned with the proposal. He also emphasized the importance of a sound research design and the need for the careful collection of data for later analysis by CASET.

**SATURDAY ACADEMY:**
**12-15-88**

The Proposal for the Saturday Academy was received in the CASET office on December 15, 1988.

**PROPOSAL COMMENTS:**
**12-16-88**

The Proposal was reviewed by Ms. Mary Ochoa, Ms. Muriel Vaughn and Dr. Adesua Ilegbodu. The comments were consolidated by Ms. Vaughn. Upon the review and approval by Dr. Nina Kay, Principal Investigator, they were sent to the Project Director on December 16, 1988.

**REVISED PROPOSAL:**
**12-27-88**

The Revised Proposal was received in the CASET office on December 27, 1988.

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| **REQUEST FOR EXTENSION:**<br>**12-27-88** | A request to extend the recruitment timeline for the Saturday Academy was received in the CASET office on December 27, 1988. Classes are to start on January 14, 1989. |
| **APPROVAL OF REQUEST:**<br>**1-3-89** | In a letter dated January 3, 1989, Dr. Kay approved the request. |
| **FINAL REVISION:**<br>**1-18-89** | The Final Revision of the Proposal for the Saturday Academy was received in the CASET office on January 18, 1989. |
| **FUNDING LETTER:**<br>**3-10-89** | A letter dated March 10, 1989 was sent to the Project Director by Dr. Kay explaining that CASET funding had been approved and clarifying the process for funding the Consortium participant institutions. |
| **FINAL PROPOSAL LETTER:**<br>**3-10-89** | In a letter dated March 10, 1989, the Dr. Kay outlined the requirements necessary to be submitted by the Project Director. |

* Was originally a pilot project; did recruitment in Fall, 1988; Converted to an "A" semester (Spring, 1989) project.

**TALLADEGA COLLEGE**
627 W. Battle Street
Talladega, Alabama 35160
205-362-0206

**ACTING PRESIDENT:**
Dr. Joseph E. Thompson
**PROJECT DIRECTOR:**
Dr. Arthur L. Bacon, Chairman
Division of Natural Sciences
and Computational Sciences

**FOCUS:** The focus of this intervention will be the retention of science students at Talladega College. The specific disciplines to be addressed are biotechnology, mathematics, chemistry, physics, computer sciences and pre-engineering. The program will be implemented during the academic year and will serve 25 fresh-men and sophomores.

**VISIT:**
**4-7-88**

The initial visit was made by Ms. Muriel C. Vaughn. She met with the following:

Dr. Bernard S. Smith, Director, Institutional Advancement
Dr. Joseph E. Thompson, Academic Dean
Dr. Arthur L. Bacon, Chair, Division of Natural Sciences and Computational Sciences

Prior to the visit, Dr. King sent a letter dated March 9, 1988 to Dr. Robert Mohr, then president, requesting the appointment and briefly describing CASET.

**LETTER OF INTENT:**
**4-26-88**

The Letter of Intent, indicating the President's willingness to participate in the Consortium, was signed by then President Paul B. Mohr on April 26, 1988.

**BASELINE REPORT:**
**6-20-88**

The Baseline Report was received in CASET office on June 20, 1988.

**CONSORTIUM MEETING LETTER:**
**6-27-88**

A letter dated June 27, 1988 containing the preliminary agenda and directions for the Consortium meeting was sent to Dr. Mohr an Dr. Smith on June 27, 1988.

**BASELINE REPORT:**
**6-21-88**

A check in the amount of $1,500.00 for the Baseline Report was sent to Dr. Mohr.

**CONSORTIUM MEETING:**
**7-20-22-88**

The Consortium Meeting was held on July 20-22, 1988. The institution's representative was Dr. Arthur L. Bacon, the Project Director.

**PROPOSAL:**
**7-22-88**

The Proposal was received in the CASET office on July 22, 1988.

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| **PROPOSAL CHECK: 7-1-88** | A check in the amount of $2,000.00 for the Proposal and to cover costs of travel to the Consortium Meeting was sent to the Project Director on August 1, 1988. |
| **CONCEPT PAPER: 11-18-88** | The Concept Paper was received in the CASET office on November 18, 1988. |
| **CONCEPT PAPER 11-23-88** | A check in the amount of $1,500.00 for the Concept Paper was sent to the Project Director on November 23, 1988. |
| **REVISED PROPOSAL: 12-29-88** | A Revised Proposal was received in the CASET office on December 29, 1988. |
| **PROPOSAL COMMENTS: 1-6-89** | The Revised Proposal was reviewed by Ms. Muriel Vaughn, Dr. Adesua Ilegbodu and Ms. Mary Ochoa. The comments were consolidated by Ms. Vaughn, reviewed and approved by Dr. Nina Kay and sent to the Project Director on January 6, 1989. |
| **PROPOSAL ADDENDUM: 2-14-89** | The Addendum to the Proposal was received in the CASET office on February 14, 1989. |
| **SERVICES AGREEMENT: 2-21-89** | The Addendum and the Proposal were incorporated into the Services Agreement and two originals of the Services Agreement were sent to the Project Director on February 21, 1989. |
| **SIGNED SERVICES AGREEMENT: 4-6-89** | The Services Agreements were signed by the Acting President, Dr. Joseph Thompson and the Project Director, Dr. Arthur Bacon, and received in the CASET office on April 6, 1989. |
| **FINAL SERVICES AGREEMENT: 4-17-89** | The Services Agreements were signed by Dr. Kay on April 17, 1989. One original was sent to the Project Director. The other was filed in the CASET office. |
| **INITIAL PAYMENT:** | A check in the amount of $ 12,325.00, pursuant to the terms of the Services Agreement was sent to the Project Director. |
| **PRE-BASELINE DATA INSTRUMENTS: 2-23-89** | The Pre-Baseline Data Instruments were sent the Project Director on February 23, 1989. |

* Dr. Joseph Thompson became acting president in June, 1988.

**TEXAS A&I UNIVERSITY***
Kingsville, TX 78363
512-595-2622

**PRESIDENT:** Dr. Steven Altman
**PROJECT DIRECTOR:****
Dr. Lionel Hewett, Chairman
Department of Physics

**FOCUS:** The foci of this intervention are retention and improved performance. The participants will be students in a Physics laboratory. The intervention will be implemented during the school year.

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| **VISIT:**<br>**4-18-88** | The initial visit was made by Dr. Nina W. Kay on April 18, 1988. |
| **LETTER OF INTENT:**<br>**5-23-88** | The Letter of Intent, indicating the president's willingness to participate in the Consortium was signed by the Director of the Office of Sponsored Research on May 23, 1988. |
| **BASELINE REPORT:**<br>**6-1-88** | The Baseline Data Report was received in the CASET office on June 1, 1988. |
| **BASELINE REPORT CHECK:**<br>**6-13-88** | A check in the amount of $1,500.00 for the Baseline Report was sent to the President on June 13, 1988. |
| **CONCEPT PAPER:**<br>**6-14-88** | The Concept Paper was received in the CASET office on June 14, 1988. |
| **CONSORTIUM MEETING LETTER:**<br>**6-27-88** | A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium meeting was sent to the president and the Project Director, Dr. Alfonso Lopez-Vasquez. |
| **CONCEPT PAPER CHECK:**<br>**6-29-88** | A check in the amount of $1,500.00 for the Concept Paper was sent to the President on June 29, 1988. |
| **PROPOSAL:**<br>**7-8-88** | The Proposal was received in the CASET office on July 8, 1988. |
| **PROPOSAL CHECK:**<br>**7-14-88** | A check in the amount of $2,000.00 for the Proposal and to cover costs of travel to the Consortium Meeting was sent to the Project Director on July 14, 1988. |
| **CONSORTIUM MEETING:**<br>**7-20-22-88** | The Consortium Meeting was held on July 20-22-1988. The institution's representatives were Dr. Lionel Hewett and Mr. Alfonso Lopez-Vasquez. |

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| **PROPOSAL COMMENTS:**<br>**8-13-88** | The Proposal was reviewed by CASET staff (Ms. Mary Ochoa, Ms. Muriel Vaughn, Ms. Linda Chappell, Dr. Adesua Illegbodu) and CASET consultants, Drs. Larry Hedges and Harris Cooper. The comments were consolidated by Ms. Vaughn and upon the review and approval of the Principal Investigator, Dr. Nina W. Kay, were sent to Project Director. |
| **PROPOSAL ADDENDUM:**<br>**1-12-89** | The Proposal Addendum was received in the CASET office on January 12, 1989. |
| **PROPOSAL DISCUSSION:**<br>**1-24-89** | In a telephone conversation between Ms. Ochoa and the Project Director on January 24, 1989, issues related to funding and the use of baseline data instruments for the collection of data about the intervention were discussed. |
| **FUNDING APPROVAL:**<br>**4-3-89** | On April 3, 1989, it was agreed that CASET would fund Texas A&I University at the level of $10,000.00 for the Spring semester (1989), $25,000.00 for the summer of 1989, and $15,000.00 for the fall of 1989. |
| **SERVICES AGREEMENT:** | The Proposal and Addendum were incorporated into the Services Agreement. Two originals were sent to the Project Director. |
| **SIGNED SERVICES AGREEMENT:** | The Services Agreements were signed by the President and the Project Director and received by CASET. |
| **FINAL SERVICES AGREEMENTS:** | The Services Agreements were signed by Dr. Kay. One original was sent to the Project Director. The other was filed in the CASET office. |
| **INITIAL PAYMENT:** | A check pursuant to the terms of the Services Agreement was sent to the Project Director. |
| **PRE-BASELINE DATA INSTRUMENTS:**<br>**4-3-89** | In a telephone conversation with Ms. Ochoa on April 3, 1989, the Project Director was advised that the CASET Principal Investigator had agreed that he could use his own Pre-Baseline Data Instruments instead of those developed by CASET. |

* Was originally a pilot project, but they need two semesters to set up the 4MAT system. The first two modules are ready and were used during "A" semester (Spring, 1989).

** In a letter dated September 30, 1988, Dr. Hewett indicated that he would be replacing Mr. Lopez-Vasquez as Project Director. The latter had taken a position in another institution.

**TEXAS SOUTHERN UNIVERSITY****
3100 Cleburne Street
Houston, Texas 77004
Telephone: 713-527-7836

**PRESIDENT:*** Dr. William H.Harris
**PROJECT DIRECTOR:**
Dr. Pearlie Fennell
Associate Professor of Chemistry

**FOCUS:** The foci of this intervention are recruitment and retention. The program will be called the Texas Southern University Minority Scientist Development Program. The participants will be 80 Texas Southern University students enrolled in their first college-level science courses who have declared their intention to major in mathematics or science. There will be 40 students in the intervention group and 40 in the control group. The term of the intervention will be 4 semesters starting in January, 1989.

**VISIT:**
**6-19-86**

In a letter dated June 19, 1986, Professor John Wiersma thanked Dr. Joseph Jones, Dean of the Graduate school of Texas Southern University, and his colleagues for meeting with him. He enclosed information about the September HBCU Conference.

Prior to the visit Professor Wiersma wrote a letter dated April 15, 1986 to then president Dr.Leonard Spearman requesting an appointment to visit to discuss CASET.

**7-2-86**

On July 2, 1986 Dr. Kay and Professor Wiersma met with Dr. Joseph Jones. At this time Dr. Jones expressed an interest in participating in the pilot test demonstration being considered for the Houston area. Attending the meeting were the following:

Mr. William Edwards, Director
Computer Services
Dr. Doretha Webb, Research
Associate
Mr. S.W. Mothershed, Director of
Libraries

Dr. Jones agreed to collaborate with Dr. Webb in the collection of data.

**STATUS REPORT:**
**7-14-86**

On July 14, 1986, Dr. Doretha Webb provided an oral status report to Dr. Kay.

**ORIGINAL PROPOSAL:**
**8-19-86**

The Original Proposal was submitted to CASET by Dr. Jones on August 19, 1986.

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| **MEMORANDUM OF UNDERSTANDING: 12-4-86** | In a letter dated December 4, 1986, Dr. Kay enclosed the Memorandum of Understanding between Huston-Tillotson College/CASET and the Graduate School/ Texas Southern University. It had been signed by Dr. King and Dr. Kay. It was to be signed by then President of TSU, Dr. Terry, and Dr. Jones, Dean of the Graduate School. |
| **NEW ACTIVITIES: 2-1-88** | In a letter dated February 1, 1988 from Dr. Jones to Professor Wiersma, Dr. Jones outlined the new activities to be undertaken by Texas Southern University. |
| **SERVICES AGREEMENT: 2-12-88 2-18-88** | A Services Agreement itemizing the new activities was signed by Dr. Kay on February 12, 1988 and by Dr. Jones on February 18, 1988. |
| **INTERVENTION PLANNING COSTS: 2-19-88** | On February 19, 1988 a check in the amount of $5,000.00 was sent to Texas Southern University to cover Intervention Planning Costs. |
| **CONSORTIUM MEETING LETTER: 6-27-88** | A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to Dr. Jones. |
| **PROPOSAL: 7-7-88** | The Proposal was received in the CASET office on July 7, 1988. |
| **CONSORTIUM MEETING: 7-20-22-88** | The Consortium Meeting was held at Johnson Space Center on July 20-22, 1988. The institution's representatives were Dr. Jones and Dr. Antoinette Boecker. |
| **INTERVENTION PLANNING COSTS: 8-4-88** | On August 4, 1988 a check in the amount of $2,500.00 was sent to Texas Southern University toward Intervention Planning Costs. |
| **PROPOSAL COMMENTS: 8-23-88** | The Proposal was reviewed by CASET staff, Ms. Linda Chappell, Ms. Muriel Vaughn and Dr. Adesua Ilegbodu. Comments were consolidated by Ms. Vaughn and sent to Dr. Boecker upon the review and approval of Dr. Kay on August 23, 1988. |

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| **REVISED PROPOSAL:**<br>**9-13-88** | The Revised Proposal was received in the CASET office on September 13, 1988. |
| **REVISED PROPOSAL COMMENTS:**<br>**10-14-88** | The Revised Proposal was reviewed by CASET staff (Ms. Mary Ochoa, Ms. Linda Chappell and Ms. Muriel Vaughn). In a letter to Dr. Jones dated October 14, 1988, Dr. Kay itemized some of the concerns of the CASET consultants and indicated that the CASET Research Team would like to meet with Dr. Jones and the Project Director, Dr. Pearlie Fennell. Ms. Ochoa consolidated the Team's comments in preparation for the meeting. The |
| **10-20-88** | meeting was held on Tuesday, October 20, 1988. Present were Dr. Pearlie Fennell, Dr. Joseph Jones, Dr. Nina Kay, Dr. Adesua Ilegbodu, Ms. Mary Ochoa, and Ms. Muriel Vaughn. In a letter dated on the same day, Dr. Kay thanked Dr. Fennell for the meeting and advised her that the Services Agreement would incorporate the addendum which she would prepare to address the comments discussed. |
| **PRE-BASELINE DATA INSTRUMENTS:**<br>**10-24-88** | The Pre-Baseline Data Instrument packet was sent to Dr. Fennell on October 24, 1988. It included the following: Instructions for Project Director, Student Consent Form, Parent Permission Form, College Student Protocol, Opinion Protocol, Standardized Test Scores Form, and the Project Director Protocol. |
| **SERVICES AGREEMENT:**<br>**10-20-88**<br>**10-31-88** | The Services Agreement was enclosed with a letter dated October 31, 1988. It was signed by Dr. Kay on October 20, 1988, by Dr. Fennell and by Dr. Harris, the President of Texas Southern University on October 31, 1988. |
| **PROPOSAL ADDENDUM:**<br>**11-7-88** | The Proposal Addendum was received in the CASET office on November 7, 1988. |
| **INITIAL PAYMENT:**<br>**11-23-88** | The Initial Payment in the amount of $20,000.00, pursuant to the terms of the Services Agreement, was sent to Texas Southern University on November 23, 1988. |

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| **MODIFIED SERVICES AGREEMENT: 1-5-89** | A modified Services Agreement, adjusting the schedule for the intervention was sent to Dr. Fennell by Dr. Kay on January 5, 1989. |
| **REVISED PRE-BASELINE DATA INSTRUMENTS: 1-12-89** | A revised Baseline Data Instruments packet was sent to Dr. Fennell on January 12, 1989. |
| **FINAL SERVICES AGREEMENT: 1-13-89** | The modified Services Agreement, signed by Dr. Jones and Dr. Fennell on January 11, 1989, was received in the CASET office on January 13, 1989. With the Services Agreement received in the CASET office on November 7, 1988, this constitutes the Final Services Agreement. |
| **SUPPORT REQUEST: 2-3-89** | A letter to Dr. Kay from Dr. Jones was received in the CASET office on February 3, 1989 requesting CASET's support in the proposal of Texas Southern University to the National Science Foundation for the establishment of a Comprehensive Regional Center for Minorities. |
| **SUPPORT LETTER: 2-20-89** | A letter of support for the above-mentioned effort was sent to Dr. Jones by Dr. Kay on February 20, 1989. |

* Dr. William Harris assumed the presidency of TSU on July 1, 1989.

** Was originally a pilot project, but they had recruitment problems with the control group and converted to an " A" semester Project (Spring, 1989).

**WESTERN NEW MEXICO UNIVERSITY**
P.O. Box 680
Silver City, NM 88062
505-538-6352

**PRESIDENT:** Dr. Rudolph Gomez
**PROJECT DIRECTOR:**
Dr. John Cunningham, Chairman
Dept. of Physical Sciences

**FOCUS:** The focus of this intervention is the recruitment of high school students into SET studies. Twenty to twenty-five students will participate in a week-long experience in the mountains during the summer of 1989.

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| **VISIT:**<br>**4-22-89** | The initial visit was made by Dr. Nina W. Kay and Consultant Cesar Trimble on April 22, 1989. |
| **LETTER OF INTENT:**<br>**7-15-88** | The Letter of Intent, indicating the President's willingness to participate in the Consortium, was signed by the President, Rudolph Gomez, on July 15, 1988. |
| **CONSORTIUM MEETING LETTER:**<br>**6-27-88** | A letter dated June 27, 1988 containing the preliminary agenda and directions for attending the Consortium Meeting was sent to the Project Director. |
| **BASELINE REPORT:**<br>**CONCEPT PAPER:**<br>**PROPOSAL:**<br>**7-12-88** | The Baseline Report, Concept Paper, and Proposal were received in the CASET office on July 12, 1988. |
| **CHECK:**<br>**7-15-88** | A check in the amount of $5,000.00 was sent to the President on July 15, 1988 for intervention planning costs: the Baseline Report, Concept Paper, the Proposal and costs to cover travel to the Consortium Meeting. |
| **CONSORTIUM MEETING:**<br>**7-20-22-88** | The Consortium Meeting was held on July 20-22-88. The institution's representative was Dr. William Hayes. |
| **PROPOSAL COMMENTS:**<br>**8-23-88** | The Proposal was reviewed by CASET staff (Ms. Linda Chappell, Dr. Adesua Ilegbodu, and Ms. Muriel Vaughn) and CASET consultants, Dr. Harris Cooper and Dr. Larry Hedges. Comments were consolidated by Ms. Vaughn and sent to the Project Director for purposes of revision on August 23, 1988 after review and approval by Dr. Nina Kay, the Principal Investigator. A copy of the Guidelines for the Proposal was also |

enclosed.

**REVISED PROPOSAL:**
**10-21-88**

The Revised Proposal was received in the CASET office on October 21, 1988.

**REVISED PROPOSAL COMMENTS:**
**11-28-88**
**11-16-89**
**1-26-89**
**1-30-89**

The Revised Proposal was reviewed by Ms. Linda Chappell, Dr. Adesua Ilegbodu, Ms. Mary Ochoa and Ms. Muriel Vaughn. Comments were consolidated by Ms. Muriel Vaughn and discussed in a conference call with Dr. Cunningham, Dr. Milligan and Dr. Cowan on November 28, 1988, with the Project Director, Dr. John Cunningham on December 15, 1988 and January 16, 1988 and with Dr. Milligan on January 30, 1989.

**PROPOSAL ADDENDUM:**
**2-13-89**
**3-22-89**

The Proposal Addendum was received in the CASET office on February 13, 1989. In a letter dated March 22, 1989, the Principal Investigator indicated that the addendum met CASET design requirements and called attention to several other recommendations.

**FUNDING PLAN:**
**3-16-89**

The plan for funding the intervention for the summer of 1989 was approved by Dr. King and Dr. Kay on March 16, 1989.

**SERVICES AGREEMENT:**
**5-3-89**

The Proposal and Addendum to the Proposal were incorporated into the Services Agreement. Two originals of the Services Agreement were sent to the Project Director on May 3, 1989.

**PRE-BASELINE DATA INSTRUMENTS:**
**5-3-89**

Included in the packet with the Services Agreement were the Pre-Baseline Data Instruments, Consent Forms for the intvention and comparison groups, Standardized Test Scores Reporting Forms Instructions for the Project Director, and Project Director.

**SIGNED SERVICES AGREEMENT:**
**5-18-89**
**5-10-89**
**5-22-89**

The Services Agreements were signed by the President and the Project Director on May 18, 1989 and May 10, 1989 respectively. It was received in the CASET office on May 22, 1989.

**FINAL SERVICES AGREEMENT:**
**5-25-89**

The Services Agreements were signed by Dr. Kay on May 25, 1989. One was sent to the Project Director. The other was

filed in the CAST office.

**INITIAL PAYMENT:** A check in the amount of $3,930.00, pursuant to the terms of the Services Agreement, was sent to the Project Director.

**WILBERFORCE UNIVERSITY**
Wilberforce, Ohio 45384-1001
Telephone: 513-376-2911 x 657

**PRESIDENT:** Dr.John L. Henderson
**PROJECT DIRECTOR:**
Ms. Jennie Hodges Sethna
Director, Dual Degree
Engineering and Computer
Science Programs

**FOCUS:** The foci of this intervention are retention and improved performance. The participants are 7th grade students from the Dayton Public School System. The term of the intervention is June 26, 1989 to July 28, 1989 with follow-up activities during the following academic year and another summer intervention in 1990.

**VISIT:**
**3-30-88**

The Initial Visit was made by Dr. John Q. Taylor King and Ms. Muriel C. Vaughn on March 30, 1988. They met with the following:

- Dr. John L. Henderson, President
- Dr. Cassandra H. Courtney, Vice President, Academic Affairs
- Dr. Surinder K. Saine, Chairperson, Natural Science Division
- Mr. Ambrose B. Nutt, Director, Dual Degree Engineering and Computer Science Program

Prior to the visit, on March 18, 1988, a letter was sent to Dr. Henderson requesting an appointment with him and briefly describing CASET. A letter dated March 23, 1989 was sent to Dr. Henderson confirming the appointment. Mr. Nutt sent Muriel Vaughn information which she requested about the dual-degree program and the National Technical Association on March 31, 1988.

**3-31-88**
**4-22-88**

Muriel Vaughn wrote to thank Mr. Nutt for the materials on April 22, 1988 and indicated that she had shared the NTA material with Dr. King and Dr. Kay.

**LETTER OF INTENT:**
**4-5-88**

The Letter of Intent, indicating the President's willingness to participate in the Consortium, was signed by the President on April 5, 1988.

**CONSORTIUM MEETING:**
**6-27-88**

A letter dated June 27, 1988 containing the preliminary agenda and directions for the Consortium Meeting was sent to the Project Director.

| | |
|---|---|
| **CONSORTIUM MEETING:**<br>**7-20-22-88** | Wilberforce University was not represented at the Consortium Meeting which was held at Johnson Space Center from July 20-22, 1988. |
| **PROJECT DIRECTOR:**<br>**7-25-88** | In a letter dated July 25, 1988, the President advised Dr. Kay that Mr. Nutt would be retiring in August and there would be no one to direct Wilberforce's participation in the Consortium at this time. He indicated that he would like to participate at some future date if possible. Dr. |
| **11-30-88** | Henderson was contacted by Ms. Muriel Vaughn about reconsidering Wilberforce's participation in the Consortium. In a letter dated November 30, 1988, Dr. King acknowledged Dr. Henderson's appointment of Ms. Jennie Sethna as the new Project Director. Ms. Sethna has replaced Mr. Nutt as the Director of the Dual-Degree Engineering and Computer Science Program. |
| **CONSORTIUM PACKET:**<br>**12-7-88** | In a letter dated December 7, 1988, the following materials were sent to Ms. Sethna: Basic Research Questions, Schedule of Planning Activities, CASET Executive Summary, Guidelines for Proposals. The date set for receipt of the Proposal was February 24, 1989. |
| **PROPOSAL:**<br>**2-24-89** | The Proposal was received in the CASET office on February 24, 1989. |
| **PROPOSAL COMMENTS:**<br>**2-27-89** | The Proposal was reviewed by CASET staff (Dr. Adesua Ilegbodu, Ms. Mary Ochoa and Ms. Muriel Vaughn). The comments were discussed briefly on the phone by Ms. Sethna and Ms. Vaughn. |
| **FUNDING LETTER:**<br>**3-10-89** | A letter indicating approval of funding by CASET and outlining the Consortium funding process was sent by Dr. Kay to the Project Director on March 10, 1989. |
| **PROPOSAL COMMENTS:**<br>**3-15-89** | A letter dated March 15, 1989 containing further comments on the Proposal was sent to the Project Director by the Principal Investigator. |
| **PROPOSAL CHECK:**<br>**3-17-89** | A check in the amount of $2,000.00 was sent to the Project Director on March 17, 1989 for the Proposal and for travel to one Consortium Meeting. |

| | |
|---|---|
| **PROPOSAL ADDENDUM:** | The Proposal addendum was received in the CASET office. |
| **SERVICES AGREEMENT:** | The Addendum was incorporated into the Services Agreement and two originals were sent to the Project Director. |
| **SIGNED SERVICES AGREEMENT:**<br>**6-12-89**<br>**6-14-89** | The Services Agreements were signed by the Project Director and the President on June 21, 1989 received in the CASET office on June 14, 1989. |
| **FINAL SERVICES AGREEMENT:**<br>**6-21-89** | The Services Agreements were signed by Dr. Kay on June 21, 1989. One original was returned to the Project Director and the other was filed in the CASET office. |
| **INITIAL PAYMENT:**<br>**6-22-89** | A check for the Initial Payment in the amount of $ 11,245.00, pursuant to the terms of the Services Agreement, was sent to the Project Director on June 22, 1989. |
| **PRE-BASELINE DATA INSTRUMENTS:** | A packet containing the Pre-Baseline Data Instruments, the Consent Forms and directions to the Project Director was sent to the Project Director. |

# APPENDIX C

# CASET INTERVENTION REPORTS

# CASET RESEARCH REPORT:

# ALABAMA STATE UNIVERSITY

# INTERVENTIONS

Prepared by:

John Q. Taylor King, Ph.D., Carl W. Scott, Ph.D., Gilbert Ramirez, Dr. P.H.,
Adesua Ilegbodu, Dr. P.H., Mary Ochoa, Linda S. Chappell, and Stephen L. Wiggins

This report was developed as one product of:

> A Study to Determine and Test Factors Impacting on the Supply of Minority and Women Scientists, Engineers, and Technologists for Defense Industries and Installations

conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College under Grant DAMD17-88-Z-8013, with support from the National Aeronautics and Space Administration under a Johnson Space Center Memorandum of Understanding.

The views, opinions, and/or findings contained in this publication are those of the author(s) and should not be construed as an official U.S. Department of the Army position unless so designated by other documentation; neither do they reflect those of the U.S. Department of Defense or National Aeronautics and Space Administration.

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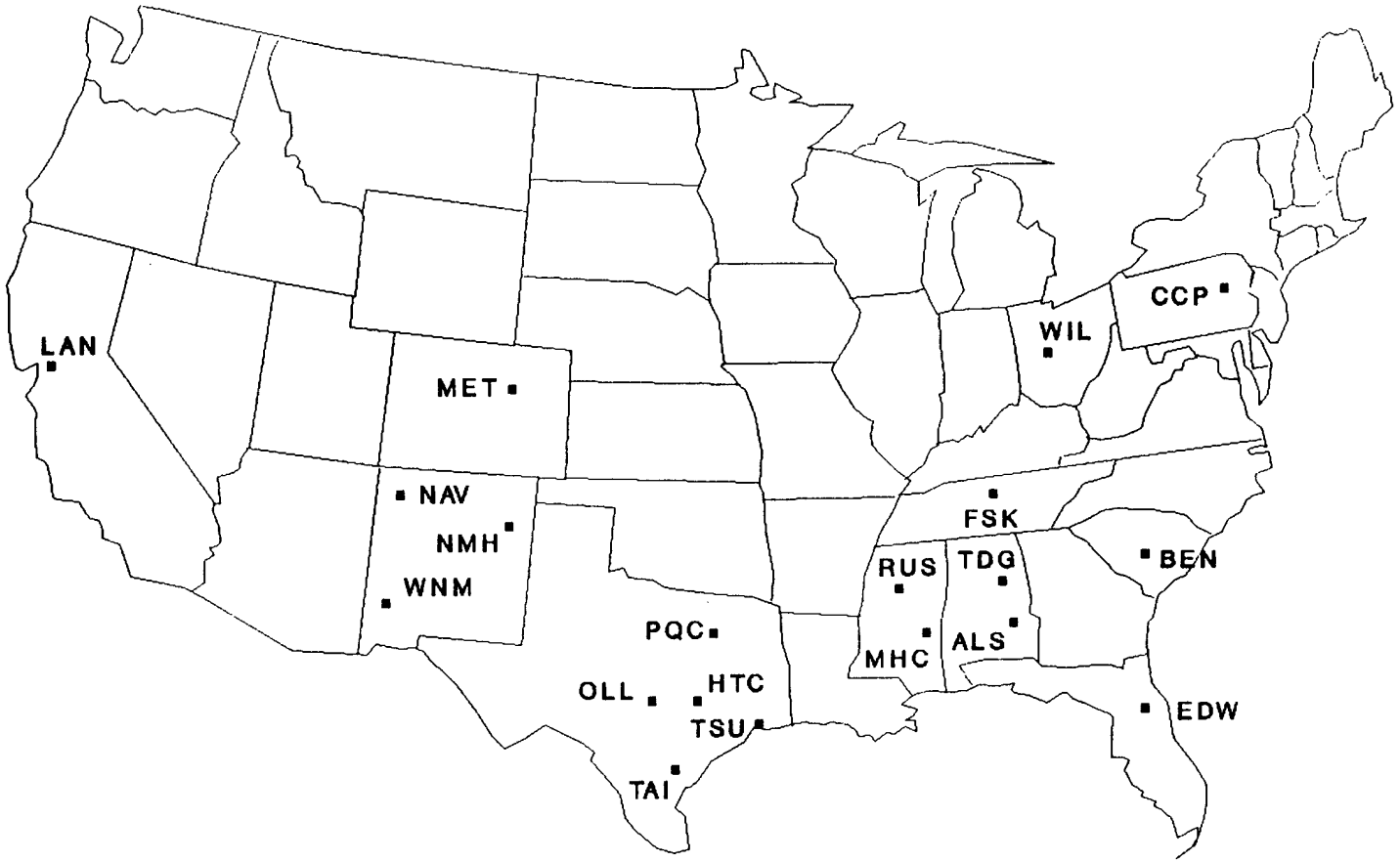
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART 1

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected come from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention- group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF ALABAMA STATE UNIVERSITY

Alabama State University is a historically Black, four-year, public, coeducational institution located in Montgomery, Alabama. The University community consists of approximately 4000 students and 270 faculty members. The University, organized into the University College, College of Arts and Sciences, College of Education, College of Business Administration, School of Music, and the Division of Aerospace Studies, offers undergraduate and graduate degrees. The student body is approximately 58 percent female and 42 percent male. Approximately 99 percent of the students are Black, and the remaining 1 percent are of other ethnic origins. The president of Alabama State University is Dr. Leon Howard.

Degrees offered at Alabama State University in quantitative subjects are the Bachelor of Science in chemistry, mathematics, physics, and computer information systems. The Department of Mathematics offers a dual degree program in mathematics and engineering in cooperation with Auburn University. The University also offers Master of Arts and Master of Science degrees through cooperation with the College of Arts and Sciences.

Montgomery has a population of approximately 194,000 in its metropolitan area. The state of Alabama has a population of approximately 4.1 million. According to U.S. Census Bureau estimates, the adult population of Alabama is 75 percent Anglo, 23 percent Black, 1 percent Hispanic, and 1 percent other ethnic origins. Montgomery has a number of other institutions of higher education, including Auburn University at Montgomery, Faulkner University, Huntingdon College, John M. Patterson State Technical College, and Troy State University at Montgomery.

# PART II:

# SUMMARY OF THE ALABAMA STATE UNIVERSITY (ASU) INTERVENTIONS

This report summarizes the five interventions conducted by Alabama State University (ASU), a historically Black, four-year public institution located in Montgomery, Alabama. ASU is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

ASU Intervention Activities:

From Summer 1989 through Spring 1991, ASU conducted five peer-tutorial programs in college precalculus, calculus and physics. Successful upper-level students majoring in SET fields were assigned to serve as Big Brothers and Big Sisters, tutoring the participants, who were Black college students, mainly freshmen, enrolled in mathematics and/or physics courses for the semester of participation. The two summer interventions included additional elements of seminars providing training in academic skills: Writing, and Critical Thinking and Problem Solving.

Findings:

- Course grades improved for tutored students in four of the five semesters of intervention.
- The most positive performance effects were associated with the first semester of intervention; this was a summer program which also featured skills seminars.
- Both summer programs had a positive impact on mathematics: In one case, retention in the class was improved; in the other case, course grade was improved.
- Throughout the semesters of intervention, little effect was demonstrated on opinion.
- This intervention design may provide benefit, not only for the tutored students, but also for the Big Brothers and Big Sisters, who are paid and recognized for the knowledge they have attained.

Recommendations:

The Big Brother-Big Sister intervention approach can have real benefit. However, it is not uniformly effective; the following recommendations are made with the goal of maximizing effectiveness:

- Monitor the effectiveness of tutors, by personal supervision of the tutoring process and by a careful reading of midterm examinations of tutees.
- Do not hesitate to intervene or change a tutor when indicated.
- Tutoring-based interventions should be supplemented with study skills seminars.

# PART III:

# CASE STUDY OF THE ASU 1989 SUMMER SEMESTER INTERVENTION

## ABSTRACT

In 1989 Alabama State University (ASU), Montgomery, Alabama, initiated and tested against a control group a summer residential enrichment intervention program. Participants were 30 Black undergraduate college students (12 women and 18 men) enrolled in Calculus I and Physics I courses. The intervention was repeated in the fall of 1989, in the spring of 1990, in the summer of 1990, and in the spring of 1991.

The ASU program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES*: Hypotheses were that the intervention would: (a) enhance performance in calculus and physics courses, (b) increase the percentage of students who finish these courses, and (c) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS*: Major components of the intervention included peer tutoring in calculus and physics by successful upper-division science and/or mathematics majors along with structured training in critical thinking, problem-solving, test-taking, time management, writing, reading, and studying.

*DATA*: All the participants furnished demographic data through the CASET College Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were college GPAs, national standardized test scores, and Calculus I and Physics I semester grades.

The outcome measure of performance was the course grade earned by each student. The preintervention measures of performance were ACT score and prior college GPA.

*RESEARCH DESIGN*: The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design; through analyses of preintervention measures it appeared that the intervention and control groups were comparable.

*FINDINGS*: In general, the intervention had a positive effect on the participants and can be considered a successful intervention. The hypotheses of enhanced student performance in calculus and physics and increased retention rates in mathematics and science received substantial support; the hypothesis of enhanced opinions about SET fields and careers received some support. The intervention significantly improved students' performance in physics. Although the intervention did not significantly improve students' performance in calculus, the retention rate in calculus was significantly higher for the intervention group than for the control group. The intervention group had significantly higher scores than the control group on the Value opinion scale, indicating more favorable opinions of the value of SET fields and careers.

## DESCRIPTION OF THE INTERVENTION

The Alabama State University (ASU) summer CASET program was an in-residence program for minority and women college students majoring in SET fields, with particular attention to freshmen and sophomores. The purposes of the summer in-residence Enrichment Program included: (1) providing the student participants with structured training in critical academic skills (reading, studying, test-taking, and technical writing); and (2) enhancing

their interest, preparedness, and confidence for the subsequent pursuit of those science and mathematics courses which are SET profession prerequisites. The three major hypotheses were that the intervention's tutoring and seminars would: (a) enhance performance in calculus and physics courses, (b) increase the percentage of students who finish the courses, and (c) enhance opinions about SET fields and careers.

The Summer Enrichment Program began on June 7, 1989, and ended August 5, 1989. Classes met daily Monday through Friday. Students were enrolled in calculus and physics courses for academic credit, and took part in two non-credit enrichment seminars: Writing, and Critical Thinking & Problem-Solving. A key component of this program was work with peer tutors: Upperclassmen who were successful SET majors provided tutoring in academic areas, particularly in calculus and physics. Each intervention-group student was assigned a Big Brother or Big Sister peer tutor; the hours from 3:00 to 5:00 p.m. each day were set aside for meetings between intervention-group students and their assigned Big Brother and Big Sister tutors. Each Big Brother and Big Sister was assigned four intervention-group students to tutor, both men and women.

Schedule for the 1989 CASET Summer Enrichment Program at ASU was as follows:

| | | |
|---|---|---|
| 8:00 - 8:50 a.m. | MWThF | College Physics I |
| | T | Physics Laboratory |
| 10:00 - 11:00 a.m. | TTh | Seminar: |
| | | Writing |
| | | Reading Comprehension Skills |
| | | Study Skills |
| 11:00 - 12:00 a.m. | TTh | Seminar: |
| | | Critical Thinking & Problem Solving |
| | | Time Management Skills |
| | | Test-Taking Skills |
| 1:00 - 2:40 p.m. | MTWTh | Calculus I |
| 3:00 - 5:00 p.m. | MTWThF | Tutoring sessions with Big Sister and Big Brother tutors |

The Project Director for this CASET intervention at Alabama State University was Dr. Wallace Maryland, Jr., Chair, Mathematics and Physical Science, Alabama State University. Faculty members for the Summer Enrichment Program were selected from ASU's summer faculty. The physics instructor was Dr. Iraj Danesh. The calculus instructor was Dr. Daniel Stallworth. The instructor for the seminar in Writing, Reading Comprehension Skills, and Study Skills was Dr. Eunice Moore. The instructor for the seminar in Critical Thinking & Problem Solving, Time Management Skills, and Test-Taking Skills was Dr. Robert B. Stone. Honors upperclassmen who served as Big Brothers and Big Sisters were Derrick Libyrd and Pyal Sylva, Big Brothers; Angelia Stanford and Vonda Cross, Big Sisters.

## METHOD

### Subjects

Participants were Black college students at ASU majoring in SET fields and taking Calculus I and Physics I during the summer of 1989. A control group of Black college students also enrolled in either Calculus I or Physics I was

identified. The control group did not participate in any intervention activities. All demographic, opinion, and performance data were collected from the control group as well as the intervention group.

A total of 30 sets of protocols was received from 16 intervention- and 14 control-group students, and all 30 sets of data were analyzed. All students were Black Americans; Table 1 shows the distribution of men and women in the intervention and control groups.

**Table 1**

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| Race/Ethnicity | Women | Men | Women | Men | Women | Men |
| American Indian | | | | | | |
| Anglo | | | | | | |
| Black | 6 | 8 | 6 | 10 | 12 | 18 |
| Hispanic | | | | | | |
| Unknown | | | | | | |
| TOTAL | 6 | 8 | 6 | 10 | 12 | 18 |

CASET Protocols and Other Instruments

The three major hypotheses of the intervention were that the tutoring and seminars would: (a) enhance performance in calculus and physics courses, (b) increase the percentage of students who finish the courses, and (c) enhance opinions about SET fields and careers.

Demographic and descriptive data about the subjects were developed through the CASET College Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gave a scalar measurement for that variable. Thus the completed Opinion Protocol provided a scale measuring each of the thirteen variables.

The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B.

The Opinion Protocol was administered to intervention- and control- group students before and after the intervention.

The preintervention measures of performance for intervention-group and control-group students were ACT score and prior college GPA. The postintervention measures of performance were the course grades in Calculus I and Physics I.

### Procedure

At the beginning of the intervention, intervention- and control- group members signed consent forms and transcript release forms. The first measures of opinion and the measures of demographic information were taken in June, 1989. In August, 1989, after the intervention, the CASET Opinion Protocol was administered a second time to all students. Final grades in Calculus I and Physics I for intervention- and control-group students were forwarded to CASET, along with the CASET Student Protocol and the preintervention and postintervention Opinion Protocols. The college also supplied college transcripts for intervention- and control-group students, and documentation of the extent of participation by each student in each component of the intervention, that is, tutoring sessions and seminars.

The items of the Opinion Protocol were coded by CASET according to the thirteen scales they represented. The items were scored so that a larger score indicated a more positive opinion. The scales were organized into three constructs--SET Goal, Environmental Support, and Attitude--as shown in Appendix C.

## RESULTS

### Methodological Issues

The three major hypotheses were that the intervention's tutoring and seminars would: (a) enhance performance in calculus and physics courses, (b) increase the percentage of students who finish the courses, and (c) enhance opinions about SET fields and careers. Most participants had preintervention and postintervention measures of opinion and performance, and the intervention was analyzed as a nonequivalent control group design. This type of quasi-experimental design has one major weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty may be addressed by analyzing the influence of preexisting characteristics on students' performance and opinion; the analysis of covariance (ANCOVA), adjusting for preintervention performance or opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that existed prior to the intervention.

### Demographic Results

The comparability of the intervention and control groups was examined by testing for differences on the items of the College Student Protocol. The complete results are given in Appendix D. Of the 54 comparisons, the groups differed on only two: (a) the intervention-group students were younger ($\underline{M}$ = 21.4 years) than the control-group students ($\underline{M}$ = 23.01 years); and (b) fewer intervention-group students were juniors or seniors (43% of intervention-group students, 93% of control-group students). The two differences between the groups on preexisting

characteristics were fewer than the number of differences expected by chance at the 10-percent probability level--five. Based on these results, the groups were judged to be comparable on demographic characteristics prior to the intervention. However, the two demographic-difference variables were correlated with performance in later analyses to judge their potential influence on performance.

## Performance Measures

*Group differences in performance.* The two preintervention measures (ACT score and preintervention college GPA) and the two postintervention measures of performance (final grade in calculus and final grade in physics) were tested for group differences, and the results are given in Table 2. Note that the intervention and control groups did not differ on any of the preintervention measures of performance, but the intervention-group students had a higher mean final grade in physics ($\underline{M}$ = 1.60, approximately a "C-") than did the control-group students ($\underline{M}$ = 0.60, approximately a "D-"). The groups did not differ significantly on calculus grades. A further analysis was conducted to investigate possible preintervention differences between the groups via ANCOVAs that adjusted for ACT composite percentile and preintervention college GPA.

**Table 2**

**GROUP COMPARISONS OF PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | Sig. p |
|---|---|---|---|---|---|---|
| ACT, Composite | Control<br>Intervention | 10<br>13 | 13.80<br>17.15 | 2.86<br>6.00 | 1.63<br>(21) | ns |
| GPA, Prior | Control<br>Intervention | 13<br>15 | 2.64<br>2.63 | 0.43<br>0.44 | -0.06<br>(26) | ns |
| Calculus Final Grade | Control<br>Intervention | 5<br>16 | 2.40<br>2.31 | 0.55<br>0.95 | -0.19<br>(19) | ns |
| Physics Final Grade | Control<br>Intervention | 5<br>15 | 0.60<br>1.60 | 0.89<br>1.35 | 1.53<br>(18) | $\leq$.10 |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

*Group differences after adjusting for pretests.* A hierarchical ANCOVA adjusted for two different pretests (ACT composite percentile and preintervention college GPA) before comparing groups on postintervention performance measures; the results are given in Table 3. This table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding the first and each subsequent variable to the multiple regression

equation (one variable per row), and the significance test of each variable's contribution toward explaining the dependent variable. The columns of the table include the cumulative percentage of explained variance (cum $R^2$), added contribution in explained variance of the variable ($sR^2$), test of the contribution of the new variable ($F(sR^2)$), and the degrees of freedom (df) for the test. Because the hypothesis was directional--improvement for the intervention group--the test statistics were compared to one-tailed probability levels; for F statistics, this involved converting from the F to t statistic ($F = t^2$), and determining the corresponding one-tailed critical value.

The results in Table 3 demonstrated that the intervention group outperformed the control group on the physics final grade and that the groups did not differ significantly on calculus grades. Of the two covariates, prior college GPA was a better covariate than was ACT percentile; the ACT percentile did not correlate significantly with either course grade. The results from Tables 2 and 3 supported the first hypothesis of better performance for the physics course only.

**Table 3**

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Calculus Final Grade | ACT | .0139 | .0139 | 0.20 | 1,14 | ns |
| | + GROUP | .0157 | .0017 | 0.02 | 1,13 | ns |
| | + ACT-x-GROUP | .0794 | .0638 | 0.83 | 1,12 | ns |
| Calculus Final Grade | PRIOR GPA | .3407 | .3407 | 8.78 | 1,17 | $\leq$.01 |
| | + GROUP | .3427 | .0020 | 0.05 | 1,16 | ns |
| | + GPA-x-GROUP | .3621 | .0194 | 0.46 | 1,15 | ns |
| Physics Final Grade | ACT | .0066 | .0066 | 0.09 | 1,14 | ns |
| | + GROUP | .0624 | .0558 | 0.77 | 1,13 | ns |
| | + ACT-x-GROUP | .0626 | .0003 | 0.00 | 1,12 | ns |
| Physics Final Grade | PRIOR GPA | .1003 | .1003 | 1.89 | 1,17 | $\leq$.10 |
| | + GROUP | .2037 | .1035 | 2.08 | 1,16 | $\leq$.10 |
| | + GPA-x-GROUP | .2079 | .0041 | 0.08 | 1,15 | ns |

All models were analyzed as one-tailed tests.

* Three models of independent variables were tested for each dependent variable. e.g.: (1) ACT alone: (2) ACT and ('+') GROUP: (3) ACT and GROUP and ACT-by-GROUP INTERACTION ('-x-').

*Group differences after adjusting for demographic differences.* Two demographic variables had differed between the intervention-group and control-group students: The control group was older and had more upper-division students. These two variables were correlated with some aspects of performance: Age was significantly correlated with prior GPA ($r = -.58$, $n = 28$, $p \leq .01$) and year in school was significantly correlated with prior GPA ($r = -.36$, $n = 28$,

$p \leq .05$) and calculus final grade ($r = -.30$, $n = 21$, $p \leq .10$). To test whether these two variables had any influence after adjusting for preintervention performance, the ANCOVAs reported in Table 3 were repeated, but age and classification were entered after preintervention GPA and before the group membership variable. The results did not change: There was no difference between groups for calculus final grades, and the groups differed significantly for physics final grades, with the group variable still accounting for about 10 percent of the variance of physics grades.

*Course completion*. The second hypothesis was that the intervention activities would help more students complete the courses. The percentages of students successfully completing the calculus class in the intervention and control groups were significantly different, chi-square ($1, N = 24$) = 3.86, $p \leq .05$ (Yates' corrected): 100 percent (16 of 16) of the intervention-group students finished the calculus course, while only 62 percent (5 of 8) of the control group finished the same course. The percentages of students successfully completing the physics class in the intervention and control groups were not significantly different: 94 percent (15 of 16) of the intervention-group students finished the physics course, while 63 percent (5 of 8) of the control-group students finished the same course. The analysis of the completion rates indicated support for the second hypothesis: A significantly higher percentage of intervention-group students finished the calculus course than did control-group students.

*Interrelationships among performance*. The interrelatedness of the performance measures was examined through intercorrelations, presented in Table 4. The significant correlations indicated the following: the ACT percentile did not correlate with either calculus or physics grades; preintervention GPA did correlate with the calculus and physics grades; ACT percentiles did correlate with GPA; and calculus and physics grades were correlated.

**Table 4**

**INTERCORRELATIONS AMONG PERFORMANCE MEASURES[A]**

| | **ACT (n) Signif. p-Value** | **GPA (n) Signif. p-Value** | **Calc Final (n) Signif. p-Value** | **Phys Final (n) Signif. p-Value** |
|---|---|---|---|---|
| ACT | 1.00 | | | |
| GPA | .47<br>(22)<br>$\leq .05$ | 1.00 | | |
| Calculus Final Grade | .12<br>(16)<br>ns | .58<br>(19)<br>$\leq .01$ | 1.00 | |
| Physics Final Grade | .08<br>(16)<br>ns | .32<br>(19)<br>$\leq .10$ | .54<br>(15)<br>$\leq .05$ | 1.00 |

[a] All correlations were analyzed as two-tailed tests.

*Relationships between performance and participation.* Table 5 displays the correlations between attendance at tutoring sessions or the seminars and calculus or physics grades. Note that tutoring attendance was significantly correlated with both grades, and that seminar attendance was significantly correlated with physics grades. Though significant correlations between performance and participation lend support to the findings of group differences that favored the intervention group, the significant correlations also may be explained as the better performing students having had better attendance coincidentally.

**Table 5**

| CORRELATIONS BETWEEN PERFORMANCE AND PARTICIPATION MEASURES | | | |
|---|---|---|---|
| **PERFORMANCE MEASURE** | **TUTORING ATTENDANCE** | **SEMINAR ATTENDANCE** | **N** |
| Calculus Grade | .68* | .30 | 16 |
| Physics Grade | .93* | .60* | 15 |
| * $p \leq .01$, two-tailed | | | |

Opinion Measures

*Group differences on pre- and postintervention measures.* The means of the intervention-group and control-group students were compared for the 13 opinion variables, three constructs, and total opinion score, before and after the intervention, as a test of the third hypothesis, i.e., enhanced opinions about SET fields as a result of the intervention. These results are given in Table 6. Before the intervention began, the intervention- and control-group students did not differ significantly on any of the 17 opinion measures; this strengthened the conclusion that the groups were comparable before the intervention. After the intervention ended, the control-group students had more internal scores on the Locus of Control scale. The one postintervention difference may have been due to the maturation of preexisting differences and not due to the intervention. In order to address this possibility, the final opinion variables were adjusted for preexisting opinion scores via ANCOVA.

**Table 6**

| GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CONSTRUCT/ Scale** | **TEST** | **CONTROL** | | **INTERVENTION** | | **t-Test** | **Sig. p** |
| | | **Mean** | **SD** | **Mean** | **SD** | | |
| Opinion, Total | Pretest | 3.11 | 0.20 | 3.06 | 0.28 | -0.62 | ns |
| | Posttest | 3.13 | 0.26 | 3.12 | 0.30 | -0.08 | ns |

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT/ Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| Set Goal | Pretest | 3.36 | .23 | 3.34 | .30 | -0.27 | ns |
| | Posttest | 3.34 | .29 | 3.43 | .30 | 0.69 | ns |
| Value | Pretest | 3.55 | .31 | 3.45 | .40 | -0.76 | ns |
| | Posttest | 3.42 | .37 | 3.59 | .42 | 0.98 | ns |
| Cultural Value | Pretest | 3.51 | .28 | 3.47 | .35 | -0.37 | ns |
| | Posttest | 3.42 | .47 | 3.55 | .31 | 0.86 | ns |
| Self-Concept | Pretest | 3.11 | .29 | 3.14 | .32 | 0.21 | ns |
| | Posttest | 3.18 | .43 | 3.24 | .21 | 0.36 | ns |
| Aspiration | Pretest | 3.39 | .27 | 3.38 | .41 | -0.08 | ns |
| | Posttest | 3.40 | .30 | 3.43 | .42 | 0.18 | ns |
| Attitude | Pretest | 2.93 | .21 | 2.90 | .38 | -0.32 | ns |
| | Posttest | 2.96 | .28 | 2.92 | .33 | -0.27 | ns |
| Math/Science Attitude | Pretest | 3.15 | .33 | 3.09 | .37 | -0.45 | ns |
| | Posttest | 3.19 | .23 | 3.20 | .32 | 0.12 | ns |
| Locus of Control | Pretest | 3.13 | .39 | 3.25 | .38 | 0.85 | ns |
| | Posttest | 3.07 | .38 | 3.36 | .55 | 1.45 | $\leq$.10 |
| Persistence | Pretest | 2.93 | .52 | 2.88 | .52 | -0.28 | ns |
| | Posttest | 3.08 | .41 | 2.86 | .54 | -1.08 | ns |
| Study Habits | Pretest | 2.91 | .44 | 2.84 | .56 | -0.36 | ns |
| | Posttest | 2.88 | .30 | 2.77 | .43 | -0.68 | ns |
| Anxiety | Pretest | 2.60 | .23 | 2.55 | .66 | -0.23 | ns |
| | Posttest | 2.61 | .43 | 2.52 | .63 | -0.37 | ns |
| Environmental Support | Pretest | 3.08 | .32 | 2.94 | .33 | -1.19 | ns |
| | Posttest | 3.13 | .32 | 3.03 | .42 | -0.66 | ns |
| Academic Support | Pretest | 2.95 | .29 | 3.00 | .57 | 0.28 | ns |
| | Posttest | 3.05 | .54 | 3.14 | .48 | 0.44 | ns |
| Career Awareness | Pretest | 3.29 | .47 | 3.19 | .34 | -0.66 | ns |
| | Posttest | 3.33 | .42 | 3.19 | .50 | -0.74 | ns |

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT/ Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| Role Model | Pretest | 3.07 | .60 | 2.73 | .61 | -1.54 | ns |
| | Posttest | 3.10 | .52 | 2.90 | .66 | -0.78 | ns |
| Equal Opportunity | Pretest | 3.02 | .44 | 2.85 | .42 | -1.07 | ns |
| | Posttest | 3.03 | .25 | 2.88 | .52 | -0.86 | ns |

All pretests were analyzed as two-tailed tests.
All posttests were analyzed as one-tailed tests.
Pretest n's: Control = 14; Intervention = 16
Posttest n's: Control = 10; Intervention = 14

*Group differences on opinion adjusting for prior scores*. Table 7 reports the tests of the effects of group membership on opinion after adjusting for preintervention opinion scores. By this analysis, the groups differed overall on one opinion measure: The intervention-group students had significantly higher Value scale scores (adjusted M = 3.61) than did the control-group students (adjusted M = 3.40). Note that after adjusting for preintervention Locus of Control score, the significant difference in favor of the control-group students disappeared. In addition to higher adjusted Value scores, the preintervention opinion score interacted with group membership for two opinion measures: Self-Concept and Equal Opportunity.

These significant interactions indicated that the relationship between preintervention and postintervention opinion scores was different in the two groups. The interactions were analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of pretest scores for which the groups differed.

**Table 7**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| OPINION, Total | PREINTERVENTION | .4604 | .4604 | 18.77 | 1,22 | $\leq$.01 |
| | +GROUP | .4659 | .0055 | 0.22 | 1,21 | ns |
| | +PRE-x-GROUP | .4734 | .0076 | 0.29 | 1,20 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Set Goal | PREINTERVENTION | .5082 | .5082 | 22.73 | 1,22 | ≤.01 |
| | +GROUP | .5292 | .0210 | 0.94 | 1,21 | ns |
| | +PRE-x-GROUP | .5304 | .0012 | 0.05 | 1,20 | ns |
| Value | PREINTERVENTION | .3323 | .3323 | 10.95 | 1,22 | ≤.01 |
| | +GROUP | .3976 | .0654 | 2.28 | 1,21 | ≤.10 |
| | +PRE-x-GROUP | .3985 | .0009 | 0.03 | 1,20 | ns |
| Cultural Value | PREINTERVENTION | .2012 | .2012 | 5.54 | 1,22 | ≤.05 |
| | +GROUP | .2268 | .0256 | 0.70 | 1,21 | ns |
| | +PRE-x-GROUP | .2274 | .0006 | 0.02 | 1,20 | ns |
| Self-Concept | PREINTERVENTION | .5626 | .5626 | 28.29 | 1,22 | ≤.01 |
| | +GROUP | .5644 | .0018 | 0.09 | 1,21 | ns |
| | +PRE-x-GROUP | .6323 | .0679 | 3.69 | 1,20 | ≤.05 |
| Aspiration | PREINTERVENTION | .5532 | .5532 | 27.24 | 1,22 | ≤.01 |
| | +GROUP | .5552 | .0021 | 0.10 | 1,21 | ns |
| | +PRE-x-GROUP | .5568 | .0016 | 0.07 | 1,20 | ns |
| Attitude | PREINTERVENTION | .4762 | .4762 | 20.00 | 1,22 | ≤.01 |
| | +GROUP | .4762 | .0001 | 0.00 | 1,21 | ns |
| | +PRE-x-GROUP | .4847 | .0085 | 0.33 | 1,20 | ns |
| Math/Science Attitude | PREINTERVENTION | .4289 | .4289 | 16.52 | 1,22 | ≤.01 |
| | +GROUP | .4330 | .0041 | 0.15 | 1,21 | ns |
| | +PRE-x-GROUP | .4336 | .0006 | 0.02 | 1,20 | ns |
| Locus of Control | PREINTERVENTION | .2157 | .2157 | 6.05 | 1,22 | ≤.05 |
| | +GROUP | .2571 | .0414 | 1.17 | 1,21 | ns |
| | +PRE-x-GROUP | .3002 | .0430 | 1.23 | 1,20 | ns |
| Persistence | PREINTERVENTION | .2621 | .2621 | 7.82 | 1,22 | ≤.01 |
| | +GROUP | .2882 | .0261 | 0.77 | 1,21 | ns |
| | +PRE-x-GROUP | .3096 | .0214 | 0.62 | 1,20 | ns |
| Study Habits | PREINTERVENTION | 1938 | .1938 | 5.29 | 1,22 | ≤.05 |
| | +GROUP | 2121 | .0183 | 0.49 | 1,21 | ns |
| | +PRE-x-GROUP | 2280 | .0159 | 0.41 | 1,20 | ns |
| Anxiety | PREINTERVENTION | .5935 | .5935 | 32.12 | 1,22 | ≤.01 |
| | +GROUP | .5935 | .0000 | 0.00 | 1,21 | ns |
| | +PRE-x-GROUP | .5936 | .0001 | 0.00 | 1,20 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Environmental Support | PREINTERVENTION | .2664 | .2664 | 7.99 | 1,22 | ≤.01 |
| | +GROUP | .2668 | .0004 | 0.01 | 1,21 | ns |
| | +PRE-x-GROUP | .2689 | .0021 | 0.06 | 1,20 | ns |
| Academic Support | PREINTERVENTION | .0163 | .0163 | 0.36 | 1,22 | ns |
| | +GROUP | .0250 | .0087 | 0.19 | 1,21 | ns |
| | +PRE-x-GROUP | .0269 | .0019 | 0.04 | 1,20 | ns |
| Career Awareness | PREINTERVENTION | .1726 | .1726 | 4.59 | 1,22 | ≤.05 |
| | +GROUP | .1785 | .0060 | 0.15 | 1,21 | ns |
| | +PRE-x-GROUP | .1786 | .0001 | 0.00 | 1,20 | ns |
| Role Model | PREINTERVENTION | .2990 | .2990 | 9.39 | 1,22 | ≤.01 |
| | +GROUP | .2992 | .0002 | 0.00 | 1,21 | ns |
| | +PRE-x-GROUP | .3009 | .0017 | 0.05 | 1,20 | ns |
| Equal Opportunity | PREINTERVENTION | .3455 | .3455 | 11.61 | 1,22 | ≤.01 |
| | +GROUP | .3455 | .0000 | 0.00 | 1,21 | ns |
| | +PRE-x-GROUP | .4118 | .0663 | 2.25 | 1,20 | ≤.10 |

All models were analyzed as one-tailed tests.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure): (1) PRETEST OPINION SCORE; (2) PRETEST OPINION SCORE and GROUP ('+'); (3) PRETEST OPINION SCORE, GROUP, and PRETEST OPINION SCORE-by-GROUP INTERACTION ('-x-').

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

The nonparallel regression lines were graphed in Figures 1 and 2.

**Figure 1**

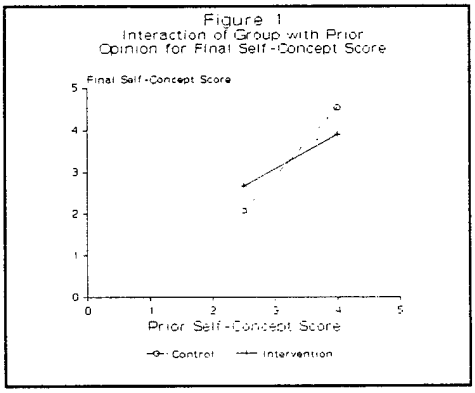



Figure 1 shows that the intervention was most successful at enhancing the opinions of students who entered with low self-concept (3.00 or less) about their potential to succeed in SET fields and courses; however, the students who entered with higher-than-average self-concept scores (3.5 or greater) did better in the control group.

**FIGURE 2**

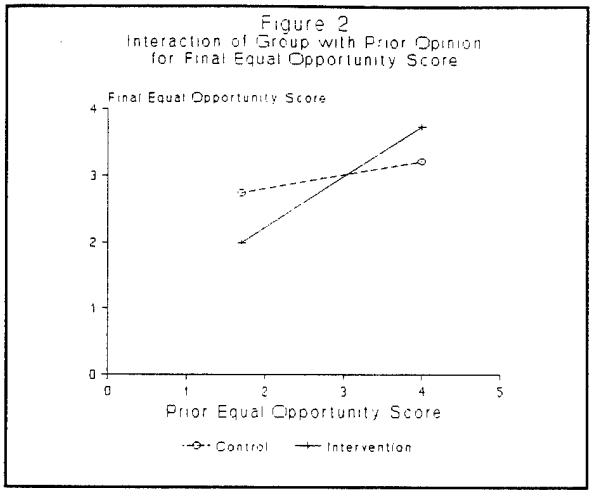



Figure 2 indicates that the intervention raised the Equal Opportunity scale scores of students who had higher-than-average scores on the preintervention measure (3.4 or greater); the control-group students with low, initial Equal Opportunity scales (2.7 or less) gained more than did comparable intervention-group students.

The findings provided only small support for the third hypothesis of enhanced opinions about SET fields and careers.

*Correlations between opinion and participation*. The correlations between opinion and participation are shown in Table 8. Seven of the 17 opinion measures were positively correlated with the number of tutoring sessions attended, and four of the 17 measures were correlated significantly with seminar attendance. Again, these correlational results may support the third hypothesis of opinion change due to the intervention, or these results may indicate that the students with more positive opinions also attended more sessions.

**Table 8**

| CORRELATIONS BETWEEN OPINION AND PARTICIPATION MEASURES | | |
|---|---|---|
| **OPINION CONSTRUCT/ Scale** | **TUTORING ATTENDANCE R (SIGNIF)** | **SEMINAR ATTENDANCE R (SIGNIF)** |
| Opinion, Total | .43 (.10) | .38 (.10) |
| Set Goal | .55 (.05) | .38 (.10) |
| Value | .55 (.05) | .40 (.10) |
| Cultural Value | .25 (ns) | .29 (ns) |
| Self-Concept | .28 (ns) | .32 (ns) |
| Aspiration | .67 (.01) | .27 (ns) |

| CORRELATIONS BETWEEN OPINION AND PARTICIPATION MEASURES | | |
|---|---|---|
| OPINION CONSTRUCT/ Scale | TUTORING ATTENDANCE R (SIGNIF) | SEMINAR ATTENDANCE R (SIGNIF) |
| Attitude | .32 (ns) | .35 (ns) |
| Math/Science Attitude | .43 (.10) | .10 (ns) |
| Locus of Control | .30 (ns) | .25 (ns) |
| Persistence | -.04 (ns) | .04 (ns) |
| Study Habits | .42 (.10) | .24 (ns) |
| Anxiety | .12 (ns) | .42 (.10) |
| Environmental Support | .26 (ns) | .26 (ns) |
| Academic Support | .40 (.10) | .23 (ns) |
| Career Awareness | .08 (ns) | .27 (ns) |
| Role Model | .09 (ns) | .05 (ns) |
| Equal Opportunity | .27 (ns) | .29 (ns) |
| All were one-tailed tests. | | |
| NOTE: Each r, the Pearson product-moment correlation coefficient, was computed on 14 cases. | | |

## DISCUSSION

Seeking the assistance of peer tutors who are successful students slightly more advanced than the target students is an interesting and potentially important idea. In this intervention, the concept seems to succeed: College students who are already committed to the pursuit of SET studies, experienced success in some particularly demanding introductory courses. The project director, a professor of physics, believed that his students would become more successful with the help and support of peer tutors and with extra work in some key areas related to study skills. The findings from this intervention support that conviction.

Of the three hypotheses tested, two of them--enhanced performance and increased completion rates--received substantial support. The third hypothesis, that opinions would be enhanced as a result of the intervention, received some support. The intervention-group students had significantly higher grades in the physics course; intervention-group students completed the calculus course at a significantly higher rate; and intervention-group students had higher opinions of the value of SET fields and careers than did the control-group students.

It is interesting that the intervention seemed to influence performance in the two courses, physics and calculus, differently. This outcome merits some discussion. The intervention-group students earned higher grades than the control-group students in what seems to be (judging by the grades earned) the more difficult of the two classes--physics. (It should be noted that the project director, though a physics professor and department chair, was not the instructor in this physics course.)

For the calculus course, the intervention did not produce a statistically significant higher grade, but did produce a higher completion rate: Fewer students in the intervention group than in the control group dropped calculus. The 38 percent of control-group students who dropped the calculus course likely had the lower grades in the group, in which case the control group's mean calculus grade would have been lower had the students not dropped; this in turn might have created a significant difference in the grades favoring the intervention group, had these withdrawals not occurred.

In physics, there was also a difference in the completion rate favoring the intervention group by 11 percent. This difference, while short of statistical significance, might be an important difference for educators.

The significant correlations between participation and grades in calculus and physics support the conclusion about the benefits of the intervention for performance. The correlation between the amount of tutoring and physics grade ($r = .93$) was significantly greater than the correlation between amount of tutoring and calculus grade ($r = .68$, $t\ (12) = 3.00$, $p \leq .01$, one-tailed). One possibility is that most of the tutors' time may have been spent helping students with physics. There are other possibilities: tutoring may affect students in the two courses differently, or the project director's being a physics professor may have resulted in selection of peer tutors who were stronger in physics than in calculus.

In summary, performance in both courses seems to have been substantially improved by the intervention: reflected in the case of physics by the higher grades, and in the case of calculus by the greater completion rate. Finally, the intervention's effects were greater on performance than on opinion, which was to be expected given that the intervention's components were focused on performance and were provided for a relatively short period of time (eight weeks) to college students.

A word of caution: Since the intervention and control groups in this first semester could not be formed by random assignment, it is possible that there are differences between the groups which influenced the results. The groups appeared well matched prior to the intervention: Significant differences appeared on only two out of 73 preintervention measures, which included a broad range of demographic (2 of 54), performance (0 of 2), and opinion measures (0 of 17). Though the two groups of students did not differ significantly on most preintervention measures, a selection-by-maturation explanation (Cook & Campbell, 1979) could have produced the differences attributed to the treatment. The intervention group was younger, at an earlier stage in their college careers (56% of the intervention-group students were freshmen or sophomores compared to 7% of the control-group students), and had higher ACT scores (significant at $p \leq .12$, two-tailed). It is possible that these intervention-group students might have matured at a faster rate and outperformed the control-group students without the intervention.

The available data do not permit the resolution of this ambiguity about the causal effects of the intervention and the possible selection-by-maturation explanation. However, the subsequent semesters of this intervention provide a basis for resolving this ambiguity: If the performance, retention, and opinion advantages for the intervention group recur under different procedures for assigning students to groups, the tentative conclusions reached here will be strengthened.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# APPENDICES

# APPENDIX A

# COLLEGE STUDENT PROTOCOL

## College Student Protocol

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. Am. Indian (Please specify the tribe which best describes your heritage.) _____
   ___ e. Hispanic Which of the following best describes your heritage?
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

6. Class:
   ___ a. College freshman
   ___ b. College sophomore
   ___ c. College junior
   ___ d. College senior
   ___ e. Other (e.g., special or temporary student, etc.)
      Specify _____

7. Have you declared a college major?
   ___ a. No
   ___ b. Yes ..... Please specify your major. _____

8. Have you taken any advanced placement tests for college credit?
   ___ a. No
   ___ b. Yes ..... Please list tests taken. _____

9. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Two years of college
   ___ b. Four years of college
   ___ c. One or more years after college
   ___ d. Other Specify _____

10. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

11. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)
   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Work-study
   ___ d. Job other than work-study
   ___ e. Tuition or other scholarship
   ___ f. Loan
   ___ g. Previous personal earnings and savings
   ___ h. GI Bill, ROTC, or other governmental assistance (other than scholarship or loan)
   ___ i. Family trust fund, insurance plan, or other similar arrangement
   ___ j. Other Specify _____

12. You may want to receive help outside your regular college course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems
   ___ f. Increasing reading ability
   ___ g. Developing good study habits
   ___ h. Improving writing ability

13. What is or was the occupation of the person(s) with whom you lived during the years you were growing up? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

_____ _____

14. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average

15. Are you:
___ a. An only child (skip to question 17)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

16. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

17. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

18. Indicate the extent of your mother's education. (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

19. What was the language spoken most often by adults in the household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe .... What is that language? _____
___ d. Other
Specify _____

20. Which of the following did your parent(s)/guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

21. Which of the following comes closest to describing your parent(s)/guardian(s)?
___ a. Do(es) not read at all
___ b. Sometimes read(s)
___ c. Read(s) a lot

22. Which of the following comes closest to describing you?
___ a. Do not read at all
___ b. Sometimes read
___ c. Read a lot

23. How many of these do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

24. From what kind of high school or secondary school did you graduate?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

25. Were you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes.....Please list the math and/or science clubs you belonged to.

_____

_____

_____

_____

26. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL WITH DIRECTIONALITY AND SCALES OF ITEMS

**Legend:**

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of my ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |

| | | | |
|---|---|---|---|
| 43 | - | AP | I would like to spend less of my school time studying science. |
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

**********

56. List below the occupations you have considered for yourself in the future.

    i. _____

    ii. _____

    iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE COLLEGE STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 16 | CONTROL n = 14 |
| 1. Sex: | | |
| Women | 38% | 43% |
| Men | 62% | 57% |
| 2. Age | 21.40 | 23.01[a] |
| 6. Class: | | |
| .Freshmen | 12% | 0% |
| .Sophomores | 44% | 7% |
| .Juniors | 31% | 50% |
| .Seniors | 12% | 43% |
| 7. Declared SET majors | 62% | 50% |
| .Missing or undeclared | 19% | 14% |
| 8. Students taken an advanced placement test | 12% | 14% |
| 9. Higher education expected: | | |
| .Two years of college | 0% | 0% |
| .Four years of college | 12% | 7% |
| .One or more years after college | 75% | 93% |
| .Other | 12% | 0% |
| 10. Studies most influenced by: | | |
| .Parents | 62% | 64% |
| .Another family member | 12% | 7% |
| .Teacher | 12% | 14% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 0% |
| .Friend | 6% | 0% |
| .Science professional | 0% | 7% |
| .Nonscience professional | 0% | 0% |
| .No one at all | 6% | 7% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 16 | CONTROL n = 14 |
| 11. Sources of income:[b] | | |
| .Parents/guardians | 56% | 36% |
| .Spouse | 0% | 0% |
| .Work study | 25% | 21% |
| .Job other than work study | 25% | 43% |
| .Tuition or scholarship | 19% | 21% |
| .Loan | 19% | 29% |
| .Grant | 50% | 57% |
| .Personal savings | 19% | 7% |
| .GI Bill, ROTC, etc. | 6% | 0% |
| .Family trust, etc. | 0% | 0% |
| .Other | 0% | 0% |
| Number of sources of income * | 2.19 | 2.14 |
| 12. Student needs help in:[b] | | |
| .Counseling on educational plans | 19% | 29% |
| .Counseling on career plans | 50% | 64% |
| .Improving math ability | 81% | 64% |
| .Finding part-time work | 19% | 36% |
| .Counseling on personal problems | 0% | 0% |
| .Increasing reading ability | 25% | 21% |
| .Developing good study habits | 38% | 36% |
| .Improving writing ability | 31% | 29% |
| Number of areas needing help * | 2.62 | 2.79 |
| 13. Sources of outside income: | | |
| .None | 0% | 7% |
| .One | 44% | 14% |
| .Two | 56% | 79% |
| 14. Family income: | | |
| .Below U.S. average | 6% | 21% |
| .About average | 75% | 50% |
| .Above average | 6% | 14% |
| .Unknown | 12% | 14% |
| 15. Birth order of student: | | |
| .Only child | 6% | 7% |
| .Oldest child | 31% | 43% |
| .Youngest child | 25% | 36% |
| .In-between child | 38% | 14% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 16 | CONTROL n = 14 |
| 16. Number of siblings: | | |
| .None | 0% | 7% |
| .One | 25% | 36% |
| .Two | 12% | 21% |
| .Three or more | 56% | 36% |
| .Missing | 6% | 0% |
| 17. Father's education: | | |
| .Grade school or less | 6% | 21% |
| .Some high school | 12% | 14% |
| .High school graduate | 44% | 21% |
| .Some college | 12% | 7% |
| .College degree or more | 25% | 36% |
| 18. Mother's education: | | |
| .Grade school or less | 6% | 0% |
| .Some high school | 6% | 14% |
| .High school graduate | 38% | 7% |
| .Some college | 25% | 21% |
| .College degree or more | 25% | 57% |
| 19. Language spoken most at home: | | |
| .English | 100% | 100% |
| .Spanish | 0% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| 20. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 69% | 79% |
| .Attend parent-teacher conferences | 38% | 43% |
| .Visit student's class | 38% | 50% |
| .Phone/visit if there's a problem | 50% | 71% |
| .Do volunteer work | 31% | 50% |
| .Assist student in course selection | 38% | 43% |
| .Assist in student's homework | 81% | 71% |
| Number of parental involvements * | 3.44 | 4.07 |
| 21. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 50% | 36% |
| .A lot | 50% | 64% |
| 22. Student reads: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 62% | 64% |
| .A lot | 38% | 36% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 16 | CONTROL n = 14 |
| 23. Items in student's home:[b] | | |
| .Desk | 88% | 64% |
| .Daily newspaper | 88% | 64% |
| .Encyclopedia | 88% | 79% |
| .Typewriter | 75% | 64% |
| .Calculator | 94% | 100% |
| .Television | 94% | 100% |
| .Computer | 31% | 36% |
| .Video Cassette Recorder (VCR) | 75% | 64% |
| Number of support items * | 6.31 | 5.71 |
| 24. Type of high school attended: | | |
| .Public | 88% | 86% |
| .Private | 12% | 14% |
| .No formal high school | 0% | 0% |
| 25. Member math/science club in high school | 63% | 43% |
| .Missing | 6% | 0% |
| 26. All activities student took part in:[b] | | |
| .Math/science club | 38% | 36% |
| .Field trip | 50% | 71% |
| .Watching science programs on TV | 69% | 64% |
| .Listen to talk by scientist | 31% | 50% |
| .Science/math fair | 38% | 43% |
| .Other science/math competition | 25% | 14% |
| .Play/work in computer lab | 69% | 57% |
| Number of activities * | 3.19 | 3.36 |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# BENEDICT COLLEGE

# INTERVENTIONS

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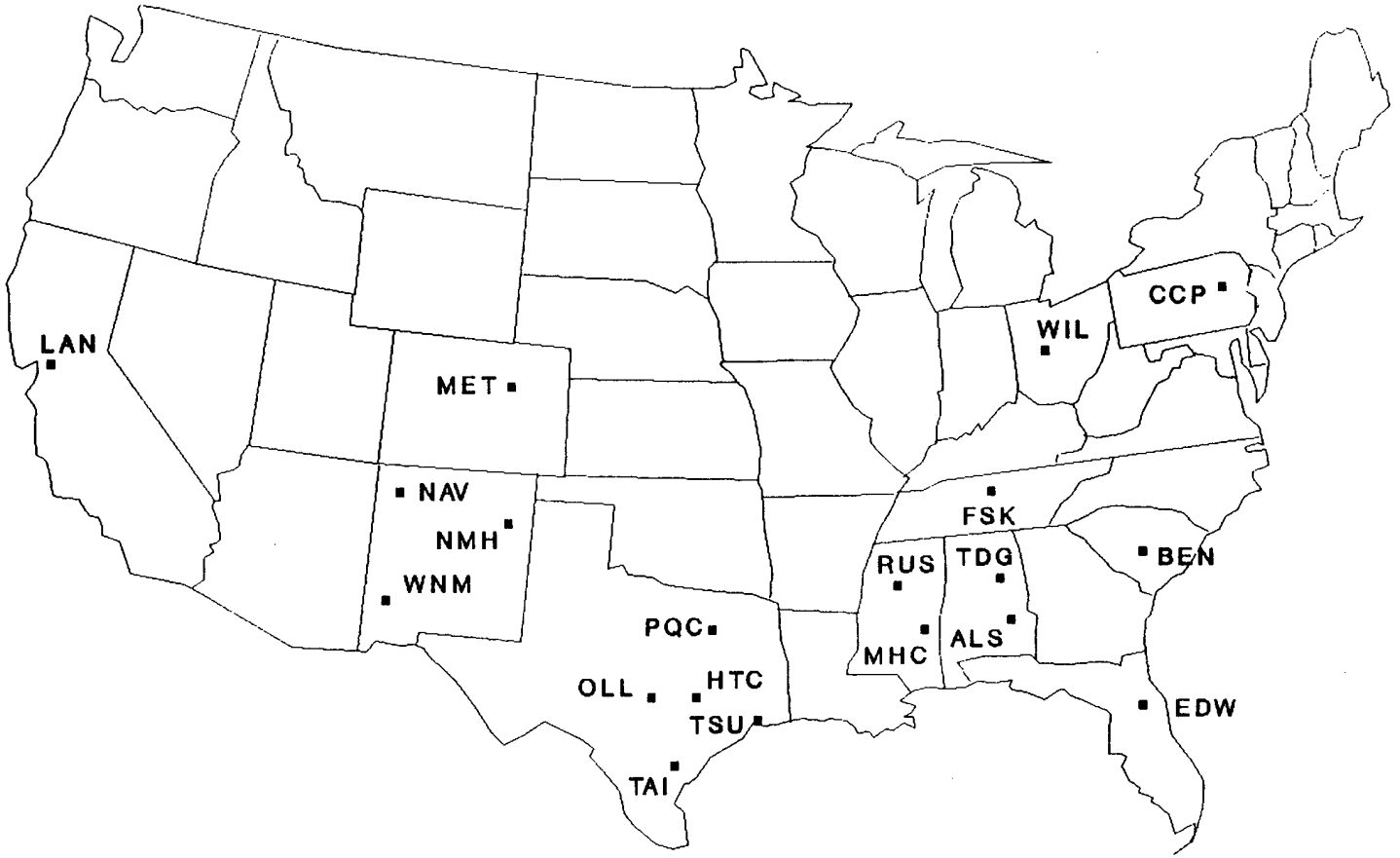
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, and each collected data to measure the effects of those interventions. Data collected came from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention-group students, as well as on a control-group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF BENEDICT COLLEGE

Benedict College is a historically Black, four-year, private, coeducational institution located in Columbia, South Carolina. The College community consists of approximately 1500 students and 116 faculty members. The College, organized into the Division of Business, Division of Humanities, Division of Mathematics and Natural Sciences, and Division of Social and Behavioral Sciences, offers undergraduate and graduate degrees. The student body is approximately 64 percent female and 36 percent male and is predominantly Black. The president of Benedict College is Dr. Marshall Grigsby.

Degrees offered at Benedict College in quantitative subjects are Bachelor of Science in mathematics, computer science, chemistry, physics, and environmental health science. The College also offers a dual degree program in engineering in cooperation with the Georgia Institute of Technology, Clemson University, and Southern Institute.

Columbia has a population of over 100,000 in its metropolitan area. The state of South Carolina has a population of approximately 3.5 million. According to U.S. Census Bureau estimates, the adult population of South Carolina is 71 percent Anglo, 27 percent Black, 1 percent Hispanic, and 1 percent other ethnic origins. Columbia has a number of other institutions of higher education, including Columbia College, Midlands Technical College, and the University of South Carolina.

# PART II

# SUMMARY OF THE BENEDICT COLLEGE (BC) INTERVENTIONS

This report summarizes the three interventions conducted by Benedict College, a historically Black, four-year private institution located in Columbia, South Carolina. The college is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Benedict College Intervention Activities:

From Summer 1989 through Spring 1990, Benedict College conducted three intervention programs in college mathematics through the Benedict College Center for Math and Science (C-MAS). On-line instruction had been the approach originally proposed, but equipment limitations necessitated the change to the use of electronic mail to send and receive course assignments, preceded by some instruction in the use of computers. Control group students were enrolled in the same courses but received and submitted their assignments in person and by hand. Participants were college students enrolled in college algebra or trigonometry; most participants were Black.

Findings:

- The intervention had positive effects on performance in mathematics in each of the three semesters of intervention.
- Effects on opinion were variable across the three semesters.
- The intervention seems to have improved opinions about SET courses and careers for intervention participants.

Recommendations:

Before requiring the use of computers in mathematics courses, it is important to examine the computer facilities available to students. Specifically, these things should be checked:

- Availability of computers for dormitory residents
- Locations of computers available to commuter students
- Typical wait time for computers
- Compatibility of available computers with printers
- Availability of technical assistance during computer use.

When computers are conveniently available and accessible, their use can be expected to enhance performance in mathematics.

# CASE STUDY OF THE BENEDICT COLLEGE (BC)

# 1989 SUMMER SEMESTER INTERVENTION

## ABSTRACT

In the summer of 1989 the Center for Math and Science (C-MAS) of Benedict College, Columbia, South Carolina, initiated and tested against a control group an intervention program designed to familiarize college students with computers and the Math and Science On-line Network (MASON) of the college. Participants were 34 undergraduate students (23 women and 11 men) enrolled in college algebra or trigonometry; a majority of the students were Black. The intervention consisted of two summer sessions. For each session, two sections of the same course taught by the same instructor were chosen to participate in the intervention; one section was designated as the intervention group and the other as the control group. The intervention was repeated in the fall of 1989 and in the spring of 1990.

The Benedict College program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance in mathematics courses, and (b) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* The major component of the intervention was student use of the on-line computer system (MASON) to receive and submit algebra or trigonometry course assignments. Students received assignments in word processor files, worked the assigned problems, then sent their answers to a data processing technician and the instructor for printing, correcting, and grading. The students also received, via the on-line system, information about incorrect answers with hints about how to solve the problems correctly.

*DATA:* All the participants furnished demographic data through the CASET College Student Protocol. All participants were administered CASET Opinion Protocols; the protocol was designed to be administered before and after the intervention, however, a proxy measure of preintervention opinion had to be constructed due to late administration of the preintervention Opinion Protocol for the algebra students. Other data collected were high school class percentile ranks, college GPAs, national standardized test scores, and final examination grades and semester grades in college algebra and trigonometry.

The outcome measures of performance were the final examination grades and course grades earned by each student. The preintervention measures of performance were high school class percentile rank, prior college GPA, and SAT-mathematics score.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment because course sections were designated as intervention or control. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design; through analyses of preintervention measures it appeared that the intervention and control groups were comparable on demographic characteristics before the intervention.

*FINDINGS:* The intervention had some positive effect on the participants and can be considered a successful intervention in that the hypothesis of enhanced student performance was partially supported: The two groups did not differ on course grades in trigonometry, but the intervention-group students outperformed the control-group students in algebra course grades. The hypothesis that the intervention would enhance opinions about SET fields and careers also received partial support: The intervention-group students had higher opinions of SET fields and careers, but the control-group students had higher opinions about their level of academic support. However, the method of student recruitment for the program may have resulted in preexisting differences between the groups; the intervention group had higher high school class ranks, college GPAs, and SAT-mathematics scores than the control group. These preexisting differences between the groups limit conclusions about the effects of the intervention.

## DESCRIPTION OF THE INTERVENTION

Seeing an essential role for Historically Black Colleges and Universities in increasing the representation of minorities in SET fields, Benedict College has supported several programs for the academic and career development of minority youth. These include the Middle School Summer Laboratory Science and Mathematics Program, Upward Bound, Science Intensive Feedback Program, Middle School Teachers Program, Minority Biomedical Research Support Program, Minority Access to Research Careers Program, and the recently established Center for Mathematics and Science (C-MAS).

The primary purpose of C-MAS is to provide information and educational enrichment experiences to achieve the long-range goal of recruiting and retaining women and minority students into the fields of mathematics, science, computer science, and engineering. The goals of C-MAS will be accomplished through five computer-automated programs: (1) Recruitment Program, (2) Retention Program, (3) Academic Enrichment Program, (4) Career Placement Program, and (5) Math and Science Literacy Program.

The CASET intervention program at Benedict College was developed under the Retention Program of C-MAS. The interactive communication service called MASON (Math and Science On-line Network) was employed to assist students with assignments in their mathematics courses, as a means of improving mathematics performance of minority and female students while providing experience with computers.

This project at Benedict College began with a set-up semester during which materials and software were prepared. It was then followed by three semesters of research with students. During these three semesters, opinions and performance of students participating in the CASET project were compared with those of students enrolled in another section of the same course who did not participate in the intervention activities.

The set-up semester was the Spring of 1989. Research with subjects was conducted during both summer sessions of the Summer 1989 semester and the Fall 1989 and Spring 1990 semesters. This is the report of the Summer 1989 research, the first semester of research with subjects. The other semesters will be reported separately, in replication reports which can be appended to this report.

The first summer session intervention, which began on May 30, 1989 and ended on June 29, 1989, was conducted with a college algebra class. The second summer session intervention, which began on July 6, 1989 and ended on August 4, 1989, was conducted with a trigonometry class. For each session, two sections of the same course taught by the same teacher were chosen to participate in the intervention. One section was designated as the intervention group and the other as the control group. The instructor delivered the same instruction and course materials to each section; the only difference between the two sections was that, during the semester, the intervention group had the opportunity to work with computers and MASON.

The computer activity for the intervention group was as follows: Intervention-group students received two weeks of basic computer training. They were taught how to log on to the system and how to use a technical word processor to access their assignments. Once a student entered his or her account, the computer notified them of a New Mail Message. Students would then read their mail and get the name of their latest assignment. They would then enter the word processor, create a new document and file the assignment into a Problems Folder. In most cases, students wrote down the problems and took them home to work. In some cases students would write the problems down and work them while on-line. Once the students solved the problems, they would input their answers into an Answers Folder and send a message to the Project Director and Data Processing Technician, notifying them of the name of their answer file. The Data Processing Technician would retrieve the answers, print them, correct the students' work, and make copies of the students' answers for the instructor. The instructor would assign a grade to the homework and return it to the students. The Data Processing Technician would send computer messages to the students indicating which answers were correct and which were not. Helpful hints were provided to help the students solve those which were incorrect. The Project

Director reported that in almost all cases, students continued to work on their incorrect problems while continuing their new assignments.

The intervention's two hypotheses were that the intervention would: (a) enhance performance in mathematics courses, and (b) enhance opinions about SET fields and careers. The Project Director for this project at Benedict College was Dr. Kenneth Alston, Director of C-MAS.

## METHOD

### Subjects

Subjects were Black college students enrolled in College Algebra or in Trigonometry at Benedict College during the Summer 1989 semester. For algebra in the first summer session, and for trigonometry in the second summer session one section was designated as the intervention group and another section taught by the same instructor was designated as the control group. The instructors delivered the same instruction and materials to both sections; the only difference between the sections was computer instruction in the intervention groups.
Control-group students filled out the same protocols and provided the same information as the intervention-group students, but did not participate in any intervention activities. Data were submitted for a total of 35 students. One student had to be eliminated from the sample because as an Asian-American woman, she was not representative of the target groups which were the subjects of this study (Asian women are not underrepresented in SET fields). Data from 16 intervention-group students and 18 control-group students were analyzed for this report. Table 1 shows the sex and ethnic breakdown for the intervention- and control-group students.

**Table 1**

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | 0 | 0 | 0 | 0 | 0 | 0 |
| Anglo | 0 | - | 0 | - | 0 | - |
| Black | 12 | 5 | 10 | 6 | 22 | 11 |
| Hispanic | 0 | 0 | 0 | 0 | 0 | 0 |
| Unknown | 1 | - | 0 | - | 1 | - |
| TOTAL | 13 | 5 | 10 | 6 | 23 | 11 |

CASET Protocols and Other Instruments

The intervention's two hypotheses were that the intervention would: (a) enhance performance in mathematics courses, and (b) enhance opinions about SET fields and careers. Demographic and descriptive data about the subjects were developed through the CASET College Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. CASET used these 13 attitudinal variables as the basis for the Opinion Protocol. For each of the 13 variables, several question items were developed, varying in directionality. Combining the question items for each variable gave a scalar measurement for that variable. Thus the completed Opinion Protocol provided a scale measuring each of the 13 variables. The Opinion Protocol was designed to be administered to intervention- and control-group students before and after the intervention. The Opinion Protocol question items, together with the scales (attitudinal variables) they represented, are shown in Appendix B.

The preintervention measures of performance for intervention-group and control-group students were high school class percentile rank, Scholastic Aptitude Test (SAT) scores, and preintervention college GPA. Postintervention measures of performance were final examination grades and course grades in mathematics. In the case of the algebra course, final examination grades were converted into letter grades, in order to make them comparable to the other measures. Conversion was conducted consistently with other submitted scores as follows:

- 90 to 100 = A
- 80 to 89 = B
- 70 to 79 = C
- 60 to 69 = D
- below 60 = F

Procedure

At the beginning of the program, intervention- and control-group students signed consent forms and transcript release forms. The first measures of opinion and the measures of demographic information were taken for the first summer session group on June 23, 1989, and on July 10, 1989 for the second summer session. After the intervention, the CASET Opinion Protocol was administered a second time to all students; this was done on June 28, 1989 for the first summer session, and on August 2, 1989 for the second summer session. Intervention- and control-group students took final examinations and received course grades, which were forwarded to CASET as an outcome measure of the performance effects of the research. High school and college transcripts for intervention- and control-group students were forwarded to CASET for analysis, along with the CASET Student Protocol and the preintervention and postintervention Opinion Protocols.

The items of the Opinion Protocol were coded by CASET according to the 13 scales they represent. Items on the Opinion Protocol were scored in such a way that a larger number reflected a more positive opinion (see Appendix B). The scales were organized into three constructs -- SET Goal, Environmental Support, and Attitude -- as shown in Appendix C.

# RESULTS

## Methodological Issues

The intervention's two hypotheses were that the intervention would: (a) enhance performance in mathematics courses, and (b) enhance opinions about SET fields and careers. There were preintervention and postintervention measures of performance and opinion for most students. The intervention was analyzed as a *nonequivalent control group* design. This type of quasi-experimental design has one common weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty about causal influence may be addressed by analyzing the influence of preexisting characteristics on students' performance and opinion; the analysis of covariance (ANCOVA), adjusting for preintervention performance or opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that existed before the intervention.

Unfortunately, the preintervention administration of the Opinion Protocol for the algebra students was not consistent with the design; the "preintervention date" of administration was well after the beginning of intervention activities. In an attempt to provide some of the same advantages as a same-scale pretest, a proxy measure of preintervention opinion was constructed using items from the postintervention Opinion Protocol. Comparable proxy measures of opinion were constructed for the trigonometry students so that the samples could be combined.

A proxy pretest should possess two qualities (Cook & Campbell, 1979): (a) it should measure a characteristic that existed prior to the intervention, and (b) it should correlate with the post-intervention measure within each group. Once a proxy is constructed, it serves two functions: (a) a proxy pretest increases the statistical power of the test of postintervention differences by reducing the error variance in an analysis of covariance (ANCOVA), and (b) a proxy pretest indicates how the formation of the groups may have created important preexisting differences. A proxy pretest is usually inferior to a same-scale pretest because the correlation between the proxy-pretest and the posttest will be smaller than the correlation between the same-scale pretest and the posttest; therefore, the proxy pretest often will underadjust for preexisting differences and provide a smaller increase in statistical power.

*Construction of the proxy measures of opinion.* The proxy measures of preintervention opinion were constructed from a group of nine opinion items that assessed enduring, preexisting characteristics; the opinion items and their numbers are:

(a) I study each day rather than just before exams (#1);

(b) I make it a point to get my assignments in on time (#15);

(c) None of my friends have ever been good at math (#18);

(d) I find myself losing interest in my studies by the middle of the semester (#20);

(e) I have trouble keeping my mind from wandering as I study (#21);

(f) I try to be one of the best students in my science classes (#26);

(g) I only do as much as I have to in my science classes (#36);

(h) My family cares a lot about education (#45); and

(i) I often feel like quitting school (#52).

Six of the proxy premeasure items came from the Attitude construct, including three items from the Study Habits scale (Items 1, 15, and 36) and three from the Persistence scale (Items 20, 21, and 52). In addition, three items were taken from the SET Goal construct: two items were from the Cultural Value scale (Items 18 and 45), and one was from the Aspiration scale (Item 26). In general, these items referred either to enduring characteristics or to experiences in the semester(s) prior to the intervention that related to a student's level of involvement in their education.

Because some of the same items occurred in two measures that were to be correlated, for example, both in Study Habits and the proxy premeasure, and because this would have violated the independence assumption of the statistical model, specific proxy measures were created for Study Habits, Persistence, Cultural Value, Aspiration, Attitude construct, and SET Goal construct by removing from the set of nine proxy items those that were also a part of that particular postintervention measure. Finally, though none of the proxy items were from the Environmental Support construct's items, the proxy measure was expected to correlate significantly with at least some of the Environmental Support variables.

## Demographic Results

The comparability of the intervention-group and control-group students was examined by testing for differences on the items of the College Student Protocol. The complete results are given in Appendix D. Of the 64 comparisons, the groups differed on three: (a) more of the intervention-group students had work-study jobs (75%) than did the control-group students (39%); (b) more intervention-group students wanted career counseling (56%) than did control-group students (22%); and (c) more intervention-group students had been members of a math/science club in high school (44%) than had control-group students (11%). Two of the three differences were ambiguous (more intervention-group students had jobs and wanted career counseling) and one difference favored the intervention-group students (more had been members of math/science clubs). The three significant differences between the groups on preexisting characteristics were not significantly different from the number of differences expected by chance at the 10-percent probability level. Based on these results, the groups were judged to be comparable on demographic characteristics before the intervention.

## Performance Measures

*Group differences in performance.* The four preintervention measures (SAT-Verbal, SAT-Mathematics, high school class percentile rank, and prior college GPA) and the two postintervention measures of performance (final exam grade and final grade in the mathematics course) were tested for group differences, and the results are given in Table 2. Note that the intervention and control groups differed significantly on one preintervention measures: The intervention-group students had a higher mean high school percentile rank ($\underline{M}$ = 72.73) than did the control-group students ($\underline{M}$ = 47.99), $\underline{t}$ (28) = 3.50, $\underline{p} \leq .01$, two-tailed. The combined groups (algebra and trigonometry students) did not differ on either postintervention measure--final exam grade or course grade.

However, the grades awarded to the algebra and trigonometry students on the final exam and for the course did differ significantly: (a) the algebra students had higher final exam grades ($\underline{M}$ = 2.22, approximately C+) than did the trigonometry students ($\underline{M}$ = 0.82, approximately D-), $\underline{t}$ (32) = 3.74, $\underline{p} \leq .01$; and (b) the algebra students had higher course grades ($\underline{M}$ = 2.39, approximately C+) than did the trigonometry students ($\underline{M}$ = 1.27, approximately D+), $\underline{t}$ (32) = 3.50, $\underline{p} \leq .01$. The two courses were analyzed separately because of these significant differences and because the intervention-group and control-group students were not evenly distributed in the two courses, i.e., 65 percent of the algebra students were in the control group and 27 percent of the trigonometry students were in the control group; this difference was statistically significant, chi-square (1, $\underline{n}$ = 34) = 2.91, $\underline{p} \leq .10$, Yates corrected.

The $\underline{t}$-tests comparing the intervention-group and control-group students for the final exam grade and course grade in each course are also given in Table 2. The intervention group had significantly higher final exam grades and final course grades in algebra; the students did not differ significantly in trigonometry final exam or course grades.

Table 2

| DIFFERENCES ON GROUP PERFORMANCE MEASURES | | | | | | |
|---|---|---|---|---|---|---|
| MEASURE | GROUP | n | MEAN | SD | t-TEST (df) | SIG P |
| SAT-Verbal | Control<br>Intervention | 4<br>4 | 310.00<br>335.00 | 39.16<br>130.26 | 0.37<br>(6) | ns |
| SAT-Math | Control<br>Intervention | 4<br>4 | 297.00<br>407.50 | 17.08<br>141.04 | 1.55<br>(6) | ns |
| High School %ile Rank | Control<br>Intervention | 16<br>14 | 47.99<br>72.73 | 23.56<br>12.85 | 3.50<br>(28) | ≤.01 |
| Prior College GPA | Control<br>Intervention | 17<br>16 | 2.41<br>2.70 | .45<br>.58 | 1.59<br>(31) | ns |
| Final Exam Score | Control<br>Intervention | 18<br>16 | 1.83<br>1.68 | .98<br>1.45 | -0.35<br>(32) | ns |
| Course Grade | Control<br>Intervention | 18<br>16 | 2.00<br>2.06 | 0.77<br>1.34 | 0.17<br>(32) | ns |
| Algebra Final Exam | Control<br>Intervention | 15<br>8 | 2.00<br>2.62 | 1.00<br>1.06 | 1.40<br>(21) | ≤.10 |
| Algebra Course Grade | Control<br>Intervention | 15<br>8 | 2.07<br>3.00 | .80<br>.76 | 2.72<br>(21) | ≤.01 |
| Trigonometry Final Exam | Control<br>Intervention | 3<br>8 | 1.00<br>0.75 | .00<br>1.16 | -0.36<br>(9) | ns |
| Trigonometry Course Grade | Control<br>Intervention | 3<br>8 | 1.67<br>1.12 | .58<br>1.13 | 0.78<br>(9) | ns |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

Because the intervention-group students had higher high school class percentile ranks, and because the preintervention college GPAs also favored the intervention group, a further analysis seemed necessary to provide a more sensitive test of the intervention's effects and to adjust for preintervention differences between the groups. ANCOVAs that adjusted for preintervention performance were completed for two postintervention performance measures: final exam grade (for both classes) and course grade (for both classes).

*Group differences after adjusting for pretests.* A Hierarchical ANCOVAs adjusted for preintervention college GPA before comparing groups on four postintervention performance measures; the results are given in Table 3. This table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding each variable to the multiple regression equation (one variable per row), and the significance test of each variable's contribution toward explaining the dependent measure. The columns of the table include the cumulative percentage of explained variance (cum $R^2$), added contribution in explained variance of the variable ($sR^2$), test of the contribution of the new variable ($F(sR^2)$), and the degrees of freedom (df) for the test.

**Table 3**

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLE | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| FINAL EXAM SCORE | PRIOR GPA | .01 | .01 | 0.26 | 1,31 | ns |
| | + GROUP | .01 | .00 | 0.11 | 1,30 | ns |
| | + GPA-x-GROUP | .07 | .06 | 1.79 | 1,29 | ns |
| COURSE GRADE | PRIOR GPA | .07 | .07 | 2.38 | 1,31 | ns |
| | + GROUP | .07 | .00 | 0.07 | 1,30 | ns |
| | + GPA-x-GROUP | .14 | .07 | 2.32 | 1,29 | ns |
| ALGEBRA COURSE GRADE | PRIOR GPA | .07 | .07 | 1.60 | 1,20 | ns |
| | + GROUP | .26 | .18 | 4.63 | 1,19 | ≤.05 |
| | + GPA-x-GROUP | .26 | .00 | 0.02 | 1,18 | ns |
| TRIGONOMETRY COURSE GRADE | PRIOR GPA | .44 | .44 | 6.99 | 1,9 | ≤.05 |
| | + GROUP | .47 | .03 | 0.44 | 1,8 | ns |
| | + GPA-x-GROUP | .49 | .03 | 0.38 | 1,7 | ns |
| FINAL EXAM SCORE | PRIOR GPA | .01 | .01 | 0.26 | 1,31 | ns |
| | + COURSE | .34 | .33 | 14.77 | 1,30 | ≤.01 |
| | + GROUP | .35 | .01 | 0.64 | 1,29 | ns |
| | + GPA-x-COURSE | .37 | .02 | 0.81 | 1,28 | ns |
| | + GPA-x-GROUP | .37 | .00 | 0.00 | 1,27 | ns |
| | + GP-x-COURSE | .39 | .02 | 1.04 | 1,26 | ns |
| COURSE GRADE | PRIOR GPA | .07 | .07 | 2.38 | 1,31 | ns |
| | + COURSE | .40 | .33 | 16.36 | 1,30 | ≤.01 |
| | + GROUP | .42 | .02 | 0.91 | 1,29 | ns |
| | + GPA-x-COURSE | .44 | .03 | 1.37 | 1,28 | ns |
| | + GPA-x-GROUP | .44 | .00 | 0.00 | 1,27 | ns |
| | + GP-x-COURSE | .51 | .06 | 3.34 | 1,26 | ≤.10 |

All models were analyzed as two-tailed tests.

The results in Table 3 demonstrated that the control-group and intervention-group students, combined for the two courses, did not differ significantly for final exam grade or course grade. Because the two courses had differed significantly on both postintervention measures, a course variable was included in subsequent analyses to test for a group effect after adjusting for preintervention GPA and course.

The results of analyses including course as a variable indicated that the course was a significant variable for both performance measures, but only for course grade did a main effect or interaction effect emerge as significant: The interaction of group and course was significant for explaining course grade. To explore this interaction, the ANCOVAs with preintervention GPA were done separately for algebra and trigonometry. The results, also given in Table 3, indicated that the intervention-group students outperformed the control-group students in algebra course grades, despite adjusting for the intervention group's advantage on preintervention performance measures. In addition, the two groups did not differ in trigonometry course grades. Note that these results from the ANCOVAs were consistent with the results from Table 2 that had found a significant advantage for the intervention-group students in algebra. Based on the results in Tables 2 and 3, the first hypothesis was partially supported: The intervention-group students outperformed the control-group students in algebra course grades.

*Interrelationships among performance measures*. The interrelatedness of the performance measures was examined through intercorrelations, presented in Table 4. As expected, the preintervention measures (SAT scores, high school class rank, and college GPA) were significantly intercorrelated; also, the postintervention measures (final exam and course grades) were correlated significantly. Of interest was the selection of the better covariate for adjusting the postintervention performance measures, choosing between high school class rank and preintervention college GPA. From the results in Table 4, preintervention GPA was selected as the better covariate because it had larger correlations with final exam grade and course grade than did high school rank; the correlation between course grade and preintervention GPA was significantly greater than was the correlation between high school rank and course grade, $t$ (27) = 1.40, $p \leq .10$, one-tailed.

**Table 4**

**INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a]**

| | SAT Verbal (n) Sig. p | SAT Math (n) Sig. p | H/S %ile Rank (n) Sig. p | Pre Coll GPA (n) Sig. p | Final Exam (n) Sig. p |
|---|---|---|---|---|---|
| SAT Math | .76 (8) ≤.05 | 1.00 | | | |
| High School Rank | .20 (7) ns | .67 (7) ≤.05 | 1.00 | | |
| Pre College GPA | .72 (7) ≤.05 | .75 (7) ≤.05 | .71 (29) ≤.01 | 1.00 | |

| INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a] | | | | | |
|---|---|---|---|---|---|
| | SAT Verbal (n) Sig. p | SAT Math (n) Sig. p | H/S %ile Rank (n) Sig. p | Pre Coll GPA (n) Sig. p | Final Exam (n) Sig. p |
| Final Exam | .33 (8) ns | .47 (8) ns | .04 (30) ns | .09 (33) ns | 1.00 |
| Course Grade | .29 (8) ns | .38 (8) ns | .13 (30) ns | .27 (33) ≤.10 | .88 (34) ≤.01 |
| [a] All correlations were analyzed as one-tailed tests. | | | | | |

Opinion Measures

*Group differences on pre- and postintervention measures.* The means of the intervention- and control-group students were compared for the 13 opinion scales, three constructs, and total opinion score, measured after the intervention; in addition, the two groups' mean scores on the seven proxy measures of preintervention opinion were also compared. The results of the 24 t-tests are given in Table 5. As estimated by the proxy measures, before the intervention began, the students in the intervention and control groups did not differ significantly on any of the seven opinion measures; this strengthened the conclusion that the groups were comparable before the intervention. After the intervention ended, the intervention-group and control-group students differed on only 2 of the 17 measures: The intervention-group students had higher scores on the postintervention Aspiration measure, and the control-group students had higher scores on the Equal Opportunity measure.

**Table 5**

| GROUP DIFFERENCES ON PROXY PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | |
|---|---|---|---|---|---|---|
| POSTTEST CONSTRUCT/Scale | CONTROL | | INTERVENTION | | t-Test | Sig. p |
| | Mean | SD | Mean | SD | | |
| OPINION, Total | 2.89 | .22 | 2.96 | .30 | 0.78 | ns |
| SET GOAL | 2.91 | .22 | 3.08 | .32 | 1.63 | ns |
| Value | 3.30 | .42 | 3.33 | .37 | 0.23 | ns |

**GROUP DIFFERENCES ON PROXY PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| | CONTROL | | INTERVENTION | | | |
|---|---|---|---|---|---|---|
| Cultural Value | 3.43 | .46 | 3.48 | .41 | 0.32 | ns |
| Self-Concept | 2.70 | .34 | 2.82 | .46 | 0.83 | ns |
| Aspiration | 2.44 | .24 | 2.85 | .53 | 2.74 | ≤.05 |
| ATTITUDE | 2.78 | .27 | 2.88 | .34 | 0.87 | ns |
| Math/Science Attitude | 2.76 | .50 | 3.04 | .45 | 1.61 | ns |
| Locus of Control | 3.04 | .55 | 3.07 | .51 | 0.12 | ns |
| Persistence | 2.91 | .54 | 2.98 | .55 | 0.36 | ns |
| Study Habits | 2.61 | .47 | 2.77 | .40 | 1.02 | ns |
| Anxiety | 2.68 | .54 | 2.59 | .55 | -0.48 | ns |
| ENVIRONMENTAL SUPPORT | 3.07 | .34 | 2.97 | .31 | -0.91 | ns |
| Academic Support | 3.06 | .52 | 3.04 | .62 | -0.05 | ns |
| Career Awareness | 3.00 | .38 | 3.11 | .32 | 0.86 | ns |
| Role Model | 2.96 | .50 | 2.76 | .50 | -1.10 | ns |
| Equal Opportunity | 3.27 | .40 | 2.96 | .35 | -2.25 | ≤.05 |

| **PROXY PRETEST CONSTRUCT/Scale** | **CONTROL** | | **INTERVENTION** | | **t-Test** | **Sig. p** |
|---|---|---|---|---|---|---|
| | **Mean** | **SD** | **Mean** | **SD** | | |
| Proxy OPINION | 3.02 | .36 | 3.07 | .50 | 0.36 | ns |
| Proxy SET GOAL | 2.91 | .38 | 2.94 | .57 | 0.19 | ns |
| Proxy Cultural Value | 2.89 | .37 | 2.95 | .55 | 0.38 | ns |
| Proxy Aspiration | 3.05 | .37 | 3.08 | .51 | 0.20 | ns |

| GROUP DIFFERENCES ON PROXY PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | | |
| Proxy ATTITUDE | 3.22 | .41 | 3.33 | .45 | 0.70 | ns |
| Proxy Persistence | 3.12 | .37 | 3.17 | .48 | 0.33 | ns |
| Proxy Study Habits | 3.02 | .42 | 3.11 | .51 | 0.51 | ns |
| All posttests were analyzed as one tailed tests.<br>Posttest n's: Control = 15; Intervention = 15 | | | | | | |

To adjust for preexisting differences and provide a more sensitive test of the intervention's effects on opinion, the final opinion measures were adjusted for preexisting opinion scores via ANCOVA.

*Group differences on opinion adjusting for prior scores*. Table 6 reports the tests of the effects of group membership on opinion after adjusting for proxy measures of preintervention opinion scores. By these analysis, the groups differed generally on three opinion measures: The intervention-group students had higher opinion scores on two measures--SET Goal construct and Aspiration--and the control-group students had higher scores on the Equal Opportunity measure. In addition, group membership interacted with the proxy measure of preintervention opinion for two measures: Value and Self-Concept. The significant interactions indicated that the relationship between prior proxy opinion score and the two final opinion scores was different in the two groups.

**Table 6**

| HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PROXY PRETEST OPINION MEASURES | | | | | | |
|---|---|---|---|---|---|---|
| **FINAL OPINION CONSTRUCT/ Scale** | **INDEPENDENT VARIABLES MODELS*** | **Cumul. $R^2$** | **$sR^2$** | **$F(sR^2)$** | **df** | **Sig. p** |
| SET GOAL | SCORE | .30 | .30 | 11.87 | 1,28 | ≤.01 |
| | +GROUP | .37 | .08 | 3.24 | 1,27 | ≤.10 |
| | +SCORE-x-GROUP | .38 | .01 | 0.22 | 1,26 | ns |
| Value | SCORE | .05 | .05 | 1.62 | 1,28 | ns |
| | +GROUP | .06 | .00 | 0.02 | 1,27 | ns |
| | +SCORE-x-GROUP | .22 | .16 | 5.35 | 1,26 | ≤.05 |
| Cultural Value | SCORE | .27 | .27 | 10.33 | 1,28 | ≤.01 |
| | +GROUP | .27 | .00 | 0.02 | 1,27 | ns |
| | +SCORE-x-GROUP | .28 | .01 | 0.47 | 1,26 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PROXY PRETEST OPINION MEASURES**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Self-Concept | SCORE | .06 | .06 | 1.74 | 1,28 | ns |
| | +GROUP | .08 | .02 | 0.57 | 1,27 | ns |
| | +SCORE-x-GROUP | .26 | .18 | 6.19 | 1,26 | ≤.05 |
| Aspiration | SCORE | .24 | .24 | 8.93 | 1,28 | ≤.01 |
| | +GROUP | .44 | .20 | 9.37 | 1,27 | ≤.01 |
| | +SCORE-x-GROUP | .47 | .03 | 1.45 | 1,26 | ns |
| ATTITUDE | SCORE | .39 | .39 | 17.97 | 1,28 | ≤.01 |
| | +GROUP | .40 | .01 | 0.29 | 1,27 | ns |
| | +SCORE-x-GROUP | .40 | .00 | 0.16 | 1,26 | ns |
| Math/Science Attitude | SCORE | .19 | .19 | 6.74 | 1,28 | ≤.05 |
| | +GROUP | .26 | .07 | 2.50 | 1,27 | ns |
| | +SCORE-x-GROUP | .26 | .00 | 0.00 | 1,26 | ns |
| Locus of Control | SCORE | .10 | .10 | 3.01 | 1,28 | ≤.10 |
| | +GROUP | .10 | .00 | 0.00 | 1,27 | ns |
| | +SCORE-x-GROUP | .12 | .03 | 0.77 | 1,26 | ns |
| Academic Support | SCORE | .30 | .30 | 11.86 | 1,28 | ≤.01 |
| | +GROUP | .30 | .00 | 0.09 | 1,27 | ns |
| | +SCORE-x-GROUP | .30 | .00 | 0.00 | 1,26 | ns |
| Career Awareness | SCORE | .06 | .06 | 1.67 | 1,28 | ns |
| | +GROUP | .08 | .02 | 0.62 | 1,27 | ns |
| | +SCORE-x-GROUP | .12 | .04 | 1.16 | 1,26 | ns |
| Role Model | SCORE | .31 | .31 | 12.58 | 1,28 | ≤.01 |
| | +GROUP | .37 | .06 | 2.50 | 1,27 | ns |
| | +SCORE-x-GROUP | .37 | .01 | 0.22 | 1,26 | ns |
| Equal Opportunity | SCORE | .06 | .06 | 1.75 | 1,28 | ns |
| | +GROUP | .23 | .17 | 5.83 | 1,27 | ≤.05 |
| | +SCORE-x-GROUP | .25 | .02 | 0.83 | 1,26 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PROXY PRETEST OPINION MEASURES**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|

All models were analyzed as one-tailed tests.

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

* Three models of independent variables were tested for each dependent variable: (1)PROXY PRETEST OPINION SCORE; (2) PRETEST OPINION SCORE and ('+') GROUP; (3) PRETEST OPINION SCORE and GROUP and SCORE-by-GROUP INTERACTION.

The interactions were analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of preintervention scores for which the groups differed. Figure 1 shows the nonparallel regression lines that indicate that for students with lower proxy opinion scores, the students in the intervention group had higher scores than did students in the control group.

In Figure 1, for students with prior proxy opinion scores at or below 2.8, the intervention-group students had higher scores that did the control-group students on the final Value scale; the control-group students had higher scores than did the intervention group only for students with prior proxy opinions at or above 3.35.

**Figure 1**

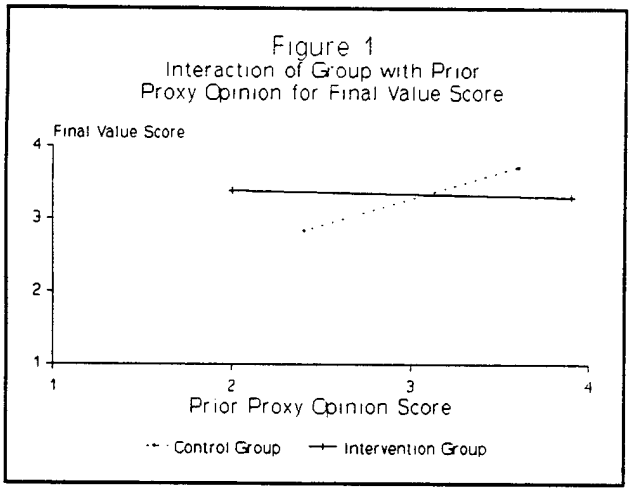



**Figure 2**

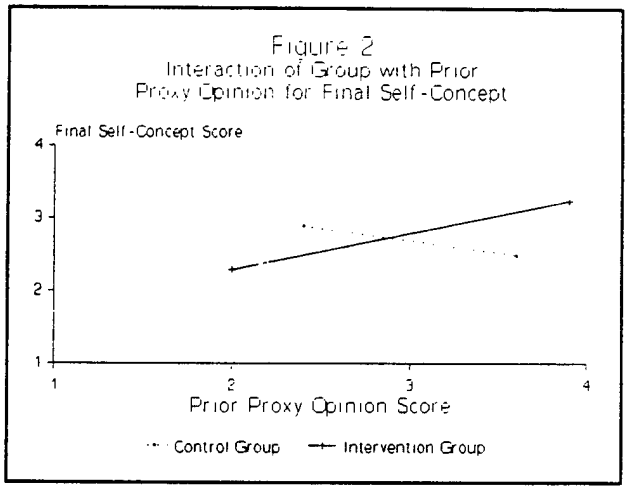



Figure 2 shows a different relationship between group membership and prior proxy opinion scores: Intervention-group students with preintervention scores at or above 3.2 had higher post- intervention Self-Concept scores than did comparable control-group students. Students with lower proxy preintervention opinion scores (2.6 or lower) did better in the control group than in the intervention group. Tests of the second hypothesis lead to the conclusion that the intervention had small, positive effects on students' opinions about SET fields and careers.

Summary of Results

Table 7 summarizes the findings as effect sizes. As the effect sizes indicate, the intervention had a large positive effect on performance and small-to-medium effects on opinion that were mostly positive. The hypotheses of enhanced performance and opinion received partial support from these results. The performance enhancements of the intervention seemed to hold for the algebra students only. The trigonometry class had only 11 students, and the finding of no-difference with such a small sample is not surprising; a sample of 64 students would have been needed to have the recommended power (.80) to detect a one-half standard deviation difference (d = .50) (Maxwell & Delaney, 1990).

**Table 7**

| Effect Sizes | | | |
|---|---|---|---|
| VARIABLE | Posttest | Adjusted Posttest | Group-by-Pretest Interaction |
| PERFORMANCE | | | |
| Final Exam Scores | -0.12 | -0.12 | .47 |
| Course Grades | 0.06 | -0.09 | .53 |
| Grade in Algebra | 1.19<br>≤.01 | 0.95<br>≤.05 | .06 |
| Grade in Trigonometry | -0.53 | -0.45 | .42 |
| OPINION | | | |
| Total Opinion | 0.28 | -- | -- |
| SET Goal | 0.60 | 0.66<br>≤.10 | 0.17 |
| Attitude | 0.32 | 0.20 | 0.15 |
| Environmental Support | -0.82<br>≤.05 | -0.51 | 0.16 |

| Effect Sizes | | | |
|---|---|---|---|
| VARIABLE | Posttest | Adjusted Posttest | Group-by-Pretest Interaction |

Note. The measure of effect size was calculated according to B.T. Johnson (1989). A positive sign in the "Posttest" or "Adjusted Posttest" columns indicates that the intervention group outperformed the control group; a negative sign indicates that the control group had the higher score. For a significant interaction effect size, a positive sign indicates that the intervention helped students scoring lower on the pretest more than it helped the higher scoring students; a negative sign on the interaction effect size indicates that the intervention helped students scoring higher on the pretest more than it helped lower scoring students.

## DISCUSSION

The two hypotheses of enhanced performance and opinion as a result of the intervention received partial support. The intervention- group students had higher algebra course grades than did the control-group students despite adjusting for prior college GPA; the small sample of trigonometry students, the grading differences between the algebra and trigonometry classes, and the asymmetrical enrollment of control-group and intervention-group students masked an overall effect of the intervention for the two classes. The enhanced opinion hypothesis received partial support: The intervention-group students had more positive attitudes about SET fields and careers, but the control-group students had higher opinions about their level of academic support. These effects were small-to-medium, and some did not reach statistical significance due to the low power (less than .50) of the tests, primarily because of the small sample.

Though the intervention was analyzed as a quasi-experiment with the ensuing caution about causal conclusions, the groups appeared comparable before the intervention. Comparisons on a total of 75 preintervention measures found significant differences on only five percent, which included a broad range of demographic (the groups differed on 3 of 64 measures), performance (the groups differed on 1 of 4), and opinion measures (the groups differed on none of 7 proxy measures).

The intervention's success in raising grades in the algebra class may have been due to preexisting differences between the groups. These differences were likely the result of the methods used to recruit students for the intervention group. The intervention-group students had higher preintervention performance levels on three measures: (a) high school class percentile ranks (effect size, $\underline{d}$ = 1.28), (b) higher preintervention college GPAs ($\underline{d}$ = .55), and (c) higher SAT-Mathematics scores ($\underline{d}$ = 1.10). The adjustments via ANCOVA may not have completely removed the preexisting advantages of the intervention-group students. As a result, there are several possible conclusions about the effects of the intervention: (a) The intervention enhances performance for all students; (b) the intervention enhances performance for students in algebra classes; (c) the intervention enhances performance for high-ability students such as those in the intervention group; or (d) the intervention had no effect on performance, but the high-ability students who participated in the intervention matured at a faster pace than did the average students in the control group. If measures of participation in the intervention are correlated with performance, this would argue against the last two conclusions. Later semesters of this intervention will provide an opportunity to verify that the intervention is associated with greater success in mathematics courses.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, a n d bulletins

# PART IV

# APPENDICES

# APPENDIX A

# COLLEGE STUDENT PROTOCOL

College Student Protocol

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. Am. Indian (Please specify the tribe which best describes your heritage.) _____
   ___ e. Hispanic Which of the following best describes your heritage?
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

6. Class:
   ___ a. College freshman
   ___ b. College sophomore
   ___ c. College junior
   ___ d. College senior
   ___ e. Other (e.g., special or temporary student, etc.)
      Specify _____

7. Have you declared a college major?
   ___ a. No
   ___ b. Yes ..... Please specify your major. _____

8. Have you taken any advanced placement tests for college credit?
   ___ a. No
   ___ b. Yes ..... Please list tests taken. _____

9. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Two years of college
   ___ b. Four years of college
   ___ c. One or more years after college
   ___ d. Other Specify _____

10. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

11. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)

   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Work-study
   ___ d. Job other than work-study
   ___ e. Tuition or other scholarship
   ___ f. Loan
   ___ g. Previous personal earnings and savings
   ___ h. GI Bill, ROTC, or other governmental assistance (other than scholarship or loan)
   ___ i. Family trust fund, insurance plan, or other similar arrangement
   ___ j. Other Specify _____

12. You may want to receive help outside your regular college course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems
   ___ f. Increasing reading ability
   ___ g. Developing good study habits
   ___ h. Improving writing ability

13. What is or was the occupation of the person(s) with whom you lived during the years you were growing up? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

_____ _____

14. Would you say that your family's income is:
    ___ a. Below the U.S. average
    ___ b. About average
    ___ c. Above average

15. Are you:
    ___ a. An only child (skip to question 17)
    ___ b. The oldest child
    ___ c. The youngest child
    ___ d. An in-between child

16. How many brothers and sisters do you have?
    ___ a. One
    ___ b. Two
    ___ c. Three or more

17. What was the highest level of school your father completed? (Check only the highest)
    ___ a. Grade school or less
    ___ b. Some high school but did not graduate
    ___ c. High school graduate
    ___ d. Some college but no degree
    ___ e. College degree or more

18. Indicate the extent of your mother's education. (Check only the highest)
    ___ a. Grade school or less
    ___ b. Some high school but did not graduate
    ___ c. High school graduate
    ___ d. Some college but no degree
    ___ e. College degree or more

19. What was the language spoken most often by adults in the household where you grew up? (Check only one)
    ___ a. English
    ___ b. Spanish
    ___ c. The language of my tribe .... What is that language? _____
    ___ d. Other
    Specify _____

20. Which of the following did your parent(s)/guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

21. Which of the following comes closest to describing your parent(s)/guardian(s)?
___ a. Do(es) not read at all
___ b. Sometimes read(s)
___ c. Read(s) a lot

22. Which of the following comes closest to describing you?
___ a. Do not read at all
___ b. Sometimes read
___ c. Read a lot

23. How many of these do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

24. From what kind of high school or secondary school did you graduate?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

25. Were you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes.....Please list the math and/or science clubs you belonged to.

_____

_____

_____

_____

26. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL WITH DIRECTIONALITY AND SCALES OF ITEMS

**Legend:**

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of my ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |

| | | | |
|---|---|---|---|
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |

| | | | |
|---|---|---|---|
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

i. _____

ii. _____

iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE COLLEGE STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 16 | CONTROL n = 18 |
| 1. Sex | | |
| Women | 62% | 72% |
| Men | 38% | 28% |
| 2. Age | 22.03 | 21.79 |
| 6. Class | | |
| .Freshmen | 0% | 0% |
| .Sophomores | 25% | 11% |
| .Juniors | 38% | 33% |
| .Seniors | 31% | 39% |
| .Missing | 6% | 17% |
| 7. Declared SET majors | 13% | 0% |
| .Missing or undeclared | 13% | 17% |
| 8. Students taken an advanced placement test | 13% | 6% |
| .Missing | 6% | 17% |
| 9. Higher education expected: | | |
| .Two years of college | 0% | 0% |
| .Four years of college | 47% | 11% |
| .One or more years after college | 50% | 72% |
| .Missing | 6% | 17% |
| 10. Studies most influenced by | | |
| .Parents | 75% | 50% |
| .Another family member | 12% | 17% |
| .Teacher | 0% | 6% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 0% |
| .Friend | 6% | 0% |
| .Science professional | 0% | 0% |
| .Nonscience professional | 0% | 0% |
| .No one at all | 6% | 28% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 16 | CONTROL n = 18 |
| 11. Sources of income[b] | | |
| .Parents/guardians | 56% | 33% |
| .Spouse | 0% | 6% |
| .Work study | 75% | 39%[a] |
| .Job other than work study | 50% | 44% |
| .Tuition or scholarship | 31% | 33% |
| .Loan | 50% | 44% |
| .Grant | 75% | 67% |
| .Personal savings | 6% | 17% |
| .GI Bill, ROTC, etc. | 0% | 11% |
| .Family trust, etc. | 0% | 0% |
| .Other | 0% | 6% |
| Number of sources of income * | 3.44 | 3.00 |
| 12. Student needs help in:[b] | | |
| .Counseling on educational plans | 19% | 11% |
| .Counseling on career plans | 56% | 22%[a] |
| .Improving math ability | 44% | 44% |
| .Finding part-time work | 38% | 28% |
| .Counseling on personal problems | 0% | 0% |
| .Increasing reading ability | 12% | 6% |
| .Developing good study habits | 31% | 22% |
| .Improving writing ability | 19% | 33% |
| Number of areas needing help * | 2.19 | 1.67 |
| 13. Sources of outside income | | |
| .None | 6% | 6% |
| .One | 69% | 39% |
| .Two | 6% | 33% |
| .Missing | 19% | 22% |
| 14. Family income: | | |
| .Below U.S. average | 25% | 11% |
| .About average | 31% | 33% |
| .Above average | 6% | 17% |
| .Unknown | 38% | 39% |
| 15. Birth order of student: | | |
| .Only child | 0% | 6% |
| .Oldest child | 38% | 28% |
| .Youngest child | 38% | 22% |
| .In-between child | 19% | 28% |
| .Missing | 6% | 17% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 16 | CONTROL n = 18 |
| 16. Number of siblings: | | |
| .None | 6% | 6% |
| .One | 19% | 6% |
| .Two | 6% | 17% |
| .Three or more | 62% | 56% |
| .Missing | 6% | 17% |
| 17. Father's education | | |
| .Grade school or less | 19% | 11% |
| .Some high school | 19% | 17% |
| .High school graduate | 50% | 22% |
| .Some college | 0% | 0% |
| .College degree or more | 6% | 22% |
| .Missing | 6% | 28% |
| 18. Mother's education: | | |
| .Grade school or less | 6% | 0% |
| .Some high school | 25% | 28% |
| .High school graduate | 50% | 28% |
| .Some college | 12% | 6% |
| .College degree or more | 0% | 22% |
| .Missing | 6% | 17% |
| 19. Language spoken most at home: | | |
| .English | 88% | 83% |
| .Spanish | 6% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| .Missing | 6% | 17% |
| 20. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 56% | 50% |
| .Attend parent-teacher conferences | 69% | 56% |
| .Visit student's class | 50% | 56% |
| .Phone/visit if there's a problem | 50% | 50% |
| .Do volunteer work | 25% | 22% |
| .Assist student in course selection | 38% | 17% |
| .Assist in student's homework | 69% | 50% |
| Number of parental involvements | 3.56 | 3.00 |
| 21. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 38% | 33% |
| .A lot | 56% | 50% |
| .Missing | 6% | 17% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 16 | CONTROL n = 18 |
| 22. Student reads: | | |
| .Not at all | 65 | 6% |
| .Sometimes | 50% | 56% |
| .A lot | 31% | 22% |
| .Missing | 12% | 17% |
| 23. Items in student's home:[b] | | |
| .Desk | 50% | 56% |
| .Daily newspaper | 50% | 61% |
| .Encyclopedia | 81% | 67% |
| .Typewriter | 56% | 61% |
| .Calculator | 81% | 72% |
| .Television | 94% | 78% |
| .Computer | 25% | 11% |
| .Video Cassette Recorder (VCR) | 69% | 61% |
| Number of support items * | 5.06 | 4.67 |
| 24. Type of high school attended | | |
| .Public | 94% | 83% |
| .Private | 0% | 0% |
| .No formal high school | 0% | 0% |
| .Missing | 6% | 17% |
| 25. Member math/science club in high school | 44% | 11%[a] |
| 26. All activities student took part in:[b] | | |
| .Math/science club | 12% | 6% |
| .Field trip | 56% | 50% |
| .Watching science programs on TV | 69% | 61% |
| .Listen to talk by scientist | 12% | 22% |
| .Science/math fair | 56% | 44% |
| .Other science/math competition | 19% | 6% |
| .Play/work in computer lab | 69% | 67% |
| Number of activities * | 2.94 | 2.56 |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# COMMUNITY COLLEGE OF PHILADELPHIA

# INTERVENTIONS

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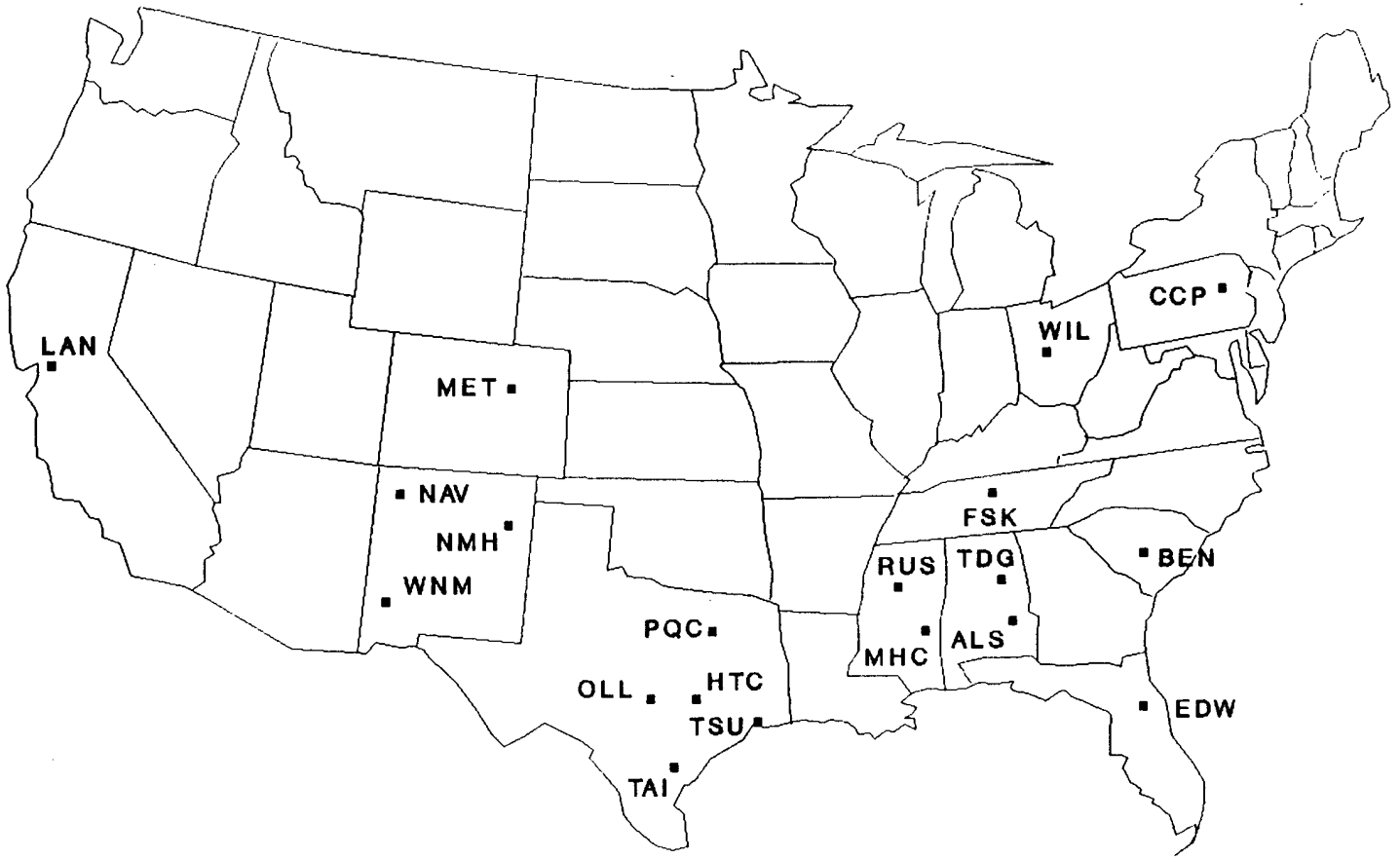
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected came from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention- group students, as well as on a control-group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.
Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF COMMUNITY COLLEGE OF PHILADELPHIA

Community College of Philadelphia is a two-year, public, coeducational institution located in Philadelphia, Pennsylvania. The College serves over 14,000 students and employs 976 full-time faculty members. The College, organized into the Division of Economics and Business Administration, Division of Educational Resources, Division of Humanities and the Arts, Division of Life Sciences and Allied Health Services, Division of Mathematics, Physical Sciences, and Engineering Technologies, and Division of Social and Behavioral Sciences and Human Service Careers, offers more than 60 different associate degree and certificate programs. Over half of the College's graduates go on to four-year colleges and universities. The student body is approximately 64 percent female and 36 percent male. Approximately 5 percent of the students are Asian Americans, 39 percent are Black, 4 percent are Hispanic, and the remaining 52 percent are of other ethnic origins, including Anglos (non-Hispanic Whites). The president of Community College of Philadelphia is Dr. Judith Eaton.

Degrees offered at Community College of Philadelphia in quantitative subjects are Associate in Applied Science in data processing and in a variety of technologies including architectural, chemical, and electronics engineering technology, and Associate in Science in computer science, engineering science, and physical sciences.

Philadelphia has a population of over 1.6 million in its metropolitan area. The state of Pennsylvania has a population of approximately 12 million. According to U.S. Census Bureau estimates, the adult population of Pennsylvania is 89 percent Anglo, 9 percent Black, 1 percent Hispanic, and 1 percent other ethnic origins. Philadelphia has another eighty-seven institutions of higher learning, including Chestnut Hill College, Drexel University, Hahnemann University, Holy Family College, La Salle University, Peirce Junior College, Philadelphia College of Textiles and Science, Saint Joseph's University, Spring Garden College, Temple University, Thomas Jefferson University, and the University of Pennsylvania.

# PART II

# SUMMARY OF THE COMMUNITY COLLEGE OF PHILADELPHIA (CCP) INTERVENTIONS

This report summarizes the three interventions conducted by the Community College of Philadelphia (CCP), a two-year, public institution which is a member of a consortium formed by The Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Community College of Philadelphia (CCP) Intervention Activities:

In 1989 CCP conducted two intensive, noncredit, three-week algebra workshops designed to expedite passage through algebra into precalculus. Participants were students whose scores were in the higher range on a test for placement into an algebraic techniques course. In 1990, CCP conducted an 11-week noncredit mathematics workshop adapted from a model developed by Dr. Uri Treisman.

Findings:

- Mathematics performance improved in all three semesters for those students who participated in the intervention group.
- For students who did complete the program, a three-week algebra workshop was as helpful as the traditional one-semester algebraic techniques course.
- Based on results of an opinion protocol given to intervention- and control-group students, the intervention was associated with enhanced opinions on several of the seven opinion scales in all three semesters.
- Both recruitment and retention in noncredit courses are difficult in an urban community college where most students have jobs and there is competition for available time.

Recommendations:

Since recruitment and retention of student participants proved to be a problem in all three semesters, these recommendations are offered:

- The low rate of participation seems to indicate that the workshops did not adequately meet students' needs or requirements. Therefore, before bringing a program such as this to a college setting, first survey students about their preferences, competency, and schedules to see what type of program most closely approximates their needs.
- Offer alternative meeting times for each program element to better accommodate students' work and class schedules.
- If course credit can be associated with such a program, the program would be more attractive to students.

# PART III

# CASE STUDY OF THE COMMUNITY COLLEGE OF PHILADELPHIA

# 1989 SUMMER SEMESTER INTERVENTION

## ABSTRACT

In 1989 Community College of Philadelphia (CCP), Philadelphia, Pennsylvania, developed and tested against a control group an intensive, summer algebra workshop designed to expedite a student's passage through algebra into precalculus. Participants were 17 college students (13 women and 4 men), primarily Black and Anglo, whose scores on a college mathematics placement test were in the higher range of scores that would place them into the Math 117 Algebraic Techniques course. The intervention was repeated in the fall of 1989 and in the fall of 1990.

The CCP program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance in mathematics courses, (b) increase enrollment in subsequent mathematics courses, and (c) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* Major components of the three-week workshop were instruction in a variety of algebraic concepts; individual, group, and computer-assisted problem-solving; and mathematics journal writing to help students learn the language of mathematics and articulate their understanding of mathematical concepts. Additional intervention activities included a chemistry demonstration and a field trip to a local science museum.

*DATA:* All the participants furnished demographic data through the CASET College Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were scores on a two-part preintervention mathematics placement test, scores on a three-part postintervention mathematics test, composite mathematics test scores, college GPAs, and information on subsequent enrollment in SET courses during the following two semesters. All mathematics tests were institution-specific.

The outcome measure of performance was the score on a three-part postintervention mathematics test covering algebra, intermediate algebra, and precalculus. The preintervention measure of performance was the score on a two-part preintervention mathematics placement test covering arithmetic and algebra.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design; through analyses of preintervention measures it appeared that the intervention and control groups were comparable.

*FINDINGS:* The intervention had some positive effect on the participants and can be considered a successful intervention in that mathematics performance was improved. The hypothesis that the intervention would improve mathematics performance received some support: The intervention group had higher intermediate algebra, precalculus, and composite test scores than did the control group; however, the intervention group outperformed the control group in only precalculus after adjusting for differences in prior mathematics performance. The hypothesis that the intervention would enhance opinions about SET fields and careers received slight support: Although the intervention-group students expressed lower anxiety than the control-group students, the overall effect on student opinion was zero. The small sample size and a possible "ceiling effect" on placement test scores lowered the sensitivity of the statistical tests, limiting the conclusions about the effects of the intervention.

## DESCRIPTION OF THE INTERVENTION

Community College of Philadelphia (CCP) developed an intervention designed to enhance the mathematics interest and performance of college students whose college mathematics placement test scores fell in the higher range of scores that would place students into the Algebraic Techniques (Math 117) course. The intervention was a three-week mathematics workshop geared to expedite students' passage through algebra into precalculus, and thus prepare them for advanced mathematics and mathematics-based courses. The intervention was also designed to enhance students' confidence in their own mathematical ability and their awareness of and interest in SET careers as an option for themselves. This is the report of the first semester of that intervention, which took place in the summer semester of 1989.

New CCP students regularly take a mathematics placement test for assignment into their mathematics courses. Intervention participants were selected from students scoring near to, but less than, the qualifying scores for precalculus courses on the regular college placement test. Ordinarily these students would have been placed in Math 117, Algebraic Techniques, which is a one-semester three-credit-hour course. Mathematics faculty reported that the performance of some of the students placed in Math 117 indicated that these students would be able to master that course material in a relatively short time, and then be prepared to move on to more advanced mathematical work. It was felt that expediting their progress through the mathematics sequence, with some motivational work, could lead them to consider mathematics-based career possibilities. An intensive three-week workshop was developed, designed to sharpen students' algebraic skills, both in problem solving and in quantitative techniques, and to prepare them to move into precalculus without further preliminary work. Other elements of the intervention were designed to enhance students' comfort with mathematics and their interest in SET fields.

The intervention's two hypotheses were that the intervention would: (a) enhance performance in mathematics courses, and (b) enhance opinions about SET fields and careers. The workshop consisted of eleven three-hour meetings on Mondays, Tuesdays, Wednesdays, and Thursdays (with the exception of the Monday Memorial Day holiday) over a three-week period. The first meeting was held on May 22, 1989; the final meeting was held on June 8, 1989.

It is noteworthy that the project director reported difficulty recruiting students for participation in the workshop; reported reasons included job conflicts, time conflicts, and a lack of commitment. A computer search of current student records had identified 135 students as candidates for the workshop. Letters were sent to these 135 students informing them of their eligibility and inviting their participation. Eighteen responded positively; these received a follow-up letter inviting them to the first meeting. The project director personally telephoned the students to repeat the invitation. Nine students attended the first meeting; six students completed the workshop. While the workshop did not offer academic credit, upon completion of the workshop students were expected to be able to move directly into the pre-calculus course.

The primary workshop activity was instruction in algebra by the project director, assisted by a mathematics specialist from the Learning Laboratory. Topics for the workshop included factoring, quadratic equations, graphing, logarithmic functions, and other algebraic concepts. There was particular attention to problem solving-- individually, in groups and by computer. High-interest and challenge problems (for example: "When is the area of a figure numerically equal to its perimeter") were featured. Each student was given a copy of the book *The Education of T.C. Mits (The Celebrated Man In The Street)* by Lillian R. Lieber. In her book, Lieber illustrates the importance of mathematics and its applications. The book is out of print, however it was duplicated for use in the workshop with permission from the publisher, W.W. Norton.

Another major workshop activity was the writing of a journal; 30 to 60 minutes at the end of each workshop meeting were devoted to journal writing under the direction of a member of the English faculty. This "diary" phase of the workshop was designed to help the students articulate their understanding of mathematical concepts and to express themselves using correct mathematical language. The idea behind the journal assignment was that it would build the students' confidence as well as bolster their understanding of the concepts.

Additional workshop activities included watching the movie "Stand and Deliver", the feature film about mathematics teacher, Jaime Escalante; career information provided by CCP graduates who had degrees in SET areas; a science demonstration conducted by a member of the chemistry faculty; and a field trip to a nearby science museum.

All the workshop faculty were CCP faculty members. The Project Director Geoffrey Schulz, Assistant Professor of Mathematics, developed the workshop and worksheet materials and conducted the workshop sessions, with Dr. Stephen Horwitz, a mathematical specialist at the Learning Laboratory. Ms. Carolyn Birden, Assistant Professor of English, developed and conducted the journal-writing segment of the workshop. Mr. David Katz, Associate Professor of Chemistry, conducted the science demonstration.

## METHOD

### Subjects

Subjects were female and minority college students, selected on the basis of their scores on the CCP placement test in mathematics. Students qualifying for the workshop were those whose scores on the placement test fell at the high end of the range of scores qualifying students for placement into Math 117, Algebraic Techniques.

The placement test has two parts: a 25-item arithmetic section, and a 15-item algebra section. A student who answered 11 of the 15 algebra items correctly would be placed beyond Math 117; algebra scores of 8, 9, or 10, which are at the high end of the scores which would place a student in Math 117, were chosen as the qualifying algebra scores for the CASET workshop. To be eligible, a student also had to score 18-25 on the arithmetic section of the test.

A control group was identified, consisting of students whose placement test scores would have qualified them for the CASET workshop but who had elected instead to take the Math 117 Algebraic Techniques course during the summer of 1989 (the same semester as the workshop was offered.) Control-group students filled out the same protocols and provided the same information as the intervention-group students, but did not participate in any intervention activities. Data were submitted for a total of 18 students: the 6 intervention students who completed the workshop and 12 control-group students. One control-group student who was not a U.S. citizen was eliminated from the sample: the subjects of this study must be only U. S. citizens. Data from 6 intervention-group and 11 control-group students were analyzed and are included in this report. Table 1 shows the ethnic and sex breakdown for the intervention and control groups.

**Table 1**

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | 0 | 1 | 0 | 0 | 0 | 1 |
| Anglo | 4 | - | 1 | - | 5 | - |

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| Black | 4 | 2 | 4 | 1 | 8 | 3 |
| Hispanic | 0 | 0 | 0 | 0 | 0 | 0 |
| Unknown | 0 | - | 0 | - | 0 | - |
| **TOTAL** | **8** | **3** | **5** | **1** | **13** | **4** |

CASET Protocols and Other Instruments

The intervention's two hypotheses were that the intervention would: (a) enhance performance in mathematics courses, and (b) enhance opinions about SET fields and careers. Demographic and descriptive data about the subjects were developed through the CASET College Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gives a scalar measurement for that variable. Thus the completed Opinion Protocol provides a scale measuring each of the thirteen variables. The Opinion Protocol was designed to be administered to intervention- and control-group students before and after the intervention. The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B. The preintervention measures of performance for intervention- and control-group students were arithmetic and algebra scores on the placement test. The placement test included 25 multiple-choice arithmetic items and 15 multiple-choice algebra items. Postintervention measures of performance for intervention- and control-group students were 15 multiple-choice items in algebra; 10 multiple-choice items in intermediate algebra, and 9 multiple-choice items in precalculus. The composite pretest score (40 items) and composite posttest score (34 items) were also included in the analysis, along with postintervention college GPA (A number of the students were new freshmen for whom a preintervention college GPA was not available).

Procedure

At the beginning of the intervention, intervention- and control-group students signed consent forms and transcript release forms. The first measures of opinion, and the measures of demographic information were taken during the third week of May, 1989. Intervention activities were conducted with the intervention group, and the control-group students took the Math 117 course. After the intervention for the intervention-group students, and after the Math 117 course for the control-group students, the CASET Opinion Protocol and the postintervention mathematical performance test were administered to all students (on June 7, 1989 for the intervention group and on June 27, 28 and 29, 1989 for the control group). The performance measures and Fall 1989 transcripts for intervention- and control-group students were

forwarded to CASET for analysis, along with the CASET Student Protocol and the preintervention and postintervention Opinion Protocols.

The items of the Opinion Protocol were coded by CASET according to the thirteen scales they represent. Items on the Opinion Protocol were scored in such a way that a larger number reflected a positive outcome (see Appendix B). The scales were organized into three constructs -- SET Goal, Environmental Support, and Attitude -- as shown in Appendix C.

## RESULTS

### Methodological Issues

The intervention's two hypotheses were that the intervention would: (a) enhance performance in mathematics courses, and (b) enhance opinions about SET fields and careers. The intervention had preintervention and postintervention measures of performance and opinion for most intervention- and control-group participants, and was analyzed as a *nonequivalent control-group* design. This type of quasi-experimental design has one common weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty about causal influence may be addressed by analyzing the influence of preexisting characteristics on students' performance and opinion; the analysis of covariance (ANCOVA), adjusting for preintervention performance or opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that existed before the intervention.

### Demographic Results

The comparability of the intervention and control groups was examined by testing for differences on the items of the College Student Protocol. The complete results are given in Appendix D. Of the 65 comparisons, the groups differed on three: (a) more of the intervention-group students claimed that no one had influenced their studies (83%) than did the control-group students (36%); (b) more intervention-group students wanted help to improve their math ability (100%) than did the control group (27%); and (c) more intervention-group students had mothers who had attended college (100%) than had the control-group students (18%). Two of the three differences were ambiguous (more intervention-group students claimed no one had influenced their studies and more wanted help with math), and one difference favored the intervention-group students (more of their mothers had been to college). The three significant differences between the groups on preexisting characteristics were not significantly different from the number of differences expected by chance at the 10-percent probability level. Based on these results, the groups were judged to be comparable on demographic characteristics before the intervention.

### Performance Measures

*Group differences in performance.* The three preintervention measures (algebra pretest, arithmetic pretest, and combined pretest) and the five postintervention measures of performance (algebra posttest, intermediate algebra posttest, precalculus posttest, combined posttest, and GPA) were tested for group differences, and the results are given in Table 2. Note that the intervention and control groups differed significantly on two preintervention measures: (a) The intervention-group students had higher mean arithmetic pretest scores ($\underline{M}$ = 90.00) than did the control-group students

($\underline{M}$ = 80.73), $\underline{t}$ (15) = 2.83, $\underline{p} \leq .05$, two-tailed; and (b) the intervention-group students had higher combined pretest scores ($\underline{M}$ = 77.00) than did the control-group students ($\underline{M}$ = 70.91), $\underline{t}$ (15) = 2.54, $\underline{p} \leq .05$, two-tailed.

The $\underline{t}$-tests comparing the intervention-group and control-group students for the postintervention measures indicated that the intervention group had higher scores on three of the five measures: (a) The intervention-group had significantly higher intermediate algebra scores ($\underline{M}$ = 75.00) than did the control-group students ($\underline{M}$ = 55.45), $\underline{t}$ (15) = 1.81, $\underline{p} \leq .05$, one-tailed; (b) the intervention-group students had significantly higher precalculus scores ($\underline{M}$ = 44.33) than did the control-group students ($\underline{M}$ = 22.09), $\underline{t}$ (15) = 2.03, $\underline{p} \leq .05$, one-tailed; and (c) the intervention-group students had significantly higher combined posttest scores ($\underline{M}$ = 68.72) than did the control-group students ($\underline{M}$ = 58.33), $\underline{t}$ (15) = 1.34, $\underline{p} \leq .10$, one-tailed. The groups did not differ on algebra posttest scores or on GPA for the subsequent semester.

**Table 2**

**DIFFERENCES ON GROUP PERFORMANCE MEASURES**

| MEASURE | GROUP | n | MEAN | SD | t-TEST (df) | SIG $\underline{P}$ |
|---|---|---|---|---|---|---|
| Algebra Pretest | Control<br>Intervention | 11<br>6 | 54.55<br>55.33 | 6.52<br>3.62 | 0.27<br>(15) | ns |
| Arithmetic Pretest | Control<br>Intervention | 11<br>6 | 80.73<br>90.00 | 5.88<br>7.48 | 2.83<br>(15) | ≤.05 |
| Combined Pretest | Control<br>Intervention | 11<br>6 | 70.91<br>77.00 | 4.37<br>5.38 | 2.54<br>(15) | ≤.05 |
| Algebra Posttest | Control<br>Intervention | 11<br>6 | 82.00<br>79.17 | 9.72<br>19.49 | -0.41<br>(15) | ns |
| Intermediate Algebra Post. | Control<br>Intervention | 11<br>6 | 55.45<br>75.00 | 19.68<br>24.29 | 1.81<br>(15) | ≤.05 |
| Precalculus Posttest | Control<br>Intervention | 11<br>6 | 22.09<br>44.33 | 20.56<br>23.55 | 2.03<br>(15) | ≤.05 |
| Combined Posttest | Control<br>Intervention | 11<br>6 | 58.33<br>68.72 | 12.10<br>20.05 | 1.34<br>(15) | ≤.10 |
| Post GPA | Control<br>Intervention | 11<br>6 | 2.96<br>2.49 | 0.85<br>1.41 | -0.86<br>(15) | ns |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

It had been hoped that subsequent enrollment in SET courses and the grades earned in these courses could be used as additional measures of performance. Unfortunately, only three of the seventeen students enrolled in a SET course in the next semester (Fall, 1989), and only two others enrolled in the following semester (Spring, 1990); the test of this difference in proportion of students who enrolled in a SET course in the following two semesters was not significant, i.e., the groups were not different. However the small number of students who enrolled in a SET course in the two subsequent semesters provided a weak test of the hypothesis of increased enrollment in SET courses.

Because the intervention-group students had significantly higher arithmetic and combined scores before the intervention began, a further analysis seemed necessary to provide a more sensitive test of the intervention's effects and to adjust for preintervention differences between the groups. ANCOVAs that adjusted for preintervention performance were completed for the five postintervention performance measures: algebra posttest, intermediate algebra posttest, precalculus posttest, combined posttest, and postintervention GPA.

*Group differences after adjusting for pretests.* A hierarchical ANCOVA adjusted for preintervention performance before comparing groups on five postintervention performance measures; the results are given in Table 3. A preintervention measure was selected as the covariate for analysis based on maximizing the pretest-posttest correlation.

This table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding each variable to the multiple regression equation (one variable per row), and the significance test of each variable's contribution toward explaining the dependent measure. The columns of the table include the cumulative percentage of explained variance (cum $R^2$), added contribution in explained variance of the variable ($sR^2$), test of the contribution of the new variable ($F(sR^2)$), and the degrees of freedom (df) for the test.

The results in Table 3 demonstrated that the control-group and intervention-group students differed significantly for precalculus posttest after adjusting for algebra pretest scores. No other adjusted postintervention difference was significant; the preintervention differences between the groups accounted for the postintervention differences of Table 2 for intermediate algebra and the combined posttest.

Based on the results in Tables 2 and 3, the first hypothesis was partially supported: The intervention-group students outperformed the control-group students in precalculus posttest scores.

**Table 3**

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION - PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLE | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| ALGEBRA POSTTEST | ALGEBRA PRETEST | .02 | .02 | 0.27 | 1,15 | ns |
| | + GROUP | .03 | .01 | 0.13 | 1,14 | ns |
| | + PRE-x-GROUP | .05 | .02 | 0.30 | 1,13 | ns |
| COMBINED POSTTEST | COMBINED PRE | .06 | .06 | 0.99 | 1,15 | ns |
| | + GROUP | .11 | .05 | 0.83 | 1,14 | ns |
| | + PRE-x-GROUP | .12 | .01 | 0.14 | 1,13 | ns |

| HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION - PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE | | | | | | |
|---|---|---|---|---|---|---|
| **DEPENDENT VARIABLE** | **INDEPENDENT VARIABLE** | **Cumul. $R^2$** | **$sR^2$** | **F ($sR^2$)** | **df** | **Sig. p** |
| COLLEGE GPA POSTINTERVENTION | ALGEBRA PRETEST | .16 | .16 | 2.96 | 1,15 | ns |
| | + GROUP | .23 | .06 | 1.10 | 1,14 | ns |
| | + PRE-x-GROUP | .23 | .00 | 0.03 | 1,13 | ns |
| INTERMEDIATE ALGEBRA POSTTEST | COMBINED PRE | .18 | .18 | 3.31 | 1,15 | ≤.10 |
| | + GROUP | .23 | .05 | 0.94 | 1,14 | ns |
| | + PRE-x-GROUP | .25 | .02 | 0.38 | 1,13 | ns |
| PRECALCULUS POSTTEST | ALGEBRA PRETEST | .13 | .13 | 2.26 | 1,15 | ns |
| | + GROUP | .32 | .19 | 4.01 | 1,14 | ≤.10 |
| | + PRE-x-GROUP | .38 | .06 | 1.26 | 1,13 | ns |

*Interrelationships among performance.* The interrelatedness of the performance measures was examined through intercorrelations, presented in Table 4. As expected, the preintervention measures (algebra, arithmetic, and the combined pretest) were significantly intercorrelated; also, the postintervention measures (algebra, intermediate algebra, precalculus, combined posttest, and GPA) were significantly correlated.

Of interest was the finding that the algebra posttest and the combined posttest were not significantly correlated with any pretest measure; as a result, the ANCOVAs for these two posttests were not as sensitive as the other ANCOVAs.

**Table 4**

| INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a] | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **AlPr Sig p** | **ArPr Sig p** | **CoPr Sig p** | **PoGPA Sig p** | **AlPo Sig p** | **IaPo Sig p** | **PcPo Sig p** |
| Arithmetic Pretest (ArPr) | .11 ns | 1.00 | | | | | |
| Combined Pretest (CoPr) | .48 ≤.05 | .93 ≤.01 | 1.00 | | | | |
| Post GPA (PoGPA) | .41 ≤.05 | -.32 ns | -.13 ns | 1.00 | | | |
| Algebra Posttest (AlPo) | -.13 ns | -.07 ns | -.11 ns | .13 ns | 1.00 | | |
| Intermediate Algebra Posttest (IaPo) | .10 ns | .44 ≤.05 | .43 ≤.05 | .07 ns | .61 ≤.01 | 1.00 | |

| INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a] | | | | | | | |
|---|---|---|---|---|---|---|---|
| | AlPr Sig p | ArPr Sig p | CoPr Sig p | PoGPA Sig p | AlPo Sig p | IaPo Sig p | PcPo Sig p |
| Precalculus Posttest (PcPo) | .36 ≤.10 | .15 ns | .27 ns | .33 ns | .38 ≤.10 | .57 ≤.01 | 1.00 |
| Combined Posttest (CoPo) | .14 ns | .22 ns | .25 ns | .21 ns | .79 ≤.01 | .89 ≤.01 | .79 ≤.01 |

[a] All correlations were analyzed as one-tailed tests.

All n's = 17

Opinion Measures

*Group differences on pre- and postintervention measures.* The means of the intervention- and control-group students were compared for the 13 opinion scales, three constructs, and total opinion score, measured after the intervention. The results of the 17 t-tests are given in Table 5.

Before the intervention began, the students in the intervention and control groups differed significantly on only one of the seventeen opinion measures: Academic Support was higher in the control group than in the intervention group. Finding only one difference strengthened the conclusion that the groups were comparable before the intervention. After the intervention ended, the intervention-group and control-group students differed on only one of the seventeen measures: The intervention-group students had higher scores on the postintervention Anxiety measure, indicating lower levels of anxiety.

**Table 5**

| GROUP DIFFERENCES ON OPINION CONSTRUCTS AND SCALES | | | | | | | |
|---|---|---|---|---|---|---|---|
| CONSTRUCT/Scale | TIME | CONTROL | | INTERVENTION | | t-Test | Sig. p |
| | | Mean | SD | Mean | SD | | |
| OPINION, Total | Pretest<br>Posttest | 3.14<br>3.05 | .26<br>.16 | 3.01<br>2.99 | .25<br>.21 | -1.03<br>-0.64 | ns<br>ns |
| SET GOAL | Pretest<br>Posttest | 3.21<br>3.15 | .31<br>.28 | 3.18<br>3.21 | .30<br>.25 | -0.23<br>0.45 | ns<br>ns |
| Value | Pretest<br>Posttest | 3.64<br>3.57 | .36<br>.37 | 3.42<br>3.54 | .30<br>.29 | -1.27<br>-0.15 | ns<br>ns |
| Cultural Value | Pretest<br>Posttest | 3.41<br>3.30 | .44<br>.46 | 3.38<br>3.46 | .56<br>.46 | -0.14<br>0.70 | ns<br>ns |

GROUP DIFFERENCES ON OPINION CONSTRUCTS AND SCALES

| CONSTRUCT/Scale | TIME | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| Self-Concept | Pretest | 2.85 | .56 | 3.00 | .26 | 0.61 | ns |
| | Posttest | 2.94 | .33 | 2.97 | .34 | 0.20 | ns |
| Aspiration | Pretest | 3.15 | .35 | 3.03 | .51 | -0.54 | ns |
| | Posttest | 2.95 | .39 | 3.03 | .37 | 0.45 | ns |
| ATTITUDE | Pretest | 3.10 | .28 | 2.90 | .20 | -1.58 | ns |
| | Posttest | 2.97 | .20 | 2.92 | .22 | -0.55 | ns |
| Math/Science Attitude | Pretest | 3.25 | .24 | 3.12 | .29 | -0.97 | ns |
| | Posttest | 3.12 | .30 | 3.05 | .27 | -0.47 | ns |
| Locus of Control | Pretest | 3.39 | .47 | 3.06 | .57 | -1.32 | ns |
| | Posttest | 3.33 | .52 | 3.22 | .34 | -0.47 | ns |
| Persistence | Pretest | 3.27 | .41 | 2.92 | .64 | -1.40 | ns |
| | Posttest | 3.18 | .32 | 2.83 | .58 | -1.61 | ns |
| Study Habits | Pretest | 2.86 | .26 | 2.54 | .53 | -1.65 | ns |
| | Posttest | 2.84 | .32 | 2.54 | .46 | -1.58 | ns |
| Anxiety | Pretest | 2.82 | .60 | 2.78 | .25 | -0.16 | ns |
| | Posttest | 2.58 | .45 | 2.92 | .31 | 1.64 | ≤.10 |
| ENVIRONMENTAL SUPPORT | Pretest | 3.10 | .41 | 2.96 | .35 | -0.70 | ns |
| | Posttest | 3.04 | .30 | 2.79 | .34 | -1.56 | ns |
| Academic Support | Pretest | 3.45 | .48 | 3.00 | .42 | -1.95 | ≤.10 |
| | Posttest | 3.15 | .52 | 2.89 | .46 | -1.03 | ns |
| Career Awareness | Pretest | 2.85 | .38 | 3.00 | .36 | 0.80 | ns |
| | Posttest | 3.03 | .38 | 2.89 | .50 | -0.66 | ns |
| Role Model | Pretest | 2.76 | .86 | 2.72 | .80 | -0.08 | ns |
| | Posttest | 2.76 | .84 | 2.56 | .69 | -0.50 | ns |
| Equal Opportunity | Pretest | 3.33 | .62 | 3.11 | .27 | -0.83 | ns |
| | Posttest | 3.24 | .42 | 2.83 | .41 | -1.92 | ns |

All pretests were analyzed as two-tailed tests. All posttests were analyzed as one tailed tests.
Pretests n's: Control = 11; Intervention = 6 Posttest n's: Control = 11; Intervention = 6

To adjust for preexisting differences and provide a more sensitive test of the intervention's effects on opinion, the final opinion measures were adjusted for preexisting opinion scores via ANCOVA.

Group differences on opinion adjusting for prior scores. Table 6 reports the tests of the effects of group membership on opinion after adjusting for proxy measures of preintervention opinion scores. By these analysis, the groups differed generally on one opinion measure: The intervention-group students had higher opinion scores on the Anxiety measure (adjusted M = 2.93) than did the control-group students (adjusted M = 2.57), again indicating lower anxiety. In addition, group membership interacted with the measure of preintervention opinion for the total Opinion score. The significant interaction indicated that the relationship between the prior total Opinion score and the final Opinion score was different in the two groups.

**Table 6**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTINTERVENTION OPINION MEASURES COVARYING PREINTERVENTION OPINION MEASURES**

| POST. OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLES MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| OPINION,Total | SCORE | .39 | .39 | 9.57 | 1,15 | ≤.01 |
| | +GROUP | .39 | .00 | 0.00 | 1,14 | ns |
| | +SCORE-x-GROUP | .54 | .15 | 4.08 | 1,13 | ≤.10 |
| SET GOAL | SCORE | .42 | .42 | 11.08 | 1,15 | ≤.01 |
| | +GROUP | .45 | .02 | 0.61 | 1,14 | ns |
| | +SCORE-x-GROUP | .48 | .03 | 0.65 | 1,13 | ns |
| Value | SCORE | .29 | .29 | 6.00 | 1,15 | ≤.05 |
| | +GROUP | .30 | .02 | 0.36 | ,14 | ns |
| | +SCORE-x-GROUP | .30 | .00 | 0.01 | 1,13 | ns |
| Cultural Value | SCORE | .57 | .57 | 20.00 | 1,15 | ≤.01 |
| | +GROUP | .61 | .04 | 1.52 | 1,14 | ns |
| | +SCORE-x-GROUP | .61 | .00 | 0.00 | 1,13 | ns |
| Self-Concept | SCORE | .33 | .33 | 7.22 | 1,15 | ≤.05 |
| | +GROUP | .33 | .00 | 0.03 | 1,14 | ns |
| | +SCORE-x-GROUP | .43 | .11 | 2.44 | 1,13 | ns |
| Aspiration | SCORE | .49 | .49 | 14.63 | 1,15 | ≤.01 |
| | +GROUP | .54 | .05 | 1.40 | 1,14 | ns |
| | +SCORE-x-GROUP | .55 | .01 | 0.43 | 1,13 | ns |
| ATTITUDE | SCORE | .37 | .37 | 8.99 | 1,15 | ≤.01 |
| | +GROUP | .38 | .01 | 0.22 | 1,14 | ns |
| | +SCORE-x-GROUP | .47 | .08 | 2.01 | 1,13 | ns |
| Math/Science Attitude | SCORE | .34 | .34 | 7.61 | 1,15 | ≤.05 |
| | +GROUP | .34 | .00 | 0.01 | 1,14 | ns |
| | +SCORE-x-GROUP | .35 | .01 | 0.21 | 1,13 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTINTERVENTION OPINION MEASURES COVARYING PREINTERVENTION OPINION MEASURES**

| POST. OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLES MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Locus of Control | SCORE | .65 | .65 | 5.60 | 1,15 | ≤.05 |
| | +GROUP | .67 | .01 | 0.05 | 1,14 | ns |
| | +SCORE-x-GROUP | .72 | .06 | 0.01 | 1,13 | ns |
| Persistence | SCORE | .65 | .65 | 28.20 | 1,15 | ≤.01 |
| | +GROUP | .67 | .01 | 0.57 | 1,14 | ns |
| | +SCORE-x-GROUP | .72 | .06 | 2.66 | 1,13 | ns |
| Study Habits | SCORE | .45 | .45 | 12.51 | 1,15 | ≤.01 |
| | +GROUP | .47 | .02 | 0.41 | 1,14 | ns |
| | +SCORE-x-GROUP | .53 | .06 | 1.63 | 1,13 | ns |
| Anxiety | SCORE | .27 | .27 | 5.44 | 1,15 | ≤.05 |
| | +GROUP | .44 | .17 | 4.20 | 1,14 | ≤.10 |
| | +SCORE-x-GROUP | .45 | .01 | 0.30 | 1,13 | ns |
| ENVIRONMENTAL SUPPORT | SCORE | .50 | .50 | 14.79 | 1,15 | ≤.01 |
| | +GROUP | .56 | .06 | 2.02 | 1,14 | ns |
| | +SCORE-x-GROUP | .58 | .02 | 0.53 | 1,13 | ns |
| Academic Support | SCORE | .53 | .53 | 17.08 | 1,15 | ≤.01 |
| | +GROUP | .54 | .01 | 0.19 | 1,14 | ns |
| | +SCORE-x-GROUP | .54 | .00 | 0.08 | 1,13 | ns |
| Career Awareness | SCORE | .24 | .24 | 4.62 | 1,15 | ≤.05 |
| | +GROUP | .31 | .07 | 1.49 | 1,14 | ns |
| | +SCORE-x-GROUP | .36 | .05 | 1.09 | 1,13 | ns |
| Role Model | SCORE | .68 | .68 | 31.35 | 1,15 | ≤.01 |
| | +GROUP | .69 | .01 | 0.55 | 1,14 | ns |
| | +SCORE-x-GROUP | .73 | .04 | 1.87 | 1,13 | ns |
| Equal Opportunity | SCORE | .09 | .09 | 1,48 | 1,15 | ns |
| | +GROUP | .24 | .15 | 2.82 | 1,14 | ns |
| | +SCORE-x-GROUP | .26 | .02 | 0.37 | 1,13 | ns |

All models were analyzed as one-tailed tests.

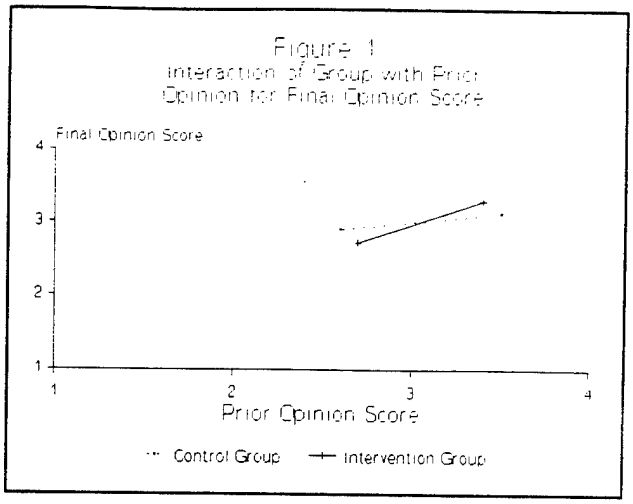
Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

* Three models of independent variables were tested for each dependent variable: (1)PRETEST OPINION SCORE; (2) PRETEST OPINION SCORE and ('+') GROUP; (3) PRETEST OPINION SCORE and GROUP and SCORE-by-GROUP INTERACTION.

**Figure 1**

The interaction was analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of preintervention scores for which the groups differed.

Figure 1 shows the nonparallel regression lines that indicate that for students with higher prior opinion scores, the students in the intervention group outperformed those in the control group. In Figure 1, for students with prior Opinion scores at or above 3.3, the intervention group outperformed the control group on the final total Opinion scale; the control group outperformed the intervention group only for students with prior Opinion scores at or below 2.8. Tests of the second hypothesis lead to the conclusion that the intervention had a few positive effects on students' opinions about SET fields and careers.




Summary of Results

Table 7 summarizes the findings as effect sizes. As the effect sizes indicate, the intervention had a moderate positive effect on performance and small-to-medium positive effects, along with small negative effects, on opinion. The hypothesis of enhanced performance received some support from these results. The performance enhancements of the intervention seemed to hold for the mathematics posttests but not for subsequent GPA. The hypothesis of enhanced opinions about SET fields received slight support; the intervention-group students had lower anxiety than the control-group students. However, the overall effect on opinion was zero, indicating some nonsignificant negative effects.

**Table 7**

| EFFECT SIZES | | | |
|---|---|---|---|
| **VARIABLE** | **Posttest** | **Adjusted Posttest** | **Group-by- Pretest Interaction** |
| **PERFORMANCE** | | | |
| Algebra Posttest | -.21 | -.18 | .28 |
| Intermediate Algebra Posttest | .92<br>≤.05 | .49 | .31 |
| Precalculus | 1.03<br>≤.05 | 1.02<br>≤.10 | .57 |

| EFFECT SIZES | | | |
|---|---|---|---|
| **VARIABLE** | **Posttest** | **Adjusted Posttest** | **Group-by- Pretest Interaction** |
| Combined Posttest | .68<br>≤.10 | .46 | .19 |
| GPA | -.44 | -.53 | .09 |
| **OPINION** | | | |
| **Total Opinion** | -.32 | .00 | -1.03<br>≤.10 |
| SET Goal | .23 | .40 | .41 |
| Attitude | -.28 | .24 | .72 |
| Environmental Support | -.97 | -.72 | .37 |

Note: The measure of effect size was calculated according to B.T. Johnson (1989). A positive sign in the "Posttest" or "Adjusted Posttest" columns indicates that the intervention group outperformed the control group; a negative sign indicates that the control group had the higher score. For a significant interaction effect size, a positive sign indicates that the intervention helped students scoring lower on the pretest more than it helped the higher scoring students; a negative sign on the interaction effect size indicates that the intervention helped students scoring higher on the pretest more than it helped lower scoring students.

Because the sample had only 17 students, a finding of no significant difference for most of the analyses is not surprising; a sample of 44 to 68 students would have been necessary to have a 50-percent chance (power = .50) of detecting a moderate, one-half standard deviation difference (d = .50); as for the combined posttest or intermediate algebra posttest in Table 3 (Gatsonis & Sampson, 1989) a sample of 97 to 153 students would have been necessary to have the recommended sensitivity (power = .80) to detect this same-sized difference.

## DISCUSSION

The hypothesis of enhanced performance as a result of the intervention received some support. The intervention-group students had higher intermediate algebra, precalculus, and combined posttest scores than did the control-group students; of these, only the precalculus difference remained after adjusting for differences in prior performance. The enhanced opinion hypothesis received slight support: The intervention-group students had more positive attitudes about SET fields and careers; other possible effects on opinion did not reach statistical significance due to the low power (less than .50) of the tests, primarily as a result of the small sample.

Another limitation to finding significant effects of the intervention was the possible "ceiling effect" on both the arithmetic pretest and the algebra posttest; that is the performance range was restricted at the upper end such that the students could not perform to their maximum ability. A score of 100 percent was slightly more than one standard deviation above the mean in the intervention group. These possible ceiling effects combined with the limited range of pretest scores in the intervention group may have lowered the pretest-posttest correlations, and as a result lowered the sensitivity of tests of significance related to the hypothesis of enhanced performance.

Though the intervention was analyzed as a quasi-experiment with the ensuing caution about causal conclusions, the groups appeared comparable before the intervention. Comparisons on a total of 85 preintervention measures found significant differences on only seven percent, which included a broad range of demographic (the groups differed on 3 of 65 measures), performance (2 of 3 measures), and opinion measures (1 of 17 measures).

The intervention's success in raising scores on the mathematics tests may have been due to preexisting differences between the groups. The intervention-group students had large preintervention performance advantages on two of the three measures: (a) arithmetic pretest (effect size, $\underline{d}$ = 1.44), and (b) combined pretest ($\underline{d}$ = 1.29).

The adjustments via ANCOVA may not have completely removed the preexisting advantages of the intervention-group students. As a result, it is not clear whether the intervention enhances performance for all students, or only for higher ability students such as those in the intervention group. Another possibility is that the higher ability students who agreed to participate in the intervention simply matured at a faster pace than did the average students in the control group.

This intervention attempted to provide in 11 days the same preparation that would have otherwise been presented in a six-week summer term; on this criterion, the intervention would have to be judged a probable success, i.e., the 11-day class was as good as the six-week class. However, the self-selection of a special group of students for the intervention presents a number of possible interpretation problems. A subsequent semester of this intervention will provide an opportunity to verify that the intervention is associated with greater success in mathematics.

An additional consideration which must be taken into account in evaluating this intervention is the reported difficulty in recruiting students to participate. It would seem that, at least for this urban population, the prospects of enhanced mathematics performance and of moving more quickly into advanced mathematical work were not sufficiently attractive to compensate for the requirement of attending three-hour meetings four afternoons a week without academic credit. An intervention which does not meet the perceived needs or requirements of students is necessarily of limited value.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# APPENDICES

# APPENDIX A

# COLLEGE STUDENT PROTOCOL

## College Student Protocol

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. Am. Indian (Please specify the tribe which best describes your heritage.) _____
   ___ e. Hispanic Which of the following best describes your heritage?
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

6. Class:
   ___ a. College freshman
   ___ b. College sophomore
   ___ c. College junior
   ___ d. College senior
   ___ e. Other (e.g., special or temporary student, etc.)
      Specify _____

7. Have you declared a college major?
   ___ a. No
   ___ b. Yes ..... Please specify your major. _____

8. Have you taken any advanced placement tests for college credit?
   ___ a. No
   ___ b. Yes ..... Please list tests taken. _____

9. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Two years of college
   ___ b. Four years of college
   ___ c. One or more years after college
   ___ d. Other Specify _____

10. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

11. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)

   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Work-study
   ___ d. Job other than work-study
   ___ e. Tuition or other scholarship
   ___ f. Loan
   ___ g. Previous personal earnings and savings
   ___ h. GI Bill, ROTC, or other governmental assistance (other than scholarship or loan)
   ___ i. Family trust fund, insurance plan, or other similar arrangement
   ___ j. Other Specify _____

12. You may want to receive help outside your regular college course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems
   ___ f. Increasing reading ability
   ___ g. Developing good study habits
   ___ h. Improving writing ability

13. What is or was the occupation of the person(s) with whom you lived during the years you were growing up? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

   _____ _____

14. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average

15. Are you:
___ a. An only child (skip to question 17)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

16. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

17. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

18. Indicate the extent of your mother's education. (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

19. What was the language spoken most often by adults in the household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe .... What is that language? _____
___ d. Other
Specify _____

20. Which of the following did your parent(s)/guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

21. Which of the following comes closest to describing your parent(s)/guardian(s)?
___ a. Do(es) not read at all
___ b. Sometimes read(s)
___ c. Read(s) a lot

22. Which of the following comes closest to describing you?
___ a. Do not read at all
___ b. Sometimes read
___ c. Read a lot

23. How many of these do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

24. From what kind of high school or secondary school did you graduate?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

25. Were you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes.....Please list the math and/or science clubs you belonged to.

_____

_____

_____

_____

26. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL WITH DIRECTIONALITY AND SCALES OF ITEMS

**Legend:**

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of any ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |

| | | | |
|---|---|---|---|
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

    i. _____

    ii. _____

    iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF

# THE COLLEGE STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 6 | CONTROL n = 11 |
| 1. Sex | | |
| Women | 83% | 73% |
| Men | 17% | 27% |
| 2. Age | 22.57 | 23.86 |
| 6. Class | | |
| .Freshmen | 67% | 73% |
| .Sophomores | 17% | 18% |
| .Juniors | 0% | 0% |
| .Seniors | 17% | 0% |
| .Missing | 0% | 9% |
| 7. Declared SET majors | 0% | 46% |
| .Missing or undeclared | 67% | 27% |
| 8. Students taken an advanced placement test | 17% | 0% |
| 9. Higher education expected: | | |
| .Two years of college | 0% | 18% |
| .Four years of college | 33% | 46% |
| .One or more years after college | 67% | 27% |
| .Missing | 0% | 9% |
| 10. Studies most influenced by | | |
| .Parents | 17% | 27% |
| .Another family member | 0% | 0% |
| .Teacher | 0% | 0% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 0% |
| .Friend | 0% | 9% |
| .Science professional | 0% | 18% |
| .Nonscience professional | 0% | 0% |
| .No one at all | 83% | 36%[a] |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 6 | CONTROL n = 11 |
| 11. Sources of income[b] | | |
| .Parents/guardians | 0% | 36% |
| .Spouse | 17% | 9% |
| .Work study | 0% | 0% |
| .Job other than work study | 67% | 46% |
| .Tuition or scholarship | 0% | 0% |
| .Loan | 33% | 9% |
| .Grant | 17% | 46% |
| .Personal savings | 50% | 27% |
| .GI Bill, ROTC, etc. | 17% | 0% |
| .Family trust, etc. | 0% | 0% |
| .Other | 0% | 9% |
| Number of sources of income * | 2.00 | 1.82 |
| 12. Student needs help in:[b] | | |
| .Counseling on educational plans | 17% | 46% |
| .Counseling on career plans | 50% | 64% |
| .Improving math ability | 100% | 27%[a] |
| .Finding part-time work | 0% | 36% |
| .Counseling on personal problems | 17% | 0% |
| .Increasing reading ability | 0% | 36% |
| .Developing good study habits | 33% | 54% |
| .Improving writing ability | 33% | 46% |
| Number of areas needing help * | 2.50 | 3.09 |
| 13. Sources of outside income | | |
| .None | 17% | 9% |
| .One | 17% | 64% |
| .Two | 67% | 27% |
| 14. Family income: | | |
| .Below U.S. average | 33% | 18% |
| .About average | 17% | 36% |
| .Above average | 50% | 18% |
| .Unknown | 0% | 27% |
| 15. Birth order of student: | | |
| .Only child | 0% | 9% |
| .Oldest child | 50% | 18% |
| .Youngest child | 33% | 27% |
| .In-between child | 17% | 46% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 6 | CONTROL n = 11 |
| 16. Number of siblings: | | |
| .None | 0% | 9% |
| .One | 17% | 27% |
| .Two | 33% | 9% |
| .Three or more | 50% | 54% |
| 17. Father's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 17% | 9% |
| .High school graduate | 33% | 46% |
| .Some college | 33% | 36% |
| .College degree or more | 17% | 9% |
| 18. Mother's education: | | |
| .Grade school or less | 0% | 9% |
| .Some high school | 0% | 36% |
| .High school graduate | 0% | 36% |
| .Some college | 67% | 9% |
| .College degree or more | 33% | 9% |
| 19. Language spoken most at home: | | |
| .English | 100% | 100% |
| .Spanish | 0% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| 20. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 33% | 46% |
| .Attend parent-teacher conferences .Visit student's class | 33% | 73% |
| .Phone/visit if there's a problem | 67% | 73% |
| .Do volunteer work | 67% | 73% |
| .Assist student in course selection | 0% | 18% |
| .Assist in student's homework | 33% | 36% |
| Number of parental involvements * | 83% | 82% |
| | 3.17 | 4.00 |
| 21. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 33% | 36% |
| .A lot | 67% | 64% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 6 | CONTROL n = 11 |
| 22. Student reads: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 17% | 46% |
| .A lot | 83% | 54% |
| 23. Items in student's home:[b] | | |
| .Desk | 83% | 64% |
| .Daily newspaper | 83% | 82% |
| .Encyclopedia | 100% | 91% |
| .Typewriter | 83% | 64% |
| .Calculator | 100% | 82% |
| .Television | 100% | 100% |
| .Computer | 50% | 36% |
| .Video Cassette Recorder (VCR) | 100% | 91% |
| Number of support items * | 7.00 | 6.09 |
| 24. Type of high school attended | | |
| .Public | 83% | 54% |
| .Private | 17% | 36% |
| .No formal high school | 0% | 9% |
| 25. Member math/science club in high school | 0% | 0% |
| 26. All activities student took part in:[b] | | |
| .Math/science club | 0% | 0% |
| .Field trip | 67% | 82% |
| .Watching science programs on TV | 67% | 82% |
| .Listen to talk by scientist | 33% | 27% |
| .Science/math fair | 33% | 54% |
| .Other science/math competition | 0% | 9% |
| .Play/work in computer lab | 67% | 54% |
| Number of activities * | 2.67 | 3.09 |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# EDWARD WATERS COLLEGE

# INTERVENTIONS

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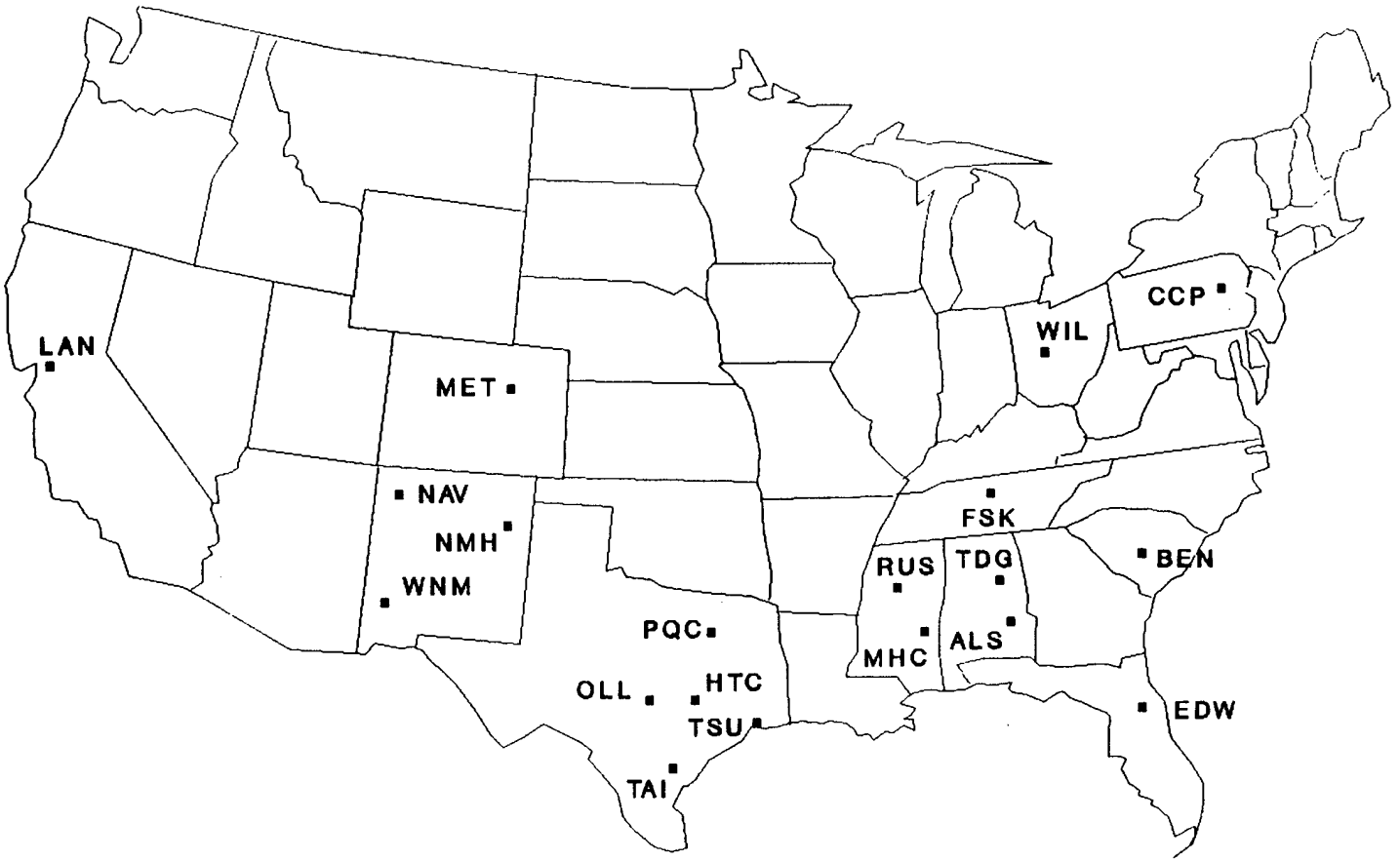
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected come from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention-group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention activities tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF EDWARD WATERS COLLEGE

Edward Waters College is a historically Black, four-year, private, coeducational institution located in Jacksonville, Florida. The College community consists of approximately 700 students and 46 faculty members. The College, organized into the Division of General Studies, Division of Business Administration, Division of Education, and Division of Arts and Sciences, offers undergraduate and graduate degrees. The student body is approximately 59 percent female and 41 percent male and is predominantly Black. The president of Edward Waters College is Dr. Robert Mitchell.

Degrees offered at Edward Waters College in quantitative subjects are Bachelor of Science in chemistry, computer science, and mathematics. The College also offers a dual degree program in engineering to chemistry or mathematics majors in cooperation with the University of Miami.

Jacksonville has a population of approximately 635,000 in its metropolitan area. The state of Florida has a population of approximately 12.5 million. According to U.S. Census Bureau estimates, the adult population of Florida is 78 percent Anglo, 12 percent Black, 9 percent Hispanic, and 1 percent other ethnic origins. Jacksonville has several other institutions of higher education, including Florida Community College at Jacksonville, Jacksonville University, and the University of North Florida.

# PART II

# SUMMARY OF THE EDWARD WATERS COLLEGE (EWC) INTERVENTIONS

This report summarizes the two interventions conducted by Edward Waters College, a historically Black, four-year private institution located in Jacksonville, Florida. Edward Waters College is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

## Edward Waters College Intervention Activities:

In Spring and Summer of 1989, Edward Waters College conducted enrichment classes for middle-school students in mathematics, communication skills, and natural science. Supplementary activities included exploration of career options, counseling in self-concept development, field trips, presentations by role models, and tutoring. Participants were Black seventh- and eighth-grade students recommended by their teachers and counselors as showing an aptitude for science and mathematics. The Spring intervention was conducted on twelve sequential Saturdays from 8:00 a.m. through 3:50 p.m. for about 71 contact hours; the Summer intervention featured daily classes from 8:30 a.m. through 3:20 p.m. Monday through Friday for seven weeks, totalling about 220 contact hours.

## Findings:

- Effects on students' opinions were consistently positive for the two semesters of intervention.
- The Spring intervention showed stronger positive effects on opinion than did the Summer intervention.
- The Spring intervention also tested for effects on students' performance in SET areas, and found a significant positive effect on performance.

## Recommendations:

- If the goal is a positive impact on student opinion, a shorter intervention may be more effective than a longer one. There may be a point of diminishing returns, after which additional contact hours do not contribute further, and may even detract. The present findings do not permit us to identify that point, but do suggest that in enhancing opinion, a shorter intervention may be more effective.
- Performance, on the other hand, may be more directly related to contact hours. Opinions can change in a short time; it takes longer exposure and practice to build knowledge and skills.

# PART III

# CASE STUDY OF THE EDWARD WATERS COLLEGE

# 1989 SPRING SEMESTER INTERVENTION

## ABSTRACT

In the spring of 1989, Edward Waters College, Jacksonville, Florida, implemented and tested against a control group the Pre-Freshman Science, Engineering, and Technologies Program (PFSETP), an enrichment intervention program held on Saturdays for minority middle school students. Participants were 58 Black seventh- and eighth-grade students (40 girls and 18 boys) from middle schools in Jacksonville who had at least a C average in school and who were recommended by their teachers and counselors as demonstrating an aptitude for science and mathematics. The intervention was repeated in the summer of 1989.

The Edward Waters College program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance in biology, chemistry, mathematics, and computer science, and (b) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* Major components of the intervention were instruction in mathematics, communications skills, computer science, and physical science; and counseling in self-concept development and career awareness. Additional intervention activities included a field trip and presentations by role models in SET fields.

*DATA:* All the participants furnished demographic data through the CASET Middle/Junior High School Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were school transcripts, national standardized California Achievement Test (CAT) mathematics and language scores, and scores on an institution-specific postintervention test of content in mathematics, communications skills, computer science, and physical science.

The outcome measure of performance was the score on the institution-specific postintervention content test of mathematics, communication skills, computer science, and physical science. The preintervention measures of performance were CAT grade equivalents in language and mathematics.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design; through analyses of preintervention measures it appeared that the intervention and control groups were comparable.

*FINDINGS:* In general, the intervention had a positive effect on the participants and can be considered a successful intervention. The hypotheses of enhanced student performance and enhanced opinions about SET fields and careers received substantial support. Analyses adjusting for prior academic achievement levels indicated that the intervention group outperformed the control group on the postintervention performance measure. Further, the intervention group had significantly higher scores than the control group on the Locus of Control and Role Model opinion scales, and a selective benefit for the intervention group was shown on the Value opinion scale. However, a large number of students, particularly control-group students, dropped out of the program and did not provide postintervention data, thus limiting the generalizability of the results.

## DESCRIPTION OF THE INTERVENTION

Because of a conviction that "early intervention with Black and/or disadvantaged students is necessary to prevent students from losing interest or falling irreparably behind in science and mathematics courses," Edward Waters College developed an intervention for middle school students. Students commuted to the Edward Waters College campus on Saturdays and summer weekdays for an intervention program called "Pre-Freshman Science, Engineering and Technologies Program" (PFSETP). This is a report of the first semester of that intervention, which was conducted on Saturdays from March 4 to May 27, 1989.

The PFSETP offered coursework in the following areas:

*Communication Skills* - This course emphasized reading skills such as vocabulary building; comprehension skills such as identifying main ideas and supporting details, and making inferences and arriving at conclusions; critical thinking skills including syllogistic reasoning and problem solving; writing skills; listening skills; self-motivation; and time management.

*Mathematics* - This course emphasized advanced mathematics including word problems, geometry, trigonometry, and algebra.

*Physical Science* - This course covered the fundamentals of the physical sciences including chemistry, physics, astronomy, and geology.

*Computer Science* - This course provided an introduction to the study of computers, computer programs and algorithms, data representation, data processing, and BASIC and Pascal programming languages.

*Self-Concept Development and Career Awareness* - This course was designed to help participants develop a healthy self-concept, become self-motivated, set realistic and attainable goals, develop a career identity, and understand the career decision-making process.

Participants were divided into two groups to permit learning in small groups. The Saturday schedule for the two groups was as follows:

| TIME | GROUP A | GROUP B |
|---|---|---|
| 8:00 - 8:50 a.m. | Mathematics | Computer Science |
| 9:00 - 9:50 a.m. | Computer Science | Mathematics |
| 10:00 - 10:50 a.m. | Communications | Career Awareness |
| 11:00 - 11:50 a.m. | Career Awareness | Science |
| 12:00 - 12:50 p.m. | LUNCH | LUNCH |
| 1:00 - 1:50 p.m. | Science | Communications |
| 2:00 - 3:50 p.m. | Optional library and laboratory study periods | |

The Project Director for this CASET intervention at Edward Waters College was Dr. James R. Kerr, Chairman, Division of Education. All of the PFSETP teaching faculty were from Edward Waters College:

*Science Professor:* Richard Barnes, Ph.D., Assistant Professor of Chemistry.

*Mathematics Professors:* Mr. A.N. Mudaliar, M.S., Instructor of Mathematics, and Mr. Willie McCullough, M.Ed., Assistant Professor of Mathematics.

*Computer Science Professor*: Mr. A.D. Mudaliar, M.S., Instructor of Computer Science and Mathematics.

*Communication Skills Professors*: Mrs. Dorothy Ward, M.A., Assistant Professor of Reading and Language Arts, and Mr. William Simpson, M.A., Assistant Professor of English.

*Counselors*: Mrs. Linda A. Collins, M.A., Coordinator of Counseling Services, and Ms. Terri L. Wilson, M.S., Career Counselor. The counselors taught the career awareness classes, self-awareness classes, motivation sessions, and tested and counseled students.

In addition to the classes and counseling, the intervention included several career awareness activities, contact with role models, and recreational activities. Two Black engineers, Mr. H.D. Patten and Ms. A'lisha Gray, spoke to the students about career opportunities, educational requirements, general salary considerations and about their own jobs. Students visited the Naval Air Rework Facility at Jacksonville, where they spoke with Black engineers about the kinds of work performed by engineers at that facility. The participants had a chance to sit in an F-18 and a P-3 aircraft. Intervention- and control-group students had an activity day at Fernandina Beach and a pizza party at the end of the semester.

## METHOD

### Subjects

Subjects were Black seventh- and eighth-grade students in the Jacksonville, Florida area who were recommended by their teachers and counselors as demonstrating an aptitude for science and mathematics; the students had at least a "C" average in their science and math classes with grades of 79 or higher. Students applying for the program were randomly assigned to intervention and control conditions: the control-group students were selected by a coin toss from pairs matched on age, sex, school attended, neighborhood, and race. However, attrition within the control group resulted in the loss of a number of control-group students, despite several testing sessions for qualifying new candidates. Altogether, over 300 potential participants were contacted; still the numbers were lower than the 80 intervention-group and 80 control-group students that had been expected.

Sixty sets of protocols were received from intervention- and control-group students. Two sets of protocols (one from an intervention-group student and one from a control-group student) were removed because the students who filled them our were Asian-American; Asian Americans are not underrepresented in SET fields and are not among the populations that are the focus of this study. Fifty-eight sets of data were analyzed, 32 from the intervention group and 26 from the control group.

Table 1 shows the ethnic and sex distribution for the intervention and control groups.

Table 1

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | | | | | | |
| Anglo | | | | | | |
| Black | 18 | 8 | 22 | 10 | 40 | 18 |
| Hispanic | | | | | | |
| Unknown | | | | | | |
| TOTAL | 18 | 8 | 22 | 10 | 40 | 18 |

CASET Protocols and Other Instruments

Demographic and descriptive data about the subjects were developed through the CASET Middle/Junior High School Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

Hypotheses tested were that the intervention would enhance student performance in biology, chemistry, mathematics, and computer science, and would change students' opinions in ways thought to be favorable to continuing in SET studies and careers. To assess attitudinal information relative to SET careers, CASET developed a 55-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gave a scalar measurement for that variable. Thus the completed Opinion Protocol provided a scale measuring each of the thirteen variables.

For middle school and junior high school students, CASET adapted the CASET Opinion Protocol items, simplifying wording and concepts to make them more appropriate for the younger age group, while addressing the same thirteen attitudinal variables as the older-level Opinion Protocol. An additional change is that for the younger students, there are only two possible answers: "yes" and "no" rather than the four-point scale of the older students' Opinion Protocol. The Opinion Protocol: Middle/Junior High School question items, together with the scales (attitudinal variables) they represented, are shown in Appendix B. The Opinion Protocol was administered to intervention- and control-group students before and after intervention activity.

To assess student performance before and after the intervention, a number of measures were used. Preintervention performance measures were grade equivalents in language and mathematics from the California Achievement Test (CAT), a nationally standardized test. The postintervention performance measure was the "Phase I Test" of content

developed by the institution. The test consisted of 62 items: There were 22 mathematics problems (36% of the questions) requiring calculations; 20 English and reading questions (32%), mostly true-or-false; 15 computer science questions (24%), 5 true-or-false and 10 multiple-choice; and 5 physical science questions (8%), 3 true-or-false and 2 requiring calculations.

### Procedure

At the beginning of the intervention, parents of the intervention- and control-group members signed consent forms and transcript release forms. The CASET Middle/Junior High School Student Protocol and the Opinion Protocol were administered to intervention- and control-group students.

Intervention-group students then took part in the intervention activities. After the intervention, the postintervention Opinion Protocol was administered to intervention- and control-group students, along with the faculty-developed Phase I Test. The Phase I Test was scored by the project faculty, and the scores were forwarded to CASET, along with the completed CASET instruments. The institution also supplied school transcripts and California Achievement Test scores for intervention- and control-group students.

The items of the Opinion Protocol were coded by CASET according to the thirteen scales they represented. Scoring of the positively worded items on the Opinion Protocol was reversed so that scores could be totaled meaningfully (see Appendix B). The scales were organized into three constructs--SET Goal, Environmental Support, and Attitude--as shown in Appendix C.

## RESULTS

### Methodological Issues

The intervention's two major hypotheses were that the intervention activities would: (a) enhance students' performance on the content measure, and (b) enhance students' opinion about SET fields and careers. The preintervention and postintervention measures of performance and opinion were analyzed in terms of a *nonequivalent control group* design. Though the groups had been formed by random assignment, the many dropouts from the control group created the quasi-experimental design. This type of quasi-experimental design has one major weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may have been due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty may be addressed by analyzing the influence of preexisting characteristics on students' performance and opinion; the analysis of covariance (ANCOVA), adjusting for preintervention performance or opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that may have existed prior to the intervention.

### Demographic Results

The comparability of the intervention and control groups prior to the intervention was examined by testing for differences on the items of the Student Protocol. The complete results are given in Appendix D. The groups did not differ significantly on any of the 38 comparisons. Based on finding no demographic differences, the groups were judged to be comparable on demographic characteristics prior to the intervention. However, because a number of students dropped out of the sample after the original random assignment of members of matched pairs to intervention and control conditions, the samples analyzed here were no longer solely the product of random assignment; other unknown

differences between the remaining intervention- and control-group students may have existed prior to the start of the intervention.

Performance Measures

*Group differences in performance.* The two preintervention measures and the one postintervention measure of performance were used to test the first hypothesis of group differences in performance, and the results are given in Table 2. Note that the control group and the intervention group did not differ on either pretest measure, but the intervention group outperformed the control group on the postintervention measure of performance. The intervention-group students' advantage was 9 points on the test that had a maximum possible score of 100 points. However, 80 percent of the control-group students and 20 percent of the intervention-group students dropped out and provided no postintervention performance measures. This substantial loss presents two problems: (a) comparisons of the two groups' postintervention performance must consider the preintervention performance of the surviving students; and (b) some evaluation of the mortality problem must be made to determine if the problem affected generalizability, causality, or both. Further analyses--ANCOVAs--adjusted for preintervention scores in testing for a group difference on the content test.

**Table 2**

**GROUP COMPARISONS OF PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | SIGP |
|---|---|---|---|---|---|---|
| CAT, Language (grade equiv.) | Control<br>Intervention | 25<br>30 | 8.77<br>9.06 | 2.24<br>2.63 | 0.43<br>(53) | ns |
| CAT, Math (grade equiv.) | Control<br>Intervention | 25<br>30 | 9.21<br>9.01 | 1.78<br>1.75 | -0.42<br>(53) | ns |
| Phase I Test | Control<br>Intervention | 5<br>24 | 47.40<br>56.38 | 9.61<br>8.98 | 2.01<br>(27) | $\leq$.05 |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

*Group differences after adjusting for pretests.* As a further test of the first hypothesis of group differences in performance, a hierarchical ANCOVA procedure adjusted for pretest scores before comparing groups on postintervention performance measures; the results are given in Table 3. This table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding the first and each subsequent variable to the multiple regression equation (one variable per row), and the significance test of each variable's contribution toward explaining the dependent variable. The columns of the table include the cumulative percentage of explained variance (cum $R^2$), the variable's contribution to explained variance ($sR^2$), the test of the variable's contribution ($F(sR^2)$), and the test's degrees of freedom (df). Because

the hypothesis was directional--improvement for the intervention group--the test statistics for the group variable were compared to one-tailed probability levels; for F statistics, this involved converting from F to t statistics ($F = t^2$) and comparing the value of t to the corresponding one-tailed critical values. All of the other tests were compared to two-tailed values.

**Table 3**

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Phase I Test | CAT, Language | .1208 | .1208 | 3.44 | 1,25 | $\leq$.10 |
| | + GROUP | .2373 | .1165 | 3.67 | 1,24 | $\leq$.05 |
| | + CATL-x-GROUP | .2456 | .0082 | 0.25 | 1,23 | ns |
| Phase I Test | CAT, Math | .2584 | .2584 | 8.71 | 1,25 | $\leq$.01 |
| | + GROUP | .3440 | .0856 | 3.13 | 1,24 | $\leq$.05 |
| | + CATM-x-GROUP | .3918 | .0478 | 1.81 | 1,23 | ns |

The by-GROUP variable in the models was analyzed as a one-tailed test; the other variables were analyzed as two-tailed tests.

* Three models of independent variables were tested for each dependent variable: (1) CAT alone; (2) CAT and ('+') GROUP; (3) CAT and GROUP and CAT-by-GROUP INTERACTION ('-x-').

The results in Table 3 were based on analyses that used two different pretest scores as covariates for the posttest measure; the finding from the analysis that used the "best" covariate, and the pattern of findings across the two different covariates would test the hypothesis of improved performance in the intervention group. Both analyses of postintervention performance found that the intervention group scored significantly higher than did the control group. The best covariate was the CAT mathematics grade equivalent (based on its explaining more of the variance of the posttest, 26% vs. 12% for the CAT language grade equivalent). The finding from this ANCOVA supported the first hypothesis: The intervention group outperformed the control group. The analyses that adjusted for the CAT language grade equivalent also found superior performance by the intervention group.

For both mathematics and language pretests, the intervention enhanced the performance of students. These findings paralleled and strengthened the findings from the t-tests of Table 2. The next section describes relationships among the performance measures.

Interrelationships among performance measures. The interrelatedness of the performance measures was examined via intercorrelations of the three measures, presented in Table 4. All three measures were related significantly, and the CAT mathematics test was more strongly related to postintervention performance than was the CAT language test, though the statistic was not quite significant ($t(24) = 1.28$), $p = .10$, one-tailed. This was consistent with the evidence from Table 3 that the CAT mathematics test was a better covariate than was the CAT language test.

Table 4

INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a]

| | CAT, Lang. Sig. p (n) | CAT, Math Sig. p (n) | Phase I Test Sig. p (n) |
|---|---|---|---|
| CAT, Language | 1.00 | | |
| CAT, Mathematics | .58<br>(55)<br>≤.01 | 1.00 | |
| Phase I Test | .35<br>(27)<br>≤.05 | .51<br>(27)<br>≤.01 | 1.00 |

[a] All correlations were analyzed as two-tailed tests.

Opinion Measures

Group differences on pre- and postintervention measures. The second hypothesis was that the intervention would enhance students' opinions of SET fields and careers, and this hypothesis was tested by evaluating the students' responses to the Opinion Protocol. The means of the intervention-group and control-group students were compared for the 13 opinion variables, three constructs, and the total opinion score, measured before and after the intervention. These results are given in Table 5. Before the intervention began, the control and intervention groups did not differ on any of the 17 opinion measures. After the intervention ended, the intervention group had higher scores on three scales (Aspiration, Locus of Control, and Role Model), and the control group had higher scores on one scale (Equal Opportunity). This mix of positive and negative effects of the intervention on performance did not take into account students' opinion prior to the intervention. The postintervention differences may have been the further development of preexisting differences and not the result of the intervention. Also, 68 percent of the control group did not provide data for the postintervention measures of opinion. In order to adjust for preexisting differences, the final opinion variables were analyzed via ANCOVA.

Table 5

| GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | | |
|---|---|---|---|---|---|---|---|
| CONSTRUCT / Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
| | | Mean | SD | Mean | SD | | |
| OPINION, Total | Pretest<br>Posttest | 1.59<br>1.77 | .06<br>.10 | 1.58<br>1.80 | .07<br>.10 | -0.36<br>0.59 | ns<br>ns |
| SET GOAL | Pretest<br>Posttest | 1.64<br>1.80 | .09<br>.14 | 1.63<br>1.82 | .11<br>.10 | -0.41<br>0.40 | ns<br>ns |
| Value | Pretest<br>Posttest | 1.86<br>1.97 | .15<br>.09 | 1.78<br>1.99 | .21<br>.05 | 1.57<br>0.86 | ns<br>ns |
| Cultural Value | Pretest<br>Posttest | 1.71<br>1.90 | .20<br>.15 | 1.72<br>1.80 | .19<br>.21 | 0.24<br>-1.14 | ns<br>ns |
| Self-Concept | Pretest<br>Posttest | 1.55<br>1.72 | .18<br>.36 | 1.54<br>1.77 | .17<br>.19 | -0.27<br>0.42 | ns<br>ns |
| Aspiration | Pretest<br>Posttest | 1.53<br>1.65 | .22<br>.21 | 1.55<br>1.76 | .27<br>.20 | 0.37<br>1.31 | ns<br>≤.10 |
| ATTITUDE | Pretest<br>Posttest | 1.50<br>1.75 | .09<br>.13 | 1.50<br>1.78 | .08<br>.14 | -0.25<br>0.54 | ns<br>ns |
| Math/Science Attitude | Pretest<br>Posttest | 1.44<br>1.83 | .13<br>.17 | 1.42<br>1.82 | .13<br>.16 | -0.73<br>-0.10 | ns<br>ns |
| Locus of Control | Pretest<br>Posttest | 1.44<br>1.75 | .25<br>.15 | 1.47<br>1.87 | .23<br>.20 | 0.49<br>1.59 | ns<br>≤.10 |
| Persistence | Pretest<br>Posttest | 1.69<br>1.74 | .29<br>.23 | 1.68<br>1.69 | .24<br>.26 | -0.13<br>-0.45 | ns<br>ns |
| Study Habits | Pretest<br>Posttest | 1.75<br>1.72 | .20<br>.16 | 1.70<br>1.68 | .27<br>.29 | -0.70<br>-0.39 | ns<br>ns |
| Anxiety | Pretest<br>Posttest | 1.33<br>1.69 | .16<br>.35 | 1.34<br>1.80 | .18<br>.28 | 0.27<br>0.93 | ns<br>ns |
| ENVIRONMENTAL SUPPORT | Pretest<br>Posttest | 1.67<br>1.77 | .09<br>.10 | 1.67<br>1.79 | .12<br>.14 | -0.13<br>0.46 | ns<br>ns |

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT / Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| Academic Support | Pretest | 1.84 | .24 | 1.87 | .19 | 0.44 | ns |
| | Posttest | 1.96 | .12 | 1.89 | .17 | -1.10 | ns |
| Career Awareness | Pretest | 1.65 | .18 | 1.61 | .18 | -0.64 | ns |
| | Posttest | 1.92 | .15 | 1.92 | .17 | 0.05 | ns |
| Role Model | Pretest | 1.68 | .20 | 1.63 | .24 | -0.85 | ns |
| | Posttest | 1.21 | .25 | 1.46 | .37 | 1.79 | $\leq .05$ |
| Equal Opportunity | Pretest | 1.52 | .22 | 1.57 | .30 | 0.62 | ns |
| | Posttest | 2.00 | .00 | 1.89 | .25 | -1.23 | $\leq .10$ |

All pretests were analyzed as two-tailed tests.
All posttests were analyzed as one tailed tests.
Pretests n's: Control = 25; Intervention = 25
Posttest n's: Control = 8; Intervention = 25

*Group differences on opinion adjusting for prior scores.* Table 6 reports further tests of the second hypothesis that measured the effects of the intervention on opinions about SET fields after adjusting for preintervention opinion scores in ANCOVAs. By these analyses, the intervention and control groups differed overall on two opinion measures: The intervention group had significantly higher Locus of Control and Role Model scores. These results paralleled two thirds of the t-test results. However, the one scale that had shown a control-group advantage in Table 5 was not significantly different when adjustments for preintervention opinion scores were made. In addition to the two overall advantages for the intervention group, there were significant interactions between preintervention opinion score and group membership for two postintervention opinion measures: Value and Persistence.

**Table 6**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURESCOVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| OPINION, Overall | PREINTERVENTION | .2816 | .2816 | 10.58 | 1,27 | $\leq .01$ |
| | +GROUP | .2873 | .0057 | 0.21 | 1,26 | ns |
| | +PRE-x-GROUP | .3109 | .0236 | 0.86 | 1,25 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURESCOVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| SET GOAL | PREINTERVENTION | .0783 | .0783 | 2.29 | 1,27 | ns |
| | +GROUP | .0973 | .0190 | 0.55 | 1,26 | ns |
| | +PRE-x-GROUP | .1084 | .0111 | 0.31 | 1,25 | ns |
| Value | PREINTERVENTION | .0482 | .0482 | 1.37 | 1,27 | ns |
| | +GROUP | .0813 | .0331 | 0.94 | 1,26 | ns |
| | +PRE-x-GROUP | .2866 | .2053 | 7.19 | 1,25 | $\leq$.05 |
| Cultural Value | PREINTERVENTION | .0035 | .0035 | 0.09 | 1,27 | ns |
| | +GROUP | .0472 | .0438 | 1.19 | 1,26 | ns |
| | +PRE-x-GROUP | .0591 | .0119 | 0.32 | 1,25 | ns |
| Self-Concept | PREINTERVENTION | .0052 | .0052 | 0.14 | 1,27 | ns |
| | +GROUP | .0178 | .0126 | 0.33 | 1,26 | ns |
| | +PRE-x-GROUP | .1134 | .0957 | 2.70 | 1,25 | ns |
| Aspiration | PREINTERVENTION | .0001 | .0001 | 0.00 | 1,27 | ns |
| | +GROUP | .0576 | .0575 | 1.59 | 1,26 | ns |
| | +PRE-x-GROUP | .0676 | .0101 | 0.27 | 1,25 | ns |
| ATTITUDE | PREINTERVENTION | .1322 | .1322 | 4.11 | 1,27 | $\leq$.10 |
| | +GROUP | .1346 | .0025 | 0.07 | 1,26 | ns |
| | +PRE-x-GROUP | .1388 | .0041 | 0.12 | 1,25 | ns |
| Math/Science Attitude | PREINTERVENTION | .1783 | .1783 | 5.86 | 1,27 | $\leq$.05 |
| | +GROUP | .1784 | .0001 | 0.00 | 1,26 | ns |
| | +PRE-x-GROUP | .1801 | .0017 | 0.05 | 1,25 | ns |
| Locus of Control | PREINTERVENTION | .0458 | .0458 | 1.30 | 1,27 | ns |
| | +GROUP | .1073 | .0615 | 1.79 | 1,26 | $\leq$.10 |
| | +PRE-x-GROUP | .1074 | .0001 | 0.00 | 1,25 | ns |
| Persistence | PREINTERVENTION | .3504 | .3504 | 14.57 | 1,27 | $\leq$.01 |
| | +GROUP | .3635 | .0130 | 0.53 | 1,26 | ns |
| | +PRE-x-GROUP | .4608 | .0973 | 4.51 | 1,25 | $\leq$.05 |
| Study Habits | PREINTERVENTION | .2134 | .2134 | 7.32 | 1,27 | $\leq$.05 |
| | +GROUP | .2273 | .0140 | 0.47 | 1,26 | ns |
| | +PRE-x-GROUP | .2565 | .0292 | 0.98 | 1,25 | ns |
| Anxiety | PREINTERVENTION | .0304 | .0304 | 0.85 | 1,27 | ns |
| | +GROUP | .0725 | .0422 | 1.18 | 1,26 | ns |
| | +PRE-x-GROUP | .1192 | .0466 | 1.32 | 1,25 | ns |

HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURESCOVARYING PREINTERVENTION OPINION

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Environmental Support | PREINTERVENTION | .1781 | .1781 | 5.85 | 1,27 | $\leq$.05 |
| | +GROUP | .1782 | .0001 | 0.00 | 1,26 | ns |
| | +PRE-x-GROUP | .1786 | .0004 | 0.01 | 1,25 | ns |
| Academic Support | PREINTERVENTION | .0078 | .0078 | 0.21 | 1,27 | ns |
| | +GROUP | .0521 | .0443 | 1.21 | 1,26 | ns |
| | +PRE-x-GROUP | .1409 | .0889 | 2.59 | 1,25 | ns |
| Career Awareness | PREINTERVENTION | .0615 | .0615 | 1.77 | 1,27 | ns |
| | +GROUP | .0615 | .0000 | 0.00 | 1,26 | ns |
| | +PRE-x-GROUP | .0890 | .0276 | 0.76 | 1,25 | ns |
| Role Model | PREINTERVENTION | .0368 | .0368 | 1.03 | 1,27 | ns |
| | +GROUP | .1008 | .0640 | 1.85 | 1,26 | $\leq$.10 |
| | +PRE-x-GROUP | .1075 | .0067 | 0.19 | 1,25 | ns |
| Equal Opportunity | PREINTERVENTION | .1889 | .1889 | 6.05 | 1,26 | $\leq$.05 |
| | +GROUP | .2122 | .0234 | 0.74 | 1,25 | ns |
| | +PRE-x-GROUP | .2214 | .0092 | 0.28 | 1,24 | ns |

All models were analyzed as two-tailed tests except for the GROUP variable, which was analyzed as a one-tailed test.

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

The interactions were analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of preintervention scores for which the groups differed.

Figures 1 and 2 show the nonparallel regression lines that indicated that the relationship between the preintervention and postintervention measures was different for the intervention and control groups.

In Figure 1, for students with preintervention Value scores at or below 1.7 (overall $\underline{M}$ = 1.8), the intervention-group students had more positive postintervention Value scores than did the control-group students.

Figure 2 indicates that for those students with prior Persistence scores of 1.5 or less (overall $\underline{M}$ = 1.7), the control-group students had more positive postintervention Persistence scores than did the intervention-group students.

Summarizing the two interactions, the intervention raised the Value scores of students who had begun at or below the mean on the Value scale (about one half of the students), and the intervention-group students who had begun with below-average levels of Persistence had lower final Persistence scores than did similar control-group students.

Figure 1

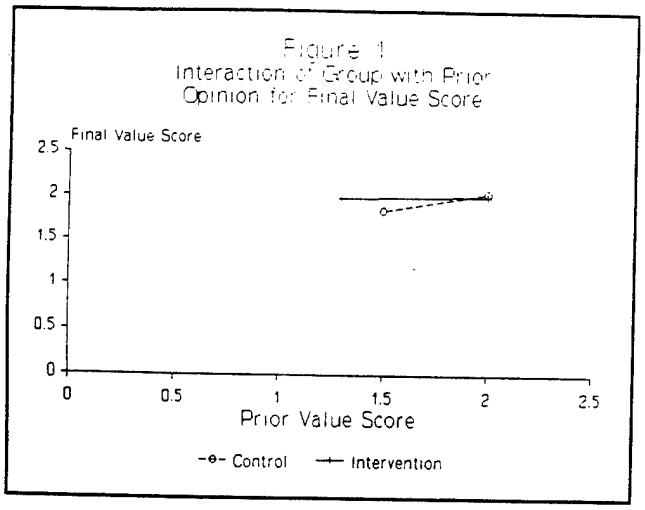
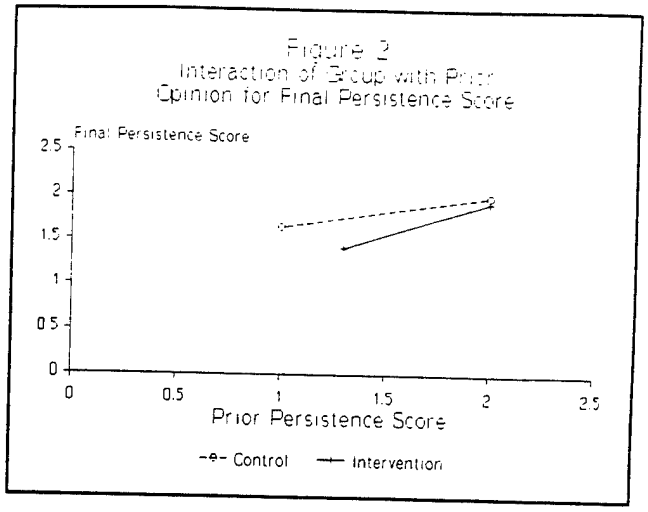



Figure 2




The test of the second hypothesis found some support for the intervention's success; the intervention group had more positive opinions than did the control group on two measures (Locus of Control and Role Model), and the average and below-average portions of the intervention group had higher scores on a third opinion measure (Value). One negative outcome was that the students in the control group who had begun with below-average Persistence increased their scores more than did comparable students in the intervention group.

*The effects of drop-out on postintervention measures.* Substantial percentages of both intervention- and control-group students did not provide postintervention data. For the performance measures, only 19 percent of the control-group students and 75 percent of the intervention-group students completed the postintervention Phase I Test, chi-square (1, $\underline{N}$ = 58) = 15.69, $\underline{p} \leq .01$ (Yates corrected). For the opinion measures, only 31 percent of the control-group students completed the postintervention Opinion Protocol, compared to 78 percent of the intervention-group students, chi-square (1, $\underline{N}$ = 58) = 11.26, $\underline{p} \leq .01$ (Yates corrected). This substantial disparity in the percentage of those who completed the program deserved further analysis.

Mortality or the drop-out of students can affect a research design in two primary ways (Cook & Campbell, 1979): (a) if similar students drop out of both groups, then the generalizability of the findings will be more limited because the original sample's diversity will have been reduced through attrition; and (b) if students drop out from the groups differentially, the changed groups may produce either a pseudo-effect of the intervention (due to the "cream of the crop" survivors receiving the intervention or the better control-group students dropping out), or a diminished effect of the intervention (by losing the lower scoring control-group students and/or the higher scoring intervention-group students).

To determine if mortality may have affected an intervention's effectiveness, Cook and Campbell (1979) recommended an analysis that tests two factors (group and survivor status) and their interaction for significant effects on the preintervention measures. A significant survivor effect would indicate that the survivors differed from the dropouts, which would limit the generalizability of the findings of the study. If the survivor-by-group interaction was significant, this would indicate that different types of students dropped out of the two groups, and that any effects of the intervention may have been due to differences in the types of survivors in each group.

These mortality analyses were completed on two preintervention performance measures--CAT language and CAT mathematics grade equivalents--and on four preintervention opinion measures--the total Opinion score and the SET Goal, Attitude, and Environmental Support constructs. Of the two performance analyses, there was no significant effect on the CAT language scores, but there was a significant survivor effect on the CAT mathematics scores, $\underline{F}(1,51) = 5.67$, $\underline{p} \leq .05$, two-tailed: The better students dropped out of both groups (dropouts' $\underline{M}$ = 9.61, survivors' $\underline{M}$ = 8.58). Three

of the four analyses of preintervention opinion measures showed nearly significant effects of survivorship: total Opinion, Attitude, and Environmental Support. However, the survivor-by-group interaction was significant for the preintervention SET Goal score, $F(1,46) = 3.74$, $p \leq .10$, two-tailed. The intervention-group students who dropped out had higher scores than those who remained, and the reverse was true for the control-group students, that is, the control-group students with lower preintervention SET Goal scores were more likely to drop out. To determine if the Value opinion measure, one of the constituent scales of the SET Goal construct, was affected by survivorship directly or via an interaction, a mortality analysis was conducted on preintervention Value scores; no significant effects of survivorship or interaction of survivorship with group were found.

Several demographic variables were tested for mortality effects in two-factor ANCOVAs, and two variables showed significant effects: (a) The students who dropped out from both groups were older ($M = 13.19$ years) than students who remained ($M = 12.89$ years), $F(1,51) = 2.84$, $p \leq .10$, two-tailed; and (b) a greater percentage of eighth graders dropped out (80%) than did seventh graders (42%), chi-square ($1, N = 55$) $= 3.28$, $p \leq .10$. These results suggest that the findings here are most generalizable to seventh-grade students who are approximately 13 years old.

## DISCUSSION

Edward Waters College developed an intervention designed to have an impact on young students. This program was developed with the idea that effective intervention should take place early, in this case in middle school. The classes and other activities, including contact with successful role models, were designed to improve performance and enhance opinions about SET fields and careers. The data indicate that the classes and activities were indeed successful with these young students.

The two hypotheses of enhanced performance and enhanced opinion as a result of the intervention received substantial support. The intervention group had significantly higher scores on the postintervention performance measure, based on both t-test and ANCOVA analyses that adjusted for prior achievement levels. After adjusting for preintervention opinion scores, the intervention-group students had more positive opinion scores than did the control-group students on two opinion scales--Locus of Control and Role Model. In addition, about one half of the intervention-group students had higher opinion scores on the Value opinion scale. The only negative outcome of the intervention was an interaction between group and one of the scales of the Opinion Protocol.

The careful selection process, with random assignment of paired students to intervention and control conditions, was reflected in the findings when the two groups were compared on a variety of demographic and preintervention performance and opinion measures. Comparisons on all 57 preintervention measures found no significant differences between the control and intervention groups. Based on finding no preexisting differences, the groups were judged comparable on preintervention measures.

A substantial percentage of the students who began the intervention did not provide postintervention data. The analyses of mortality effects indicated that the students with higher CAT mathematics scores dropped out of both groups; this limits the generalizability of the results, i.e., this intervention may only raise the performance of average and below-average students. A second mortality finding was the significant interaction between group and survivorship, wherein students starting with higher SET Goal opinion scores dropped out of the intervention group and those with lower scores dropped out of the control group. This finding poses a question about the effects of the differential experimental mortality on the results. It is possible that the loss of the more promising candidates from the intervention group may have masked further significant effects of the intervention. Demographic analyses found that the majority of the eighth-grade students dropped out of both groups, so that the findings may or may not be generalizable to eighth graders. In future interventions, an assessment of students' reasons for dropping out would provide information useful for retaining larger percentages of participants and for improving the strength of the causal conclusions about the intervention's effects.

The primary measure of postintervention performance--the Phase I Test--seems to have been a valid measure, as it correlated significantly with both CAT scores. One improvement in measurement would be to have separate scores for mathematics, computer science, and English and reading components; analyses of these separate scores would permit some evaluation of the quality of the intervention's components. A test with separate scores, together with measures of students' attendance, would improve the quality of the conclusions about the intervention's effects and provide more specific recommendations for improvements in the intervention.

The replication of some or all of these findings in a subsequent implementation of this intervention will greatly strengthen conclusions about the positive effects of this intervention.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# PART IV

# APPENDICES

# APPENDIX A

# MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

Participant Number: _____

## MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

Thank you for agreeing to participate in this important project. It is geared to help us develop new programs for students and improve existing programs.

Your opinions and experience are important to us. Please read each question carefully and answer completely and accurately to the best of your ability. All of your answers will be kept in confidence. Your answers will be grouped with those of other students in other places, and together they will help us better understand students' needs and preferences today.

Please ask your administrator if any of these questions are unclear to you.

Thanks for your help!

---

1. Sex:
   - ___ a. Male
   - ___ b. Female

2. When were you born? _____ _____ _____
   month day year

3. Ethnicity/race:
   - ___ a. Anglo
   - ___ b. Black
   - ___ c. Asian American
   - ___ d. American Indian (Please specify the tribe which best describes your heritage.)

     _____
   - ___ e. Hispanic (Which of the following best describes your heritage?)
     - ___ a. Cuban-American
     - ___ b. Mexican-American
     - ___ c. Puerto Rican
     - ___ d. Other Specify _____
   - ___ f. Other Specify _____

4. Are you a United States citizen?
   - ___ a. Yes
   - ___ b. No

5. Name of your school: _____

   City: _____ State: _____

6. Class:
   ___ a. 4th grade
   ___ b. 5th grade
   ___ c. 6th grade
   ___ d. 7th grade
   ___ e. 8th grade

7. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Less than high school graduation
   ___ b. High school graduation
   ___ c. Two-year college degree (community college or junior college)
   ___ d. Four-year college degree
   ___ e. Education beyond four years of college
   ___ f. Other Specify _____

8. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

9. What is or are the occupation(s) of the person(s) with whom you live? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")
   _____ _____

10. Would you say that your family's income is:
   ___ a. Below the U.S. average
   ___ b. About average
   ___ c. Above average
   ___ d. Don't know

11. Are you:
   ___ a. An only child (skip to question 13)
   ___ b. The oldest child
   ___ c. The youngest child
   ___ d. An in-between child

12. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

13. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

14. What was the highest level of school your mother completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

15. What is the language spoken most often by adults in your household? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe (What is that language?) _____
___ d. Another language - Specify _____

16. Which of the following did your parent(s) or guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Help you with your homework

17. Which of the following comes closest to describing how much your parent(s) or guardian(s) read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

18. Which of the following comes closest to describing how much you read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

19. Which of these items do you have in your family home? (Check all that apply)
    ___ a. A desk
    ___ b. Daily newspaper
    ___ c. Encyclopedia
    ___ d. Typewriter
    ___ e. Pocket calculator
    ___ f. Television
    ___ g. Computer
    ___ h. Video cassette recorder (VCR)

20. Have you ever taken part in any of these activities? (Check all that apply)
    ___ a. Math and science clubs
    ___ b. Field trip to science museum, laboratory, or other place where scientists work
    ___ c. Watching science programs on TV
    ___ d. A talk by a scientist
    ___ e. Science/math fair
    ___ f. Other science/math competition
    ___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL ITEMS WITH DIRECTIONALITY AND SCALES

Legend:

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | Do you study each day rather than just before exams? |
| 2. | + | AT | Are scientists smarter than most people? |
| 3. | + | SC | Can you imagine yourself as a scientist? |
| 4. | - | AX | Do word problems in mathematics make you nervous? |
| 5. | + | VL | Do you think mathematics is needed in most jobs? |
| 6. | + | VL | Is science important to our country? |
| 7. | + | LC | When you make plans, can you usually make them work? |
| 8. | + | CA | Do girls have a good chance of becoming scientists when they grow up? |
| 9. | + | PS | Do you usually finish the things you start? |
| 10. | + | CV | Is it important to you that your people be proud of you? |
| 11. | - | SH | Do you prefer to study alone? |
| 12. | - | AT | Do scientists do boring work? |
| 13. | + | AS | If you have problems at school, is there someone who will help you? |
| 14. | - | AX | Do tests make you nervous? |

| | | | |
|---|---|---|---|
| 15. | + | SH | Do you get your homework done on time? |
| 16. | - | SC | Are science experiments hard for you to understand? |
| 17. | + | AP | Do you want to take any more mathematics courses? |
| 18. | + | CV | Are your friends good at mathematics? |
| 19. | - | EO | Does a person's color make a difference in whether or not they get to be a scientist? |
| 20. | - | PS | Do you get bored with your school work by the middle of the school year? |
| 21. | - | PS | Do you have trouble keeping your mind on your homework? |
| 22. | + | EO | Do people care if a good scientist is a man or a woman? |
| 23. | + | AP | Are you thinking of becoming a scientist? |
| 24. | - | AT | Is mathematics boring? |
| 25. | + | RM | Are many people of your ethnic/racial group successful scientists? |
| 26. | + | AP | Do you try to get good grades in science? |
| 27. | - | LC | Is success mostly a matter of luck? |
| 28. | + | AT | Do most scientists enjoy their work? |
| 29. | + | AT | Do you enjoy solving mathematics problems? |
| 30. | + | VL | Does mathematics come in handy outside of class? |
| 31. | - | AX | Do you feel scared when you have to work a mathematics problem? |
| 32. | + | CA | Can you really become a scientist if you want to? |

| | | | |
|---|---|---|---|
| 33. | + | CA | Do you think there are a lot of jobs for scientists? |
| 34. | - | AX | Do tests scare you even when you have studied for them? |
| 35. | + | SC | Do you think you are a good science student? |
| 36. | + | SH | Do you like to read about science? |
| 37. | + | RM | Have you ever met a scientist? |
| 38. | + | VL | Is science an important subject? |
| 39. | + | SC | Are you good at figuring out mathematics problems? |
| 40. | + | AP | Do you want to improve your mathematics skills? |
| 41. | + | AS | Do the teachers in your school care how well you do in school? |
| 42. | + | CV | Do your people think highly of scientists? |
| 43. | - | AP | Would you like to spend less time on science in school? |
| 44. | - | AS | Do your teachers think you don't do very well? |
| 45. | + | CV | Does your family care a lot about education? |
| 46. | - | AT | Are scientists unfriendly? |
| 47. | - | AX | Do you worry about being able to understand your science assignments? |
| 48. | + | RM | Is there a scientist you look up to? |
| 49. | - | EO | Are boys better in science than girls? |
| 50. | + | LC | Can you control whether or not you have a good day? |

51. - SC Is science too hard for you?

52. - PS Do you often quit when things get tough?

53. - AX Do you get scared when you are called on to answer a question in mathematics?

54. + AT Is science interesting?

55. + SC Are you very good at mathematics?

56. What do you want to be when you grow up?

a. _____

b. _____

c. _____

57. Please describe the work you feel scientists do in a typical work day. If you don't know, just use your imagination.

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE MIDDLE/JUNIOR HIGH STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 32 | CONTROL n = 25 |
| 1. Sex | | |
| Women | 69% | 68% |
| Men | 31% | 32% |
| 2. Age | 12.98 | 13.10 |
| 6. Class | | |
| .Seventh grade | 88% | 76% |
| .Eighth grade | 12% | 24% |
| 7. Higher education expected: | | |
| .Less than high school | 3% | 4% |
| .High school graduation | 3% | 0% |
| .Two-year college degree | 9% | 4% |
| .Four-year college degree | 34% | 32% |
| .One or more years after college | 50% | 56% |
| .Missing | 0% | 4% |
| 8. Studies most influenced by | | |
| .Parents | 59% | 64% |
| .Another family member | 12% | 20% |
| .Teacher | 3% | 0% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 0% |
| .Friend | 6% | 12% |
| .Science professional | 0% | 0% |
| .Nonscience professional | 3% | 0% |
| .No one at all | 12% | 4% |
| .Missing | 3% | 0% |
| 9. Sources of income | | |
| .None | 9% | 0% |
| .One | 34% | 64% |
| .Two | 41% | 24% |
| .Missing | 16% | 12% |
| 10. Family income: | | |
| .Below U.S. average | 0% | 4% |
| .About average | 19% | 36% |
| .Above average | 12% | 8% |
| .Unknown or missing | 69% | 52% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 32 | CONTROL n = 25 |
| 11. Birth order of student: | | |
| .Only child | 9% | 16% |
| .Oldest child | 41% | 40% |
| .Youngest child | 31% | 28% |
| .In-between child | 19% | 12% |
| .Missing | 0% | 4% |
| 12. Number of siblings: | | |
| .None | 9% | 16% |
| .One | 25% | 44% |
| .Two | 31% | 16% |
| .Three or more | 31% | 20% |
| .Missing | 3% | 4% |
| 13. Father's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 0% | 0% |
| .High school graduate | 19% | 24% |
| .Some college | 9% | 0% |
| .College degree or more | 19% | 24% |
| .Missing | 53% | 52% |
| 14. Mother's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 0% | 0% |
| .High school graduate | 16% | 20% |
| .Some college | 6% | 20% |
| .College degree or more | 44% | 24% |
| .Missing | 34% | 36% |
| 15. Language spoken most at home: | | |
| .English | 100% | 100% |
| .Spanish | 0% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| 16. Parents involvement during student's years in school:[a] | | |
| .Attend PTA meetings | 53% | 68% |
| .Attend parent-teacher conferences | 59% | 60% |
| .Visit student's class | 50% | 48% |
| .Phone/visit if there's a problem | 50% | 48% |
| .Do volunteer work | 53% | 32% |
| .Assist in student's homework | 75% | 88% |
| Number of parental involvements * | 3.41 | 3.44 |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 32 | CONTROL n = 25 |
| 17. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 31% | 32% |
| .A lot | 66% | 68% |
| .Missing | 3% | 0% |
| 18. Student reads: | | |
| .Not at all | 3% | 0% |
| .Sometimes | 50% | 52% |
| .A lot | 44% | 48% |
| .Missing | 3% | 0% |
| 19. Items in student's home:[a] | | |
| .Desk | 72% | 64% |
| .Daily newspaper | 69% | 88% |
| .Encyclopedia | 88% | 80% |
| .Typewriter | 72% | 72% |
| .Calculator | 91% | 96% |
| .Television | 100% | 100% |
| .Computer | 44% | 24% |
| .Video Cassette Recorder (VCR) | 78% | 56% |
| Number of support items * | 6.12 | 5.80 |
| 20. All activities student took part in:[a] | | |
| .Math/science club | 22% | 32% |
| .Field trip | 81% | 92% |
| .Watching science programs on TV | 78% | 68% |
| .Listen to talk by scientist | 28% | 24% |
| .Science/math fair | 59% | 44% |
| .Other science/math competition | 25% | 20% |
| .Play/work in computer lab | 88% | 80% |
| Number of activities * | 3.81 | 3.60 |

[a] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# FISK UNIVERSITY

# INTERVENTIONS

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# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected come from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention- group students, as well as on a control-group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF FISK UNIVERSITY

Fisk University is a historically Black, private, coeducational liberal arts institution located in Nashville, Tennessee. The University community consists of approximately 770 students and 81 faculty members. The University, offers undergraduate and graduate degrees and is organized into the Division of Humanities and Fine Arts, Division of Natural Science and Mathematics, Division of Social Sciences, and the Division of Business Administration. The student body is approximately 70 percent female and 30 percent male. Approximately 98 percent of the students are Black, and 2 percent are of other ethnic origins. The president of Fisk University is Dr. Henry Ponder.

Degrees offered at Fisk University in quantitative subjects are Bachelor of Arts in chemistry, mathematics, and physics; Bachelor of Science in chemistry; and Master of Arts in chemistry and physics. Students at Fisk may pursue a minor field of study in computer science. Fisk University offers a dual degree program in natural science and engineering in cooperation with selected universities.

Nashville has a population of approximately 481,000 in its metropolitan area. The state of Tennessee has a population of approximately 4.9 million. According to U.S. Census Bureau estimates, the adult population of Tennessee is 84 percent Anglo, 15 percent Black, and 1 percent other ethnic origins, including Hispanic. Nashville has a number of other institutions of higher education, including Belmont College, David Lipscomb College, Nashville State Technical Institute, Tennessee State University, and Vanderbilt University.

# PART II

# SUMMARY OF THE FISK UNIVERSITY (FU) INTERVENTIONS

This page is a summary of the two interventions conducted by Fisk University, a historically Black, four-year private institution located in Nashville, Tennessee. Fisk University is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Fisk University Intervention Activities:

In Spring and Summer of 1990, Fisk University conducted enrichment classes for middle-school students in mathematics, computer science, and natural science. Morning classes on seven Saturdays constituted the Spring intervention; the Summer intervention included four weeks of Monday-Friday morning classes, with team work on special computer projects in the afternoons. The summer program also included a field trip and presentations by two Black scientists. Some summer classes were held outdoors. Participants were Black fourth- and fifth-grade students recruited from Nashville-area elementary and middle schools.

Findings:

- This intervention was associated with gains in opinion as well as in performance.
- Opinion gains were demonstrated in the summer intervention and not in the spring intervention.
- Fifth-grade students who participated in both the spring and the summer interventions showed a gain in science performance compared with students who participated in summer only.
- For fourth-grade students, the primary performance advantage was in mathematics rather than in science.
- Both fourth-grade and fifth-grade students showed more positive opinions after the intervention.

Recommendations:

- A spring-summer intervention is recommended for stronger improvement in performance.
- If the goal is enhanced opinion, a summer-only intervention may be preferable.
- In teaching middle-school students, it is imperative to identify teachers who can work effectively with students of this age. This is particularly important with mathematics.
- Good working relationships with parents, middle school counselors and teachers is essential to the smooth functioning of this intervention.

# PART III

# CASE STUDY OF THE FISK UNIVERSITY

# 1990 SPRING SEMESTER INTERVENTION

## ABSTRACT

In 1990 Fisk University, Nashville, Tennessee, developed and tested against a control group an intervention program designed to build the competence and confidence of fourth- and fifth-grade students in science. Participants in the spring and summer interventions were 51 Black middle school students (28 girls and 23 boys) from the Nashville area.

The Fisk University program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance in science and mathematics, and (b) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* The major component of the intervention was classroom instruction in mathematics, science, and computer science taught by Fisk University faculty. The spring intervention consisted of classes held on eight Saturdays; the summer schedule included weekday classes, along with special projects, a field trip, and presentations by Black scientists.

*DATA:* All the participants furnished demographic data through the CASET Middle/Junior High School Student Protocol. Participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were national standardized test scores, and scores on faculty-developed tests of mathematics and science content.

The outcome measures of performance were the scores on the faculty-developed tests of mathematics and science. The preintervention measures of performance were scores on the Stanford Achievement Test and on content pretests of mathematics and science.

*RESEARCH DESIGN:* Data analysis was based on three research designs, each with specific limitations: (a) an investigation of the influence of student participation in the intervention on the opinions about mathematics and science of fourth graders in the spring; (b) comparisons between the performance and opinions of fifth graders who attended in both the spring and summer and those who attended only in the summer; and (c) comparisons between the performance and opinions of fourth graders who attended in the summer and those who did not.

*FINDINGS:* The intervention had mixed effects on the participants and can be considered a successful intervention for certain students in certain areas. For the fourth graders attending in the spring, the intervention-group students had significantly lower scores at the end of the intervention on 5 of the 17 opinion scales than at the beginning, and for this group, greater participation was not associated with enhanced opinions. For the fifth graders, the intervention had no significant effect on the mathematics performance, but had a medium, positive effect on the science performance of fifth graders who participated in both the spring and summer. For fourth graders, the intervention had a medium, positive effect on mathematics performance, but a large, negative effect on science performance. On opinion measures, the intervention had small-to-medium positive effects for both the fourth-grade and fifth-grade intervention-group students.

## DESCRIPTION OF THE INTERVENTION

Fisk University, having had experience in how science intervention work with seventh, eighth, and ninth graders, proposed to extend that success to a younger age cohort. Thus in the spring and summer of 1990, Fisk University undertook an intervention for fourth-grade students (in the spring) and then fourth- and fifth-grade students (in the summer).

The goals of the intervention were to build competence and confidence in the areas of science, mathematics, and computer science in the young students, thus encouraging them to see careers in science and engineering as a real possibility.

The spring intervention consisted of eight Saturday classes, conducted from April 7 through May 26, 1990, for fourth-grade students on the Fisk University campus. The first Saturday was spent conducting registration, orientation, and pre-testing. The following schedule was observed for the next seven Saturdays.

| | |
|---|---|
| 9:00 - 9:50 a.m. | Science class |
| 10:00 - 10:50 a.m. | Mathematics class |
| 11:00 - 11:50 a.m. | Computer Science class |

The spring students were invited to continue as fifth graders in the summer program, and a number of them did so. In addition, a new group of fifth graders, who had not participated in the spring project, joined, as well as a new group of fourth graders (students who had just completed the third grade) who also had not been prior participants.

For the summer intervention students were separated into their two age cohorts (fourth graders and fifth graders) for classes. The summer class schedule was as follows:

| TIME | FOURTH GRADERS | FIFTH GRADERS |
|---|---|---|
| 9:00-9:50 a.m. | Mathematics | Science |
| 10:00-10:50 a.m. | Science | Computer Science |
| 11:00-11:50 a.m. | Computer Science | Mathematics |
| 12:00-1:30 p.m. | LUNCH | LUNCH |
| 1:30-2:45 p.m. | Special Projects | Special Projects |

The following are some sample topics covered in the classes:

Computer:

- Kinds of storage; use of floppy disk; proper way to exit a software. Additional topics for fifth graders: Input and output devices; IBM compatible and Apple computers; understanding computer prompts.

Computer applications:

- Mathematical computer games; full-color animated programs introducing measurements and energy.

Mathematics:

- Operations; word problem-solving; circle and bar graphs; use of data from charts, tables, graphs.

Science:

- Topics for fourth-graders: Parallel and series circuits; properties of conductors and insulators; rules of safety while using electricity; effect of matter on sound waves; relation between vibration and pitch; sources of heat and light.
- Topics for fifth graders: Mass density; weight density; dispersion, reflection and refraction of light; mechanical work; work of simple machines.

The Special Projects:

- These were assignments in mathematics and science, which the students, working in teams had to complete on the computers.

Summer classes were held Monday through Friday, June 18 through July 13, 1990. Because of electrical problems in the buildings, some of the classes in the summer were held outdoors.

The intervention activities also included a field trip to Opryland in Nashville, which combined enjoyment and learning as the instructors explained the scientific functions and operations of equipment such as roller coasters. On two Friday afternoons, Black scientists made presentations to the students about science as a career.

The Project Director for this intervention was Dr. George Neely, Jr., Executive Vice President and Professor of Physics, Fisk University. Dr. Neely also served as the instructor for the science classes. Instructor of mathematics was Theodore R. Sykes, Professor and Chair, Mathematics Department, Fisk University. Computer science classes were taught by Sanjin Ranjan, Assistant Professor, Fisk University. Testing consultant was Carrell P. Horton, Professor and Chair, Psychology Department, and Director, Social Science Division.

# METHOD

## Subjects

Subjects were Black fourth- and fifth-grade students recruited from Nashville-area elementary and middle schools. The spring intervention students were fourth graders, several of whom continued in the summer as fifth graders. The summer intervention also included a new group of fifth graders. In addition, the summer intervention included new fourth-graders (who had just completed the third grade); the fourth-grade applicants were divided into intervention and control groups. The intervention-group students participated in the intervention classes and activities; the control-group students supplied the same information and filled out the same tests and protocols as the intervention students, but did not take part in any intervention activities. Thus there are the following groups of subjects: in the spring, an intervention group of 13 fourth graders (six boys and seven girls); in the summer, four groups: 10 continuing fifth graders (six boys and four girls, all of whom had been fourth-grade participants in spring); 11 new fifth graders, four boys and seven girls, who had not participated in the spring intervention; eight new fourth graders, three boys and five girls, who had just completed third grade and had not participated previously; and a control group of nine fourth graders, four boys and five girls, who had just completed third grade.

Data was received for a total of 51 intervention and control students. All students were Black American citizens, and all are included in this analysis.

## CASET Protocols and Other Instruments

Demographic and descriptive data about the subjects were developed through the Middle/Junior High School Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several questions were developed, varying in directionality. Combining the question for each variable gave a scalar measurement for that variable. Thus the completed Opinion Protocol provided a scale measuring each of the thirteen variables.

For middle school and junior high school students, CASET adapted the CASET Opinion Protocol items, simplifying wording and concepts to make them more appropriate to the younger age group while addressing the same thirteen attitudinal variables as the older-level Opinion Protocol. An additional change was that for the younger students, there were only two possible answers: "yes" and "no" rather than the four-point scale of the older students' Opinion Protocol. The Opinion Protocol question items, together with the scales (attitudinal variables) they represented, are shown in Appendix B.

The institution developed pre- and posttests of content in science and mathematics. In science, two test were developed, one for fourth graders and a different one for fifth graders. In mathematics, the fourth and fifth graders took the same test. These tests were developed, administered, and scored by the institution, and the scores forwarded to CASET, along

with the completed CASET protocols and Stanford Achievement Test scores for intervention- and control-group students, from a preintervention administration of the test.

### Procedure

As each student joined the CASET project as an intervention- or control-group student, parents signed a consent form and the student completed the CASET Middle/Junior High School Student Protocol. At the beginning of the spring intervention and at the end of the summer intervention, students completed the CASET Opinion Protocol.

At the beginning of the summer intervention, students completed the faculty-developed tests of mathematics and science content. These content tests were scored by the intervention faculty, who forwarded to CASET, content test scores, CASET protocols, and preintervention Stanford Achievement Test grade equivalents for intervention and control-group students.

The items of the Opinion Protocol were coded according to the thirteen scales they represent. Items on the Opinion Protocol were scored in such a way that a large number reflected a positive outcome (see Appendix B). The scales were organized into three constructs -- SET Goal, Environmental Support, and Attitude -- as shown in Appendix C.

Students who continued from spring to summer were administered the Opinion Protocol three times: April 7, May 26, and July 13, 1990. The May 26, 1990 administration is considered a POST-intervention measure for Spring and a pre-intervention measure for Summer.

For the other students, however, a consistent preintervention administration of the Opinion Protocol was not available, particularly for control-group students. Dates of administration varied widely; in some cases protocols were completed well after the beginning of intervention activities.

## RESULTS

### Methodological Issues

Two hypotheses about the effects of the intervention were evaluated: (a) The intervention would increase mathematics and science test scores, and (b) the intervention would enhance opinions about SET fields and careers. These two hypotheses were tested through three sets of analyses: (a) an examination of the influence of level of participation in the intervention on fourth graders' opinion in the Spring 1990 (no control group); (b) comparisons between the performance and opinions of fifth-grade students with a Spring and Summer intervention and fifth graders with only a Summer intervention; and (c) comparisons between the performance and opinions of fourth graders with and without a Summer intervention. Each of the three sets of analyses was based on different research designs that had their specific limitations. The first set of analyses used data collected in Spring 1990, and the other two used data collected in the summer of 1990. Because the Spring semester's design was so different from the Summer's designs, the Spring semester's design will be discussed separately.

Analyses of the Spring semester's data examined the effects of the intervention on opinion through a one-group pretest-posttest design with treatment partitioning via attendance. The typical one-group pretest-posttest design has so many weaknesses concerning the causal effects of the intervention that findings from the design are uninterpretable; the weaknesses of the design include history, maturation, testing, selection, and interactions between selection and maturation, history, and testing. By introducing a partitioning of the treatment via attendance at the intervention's sessions, one can strengthen the design enough to overcome some of the problems (history, testing) and reach some tentative conclusions about the intervention's effects; however, the design still has the possible problems of maturation and interactions of selection with maturation, history, and testing. These problems of the Spring's design were controlled better in the Summer's designs.

The Summer intervention was made with fourth- and fifth-grade students, who had pretest and posttest measures of mathematics and science performance in addition to opinion measures. The results for the fourth- and fifth-grade students were analyzed separately because the fourth-grade students were divided into an intervention group and a no-treatment control group, and the fifth-grade students were divided into a group who participated in the Summer intervention and another group who participated in both the Spring and Summer intervention. Unfortunately, the preintervention administration of the Opinion Protocol was not consistent, particularly for control-group students; the dates of administration varied widely, and in some cases the "preintervention date" was well after the beginning of intervention activities. In an attempt to provide some of the same advantages as a same-scale pretest, a proxy measure of preintervention opinion was constructed using items from the postintervention Opinion Protocol.

A proxy pretest should possess two qualities (Cook & Campbell, 1979): (a) it should measure a characteristic that existed prior to the intervention, and (b) it should correlate with the post-intervention measure within each group. Once a proxy is constructed, it serves two functions: (a) a proxy pretest increases the statistical power of the test of postintervention differences by reducing the error variance in an analysis of covariance (ANCOVA), and (b) a proxy pretest provides an indication of how the formation of the groups may have created important preexisting differences. A proxy pretest is usually inferior to a same-scale pretest because the correlation between the proxy-pretest and the posttest will be smaller than the correlation between the same-scale pretest and the posttest; therefore, the proxy pretest often will underadjust for preexisting differences and provide a smaller increase in statistical power.

The Summer intervention had two different versions of two designs: (a) the performance data were in a nonequivalent control-group design for fourth-grade students and fifth-grade students for mathematics and science test scores; and (b) the opinion data were in a nonequivalent control-group design with proxy measures of preintervention opinion for fourth- and fifth-grade students. The chief problems of these nonequivalent control-group designs are possible interactions of selection-maturation, selection-history, selection-testing, possible regression (if groups were formed based on extreme scores), and underadjustment for prior differences by proxy pretests. Additional analyses with level of participation in the intervention can provide some control for the interactions of selection with history and selection with testing. The only way to control for the remaining problems is to replicate the findings with another sample.

*Construction of the proxy measures of opinion.* The proxy measures of preintervention opinion were constructed from a group of nine opinion items that assessed enduring, preexisting characteristics. The opinion items and their numbers are:

(a) I study each day rather than just before exams (#1);

(b) I make it a point to get my assignments in on time (#15);

(c) None of my friends have ever been good at math (#18);

(d) I find myself losing interest in my studies by the middle of the semester (#20);

(e) I have trouble keeping my mind from wandering as I study (#21);

(f) I try to be one of the best students in my science classes (#26);

(g) I only do as much as I have to in my science classes (#36);

(h) My family cares a lot about education (#45); and

(i) I often feel like quitting school (#52).

Six of the proxy premeasure items came from the Attitude construct, including three items from the Study Habits scale (1, 15, and 36) and three from the Persistence scale (20, 21, and 52). In addition, three items were taken from the SET Goal construct: two items were from the Cultural Value scale (18 and 45), and one was from the Aspiration scale (26). In general, these items referred either to enduring characteristics or to experiences in the semester(s) prior to the intervention that related to a student's level of involvement in his/her education.

Since some of the same items occurred in two measures that were to be correlated; (for example, both in Study Habits and the proxy premeasure), and as this would have violated the independence assumption of the statistical mode; specific proxy measures were created for the Study Habits, Persistence, Cultural Value, and the Aspiration scales; as well as the Attitude and SET Goal constructs. These measures were created by removing from the set of nine proxy items those that were also a part of that particular postintervention measure. Finally, though none of the proxy items were from the Environmental Support construct's items, the proxy measure was expected to correlate significantly with at least some of the Environmental Support variables.

The presentation of the results begins by testing the hypothesis of enhanced opinions about SET fields and careers as a result of the Spring 1990 intervention. Next are tests of the preintervention equivalence of the two groups on the demographic characteristics. Following this are the tests of the intervention's hypotheses of enhanced performance and opinions about SET careers with the Summer 1990 data.

## Opinion Results, Spring 1990

In the Spring 1990 semester, 13 Black students from the fourth grade (6 girls and 7 boys) participated in the intervention. Two hypotheses about the effects of the intervention were tested:
(a) intervention-group students' opinions would increase significantly from pre- to postintervention, tested by within-subjects t-tests; and (b) the increase in intervention-group students' opinions about SET fields and careers would vary with their level of participation, tested by ANCOVAs that covaried preintervention opinion before testing the significance of level of participation in the intervention.

Table 1 presents the results of the within-subjects t-tests of preintervention and postintervention opinion scores. Of the 17 comparisons, 5 were significant at the $p \leq .10$ level; unfortunately, all 5 significant changes were in the direction opposite to the hypothesis. Postintervention scores on total Opinion, Attitude construct, Math/science attitude, Persistence, and Academic Support opinion scales were lower at the end of the intervention than they had been before the intervention.

Table 1

PRE-POST DIFFERENCES ON OPINION CONSTRUCTS AND SCALES

| OPINION CONSTRUCT / Scale | PREINTERVENTION | | POSTINTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| OPINION,Total | 1.77 | .07 | 1.70 | .14 | -2.28 | ≤.05 |
| SET GOAL | 1.77 | .12 | 1.75 | .11 | -0.65 | ns |
| Value | 1.88 | .20 | 1.85 | .20 | -0.43 | ns |
| Cultural Value | 1.83 | .16 | 1.83 | .25 | 0.00 | ns |
| Self-Concept | 1.67 | .22 | 1.60 | .21 | -0.69 | ns |
| Aspiration | 1.46 | .15 | 4.76 | .14 | 0.14 | ns |
| ATTITUDE | 1.77 | .10 | 1.66 | .19 | -2.14 | ≤.10 |
| Math/Science Attitude | 1.93 | .10 | 1.75 | .21 | -2.84 | ≤.05 |
| Locus of Control | 1.69 | .26 | 1.61 | .37 | -0.67 | ns |
| Persistence | 1.75 | .21 | 1.51 | .24 | -3.17 | ≤.01 |
| Study Habits | 1.76 | .25 | 1.77 | .22 | 0.10 | ns |
| Anxiety | 1.64 | .23 | 1.59 | .26 | -0.60 | ns |
| Environmental Support | 1.75 | .15 | 1.71 | .16 | 1.25 | ns |
| Academic Support | 1.92 | .21 | 1.75 | .32 | -2.57 | ≤.05 |
| Career Awareness | 1.86 | .17 | 1.92 | .15 | 1.48 | ns |
| Role Model | 1.44 | .36 | 1.44 | .36 | 0.00 | ns |
| Equal Opportunity | 1.78 | .22 | 1.72 | .40 | -0.69 | ns |

The intervention n's = 12

All tests were made as two tailed tests.

A second set of analyses adjusted for preintervention opinion before testing for the effect of level of participation. The results from the ANCOVAs are given in Table 2. Of the 17 measures tested, two showed main effects of participation: Greater participation was related to higher Self-Concept and lower Role Model scores. In addition, two measures -- Value and Cultural Value -- showed interactions between preintervention opinion score and participation level. The two interactions are graphed in Figures 1 and 2. The interactions were analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of preintervention scores for which the groups differed.

**Table 2**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTTEST OPINION MEASURES COVARYING PRETEST OPINION MEASURES**

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLES MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| OPINION, Overall | SCORE | .46 | .46 | 8.42 | 1,10 | ≤.05 |
| | +P | .47 | .01 | 0.21 | 1,9 | ns |
| | +SCORE-x-P | .59 | .12 | 2.39 | 1,8 | ns |
| SET GOAL | SCORE | .04 | .04 | 0.46 | 1,10 | ns |
| | +P | .11 | .07 | 0.72 | 1,9 | ns |
| | +SCORE-x-P | .16 | .05 | 0.47 | 1,8 | ns |
| Value | SCORE | .42 | .42 | 7.19 | 1,10 | ≤.05 |
| | +P | .26 | .04 | 0.65 | 1,9 | ns |
| | +SCORE-x-P | .67 | .21 | 4.97 | 1,8 | ≤.10 |
| Cultural Value | SCORE | .44 | .44 | 7.78 | 1,10 | ≤.05 |
| | +P | .45 | .01 | 0.18 | 1,9 | ns |
| | +SCORE-x-P | .05 | .20 | 4.42 | 1,8 | ≤.10 |
| Self-Concept | SCORE | .04 | .04 | 0.43 | 1,10 | ns |
| | +P | .32 | .28 | 3.64 | 1,9 | ≤.10 |
| | +SCORE-x-P | .32 | .00 | 0.01 | 1,8 | ns |
| Aspiration | SCORE | .11 | .11 | 1.25 | 1,10 | ns |
| | +P | .14 | .03 | 0.28 | 1,9 | ns |
| | +SCORE-x-P | .27 | .14 | 1.49 | 1,8 | ns |
| ATTITUDE | SCORE | .09 | .09 | 0.96 | 1,10 | ns |
| | +P | .19 | .10 | 1.10 | 1,9 | ns |
| | +SCORE-x-P | .27 | .09 | 0.96 | 1,8 | ns |
| Math/Science Attitude | SCORE | .05 | .05 | 0.47 | 1,10 | ns |
| | +P | .17 | .13 | 1.37 | 1,9 | ns |
| | +SCORE-x-P | .34 | .17 | 2.09 | 1,8 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTTEST OPINION MEASURES COVARYING PRETEST OPINION MEASURES**

| | | | | | | |
|---|---|---|---|---|---|---|
| Locus of Control | SCORE | .01 | .01 | 0.15 | 1,10 | ns |
| | +P | .28 | .26 | 3.26 | 1,9 | ns |
| | +SCORE-x-P | .29 | .01 | 0.14 | 1,8 | ns |
| Persistence | SCORE | .13 | .13 | 1.54 | 1,10 | ns |
| | +P | .27 | .13 | 1.64 | 1,9 | ns |
| | +SCORE-x-P | .27 | .00 | 0.00 | 1,8 | ns |
| Study Habits | SCORE | .25 | .25 | 3.29 | 1,10 | ≤.10 |
| | +P | .33 | .08 | 1.08 | 1,9 | ns |
| | +SCORE-x-P | .51 | .18 | 3.06 | 1,8 | ns |
| Anxiety | SCORE | .16 | .16 | 1.85 | 1,10 | ns |
| | +P | .20 | .04 | 0.47 | 1,9 | ns |
| | +SCORE-x-P | .25 | .05 | 0.51 | 1,8 | ns |
| ENVIRONMENTAL SUPPORT | SCORE | .51 | .51 | 10.40 | 1,10 | ≤.01 |
| | +P | .53 | .02 | 0.29 | 1,9 | ns |
| | +SCORE-x-P | .54 | .01 | 0.26 | 1,8 | ns |
| Academic Support | SCORE | .52 | .52 | 10.74 | 1,10 | ≤.01 |
| | +P | .53 | .01 | 0.22 | 1,9 | ns |
| | +SCORE-x-P | .56 | .03 | 0.57 | 1,8 | ns |
| Career Awareness | SCORE | .47 | .47 | 8.75 | 1,10 | ≤.05 |
| | +P | .47 | .00 | 0.03 | 1,9 | ns |
| | +SCORE-x-P | .47 | .00 | 0.03 | 1,8 | ns |
| Role Model | SCORE | .28 | .28 | 3.83 | 1,10 | ≤.01 |
| | +P | .54 | .27 | 5.30 | 1,9 | ns |
| | +SCORE-x-P | .55 | .01 | 0.10 | 1,8 | ns |
| Equal Opportunity | SCORE | .55 | .55 | 12.15 | 1,10 | ≤.01 |
| | +P | .62 | .08 | 1.82 | 1,9 | ns |
| | +SCORE-x-P | .64 | .01 | 0.30 | 1,8 | ns |

All models were analyzed as two-tailed tests.

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $\underline{F}(sR^2)$ is the test of significance for that proportion of variance.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure), (1) PRETEST OPINION SCORE; (2) PRETEST OPINION SCORE and PARTICIPATION; (3) PRETEST OPINION SCORE and PARTICIPATION and SCORE-by-PARTICIPATION INTERACTION.

**Figure 1**

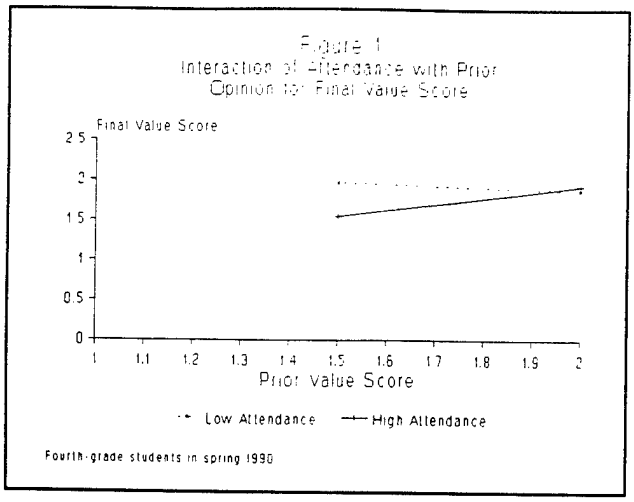
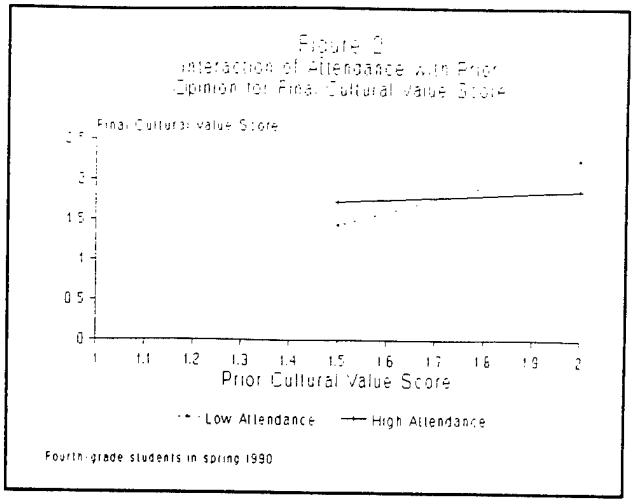



**Figure 2**




As Figure 1 indicates, lower attendance was associated with higher post- intervention Value scores for students who began with lower Value scores.

Figure 2 indicates that students who began with lower Cultural Value scores had higher postintervention scores if they had higher attendance; students who began with higher Cultural Value scores did better with lower attendance.

A third set of analyses examined how the results of ANCOVAs would differ if a same-scale pretest was used or if a proxy pretest was used. The three constructs were tested using the proxy premeasures, as described above, and the results are given in Table 3. The results changed somewhat with the proxy measures: (a) the size of the total explained variance increased for two constructs with the proxy measures, for SET Goal from .16 to .45, for Attitude from .27 to .20, and for Environmental Support from .54 to .76; (b) the three main effects tests remained nonsignificant; and (c) two premeasure-by-participation interactions, SET Goal, and Environmental Support, became significant with the proxy measure.

**Table 3**

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION OPINION COVARYING PREINTERVENTION PROXY OPINION**

| OPINION CONSTRUCT | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| SET GOAL | PROXY PRE | .14 | .14 | 1.65 | 1,10 | ns |
| | +P | .15 | .00 | 0.04 | 1,9 | ns |
| | +PRE-x-P | .45 | .31 | 4.45 | 1,8 | ≤.10 |

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION OPINION COVARYING PREINTERVENTION PROXY OPINION**

| | | | | | | |
|---|---|---|---|---|---|---|
| ATTITUDE | PROXY PRE | .03 | .03 | 0.30 | 1,10 | ns |
| | +P | .17 | .14 | 1.51 | 1,9 | ns |
| | +PRE-x-P | .20 | .04 | 0.37 | 1,8 | ns |
| ENVIRONMENTAL SUPPORT | PROXY PRE | .48 | .48 | 9.09 | 1,10 | ≤.05 |
| | +P | .52 | .05 | 0.86 | 1,9 | ns |
| | +PRE-x-P | .76 | .24 | 7.75 | 1,8 | ≤.05 |

All models were analyzed as two-tailed tests.

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $\underline{F}(sR^2)$ is the test of significance for that proportion of variance.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure), (1) PROXY PRETEST OPINION CONSTRUCT, (2) PROXY PRETEST OPINION CONSTRUCT and PARTICIPATION; (3) PROXY PRETEST OPINION CONSTRUCT and PARTICIPATION and PROXY PRETEST-by-PARTICIPATION INTERACTION.

The interactions from Table 3 are shown in Figures 3 and 4.

As seen in Figure 3, students with lower proxy scores who had better attendance had higher post- intervention SET Goal scores.

**Figure 3**

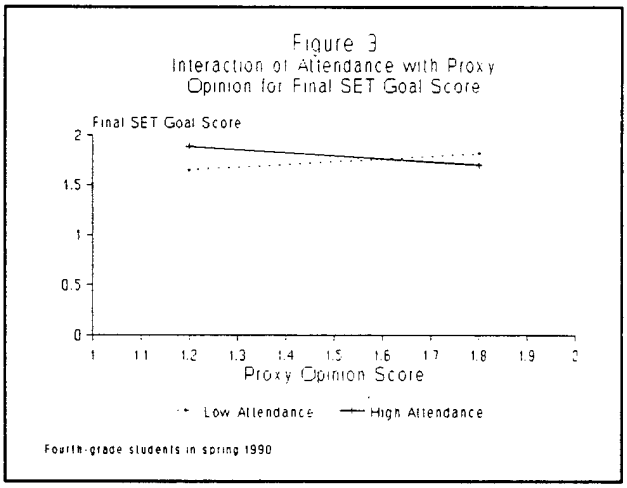



**Figure 4**

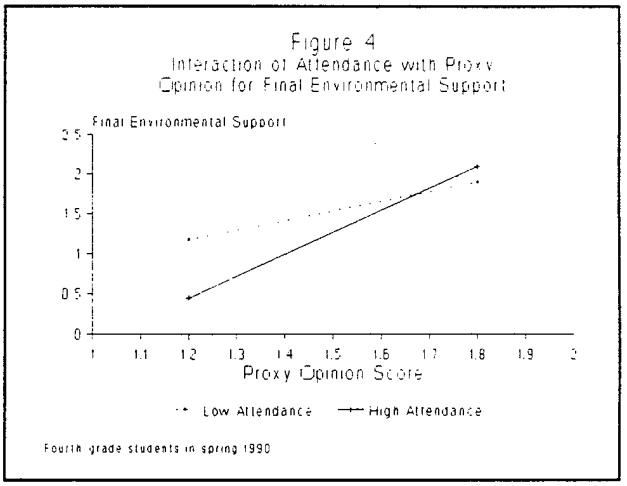



Figure 4 indicates that students with lower proxy pre- measure scores who had lower levels of attendance had higher postinterven-tion Environmental Support scores.

A comparison of the same-scale and proxy pretest results suggested that the proxy premeasures would increase suitably the sensitivity of the analyses. However, the differences between the results using same-scale or proxy premeasures and the greater explanatory power of models with the proxy premeasures raised some questions about the proxy measures that these data cannot answer.

Demographic Comparisons of Summer 1990 Groups

The distribution of students by sex and grade-level is given in Table 4.

**Table 4**

| GRADE AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| SEMESTER/GRADE | GIRLS | BOYS | GIRLS | BOYS | GIRLS | BOYS |
| Spring-only 4th Graders | - | - | 7 | 6 | 7 | 6 |
| Spring-Summer 5th Graders | - | - | 4 | 6 | 4 | 6 |
| Summer-only 4th Graders | 5 | 4 | 5 | 3 | 10 | 7 |
| Summer only 5th Graders | - | - | 7 | 4 | 7 | 4 |
| TOTAL | 5 | 4 | 23 | 19 | 28 | 23 |

Two sets of demographic comparisons were made to ascertain preintervention equality of the groups, and they are given in Appendices D and E: (a) for the fourth-grade students in the intervention and control group (Appendix D); and (b) for the fifth-grade students who participated in one or two interventions (Appendix E).

The fourth-grade students in the intervention and control-groups differed on 5 of 38 demographic comparisons, all of which favored the control group: (a) father's educational level was higher in the control group, chi-square (3, $N$ = 17) = 10.05, $p \leq .05$; (b) mother's education level was higher in the control group, chi-square (3, $N$ = 17) = 6.30, $p \leq .10$; (c) more control-group students had seen science programs on TV (control = 100%, intervention = 38%), (d) more control-group students had heard a scientist's lecture (control = 100%, intervention = 12%), and (e) control-group students had participated in a greater number of math/science activities, $t(15) = 2.94$, $p \leq .01$ (control $M$ = 4.89, intervention $M$ = 2.88). Three of the differences concerned math/ science activities, and the number of these activities was used as an additional covariate in supplementary analyses reported below.

The two groups of fifth graders (summer-only and spring-summer participants) differed on 6 of the 38 demographic comparisons, and all favored the two-intervention group (their demographic measures had been made prior to the first intervention in Spring 1990): (a) more of the spring-summer students had a typewriter in their home (spring-summer = 78%, summer-only = 36%); (b) more of the spring-summer students had a computer in their home (spring-summer = 67%, summer-only = 18%); (c) more of the spring-summer students had a VCR in their home

(spring-summer = 100%, summer-only = 64%); (d) the spring-summer students had a greater number of support items in their home, $t$ (18) = 3.00, $p \leq .01$ (spring-summer $M$ = 6.33, summer-only $M$ = 4.00); (e) more of the spring-summer students had played or worked in a computer lab (spring-summer = 100%, summer-only = 54%); and (f) the spring-summer students had participated in a greater number of math/science activities, $t$ (18) = 2.11, $p \leq .05$ (spring-summer $M$ = 3.78, summer-only $M$ = 2.55). All 6 differences concerned support items in the home and math/science activities, and supplementary analyses used both measures as additional covariates in ANCOVAs reported below.

Performance Results, Summer 1990

The two parts of the hypothesis about performance were: (a) Would the fourth-grade intervention-group students outperform the control-group students? and (b) Would the fifth-grade spring-summer students outperform the summer-only students? These two hypotheses were tested in a series of analyses that ranged from between-group $t$-tests, ANCOVAs with pretest covariate, within-subjects $t$-tests, and ANCOVAs with additional covariates.

*Between-group t-tests.* The results of the between-group $t$-tests are given in Table 5. The fourth-grade intervention-group and control-group students did not differ on the Stanford Achievement Test, the mathematics pretest, the science pretest, or the science posttest; however, the intervention group outperformed the control group on the mathematics posttest. The two groups of fifth-grade students differed on only one pretest measure--the science pretest score was higher in the spring-summer group--and did not differ on any posttest.

**Table 5**

**DIFFERENCES ON GROUP PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | SIG $p$ |
|---|---|---|---|---|---|---|
| Stanford Achieve. Test<br>4th Graders | Control<br>Intervention | 9<br>6 | 4.00<br>4.17 | 1.41<br>1.94 | 0.19<br>(13) | ns |
| Stanford Achieve. Test<br>5th Graders | Summer-only<br>Spring-Summ. | 10<br>13 | 4.90<br>4.00 | 1.10<br>1.83 | 1.37<br>(21) | ns |
| Math Pretest<br>4th Graders | Control<br>Intervention | 9<br>8 | 35.00<br>39.38 | 9.01<br>10.50 | 0.92<br>(15) | ns |
| Math Posttest<br>4th Graders | Control<br>Intervention | 8<br>6 | 34.38<br>45.00 | 14.00<br>11.83 | 1.50<br>(12) | ≤.10 |
| Math Pretest<br>5th Graders | Summer-only<br>Spring-Summ. | 11<br>5 | 40.45<br>41.00 | 9.61<br>13.87 | 0.09<br>(14) | ns |
| Math Posttest<br>5th Graders | Summer-only<br>Spring-Summ. | 9<br>5 | 48.89<br>49.00 | 13.87<br>12.94 | 0.01<br>(12) | ns |

**DIFFERENCES ON GROUP PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | SIG p |
|---|---|---|---|---|---|---|
| Science Pretest 4th Graders | Control<br>Intervention | 9<br>8 | 56.11<br>56.25 | 12.44<br>11.57 | 0.02<br>(15) | ns |
| Science Posttest 4th Graders | Control<br>Intervention | 8<br>6 | 55.00<br>48.33 | 12.54<br>9.83 | -1.07<br>(12) | ns |
| Science Pretest 5th Graders | Summer-only<br>Spring-Summ. | 11<br>8 | 33.64<br>40.00 | 8.97<br>5.34 | 1.78<br>(17) | ≤.10 |
| Science Posttest 5th Graders | Summer-only<br>Spring-Summ. | 9<br>5 | 30.56<br>37.00 | 14.88<br>13.51 | 0.80<br>(12) | ns |

Pretest scores were compared using two-tailed probabilities. Posttest scores were compared using one-tailed probabilities.

*Group differences after adjusting for pretests.* As a further test of the first hypothesis of group differences in performance, a hierarchical ANCOVA procedure adjusted for pretest scores before comparing groups on postintervention performance measures. The results, presented in Table 6 indicated that the effect of the intervention on fourth graders' mathematics performance was not significant after adjusting for pretest scores, but the control-group students had significantly higher adjusted means on the science posttest ($\underline{M}$ = 55.22) than did the intervention-group students ($\underline{M}$ = 48.10). The fifth-grade groups did not differ on either performance measure.

**Table 6**

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Math Posttest 4th Graders | MATH PRETEST | .40 | .40 | 8.04 | 1,12 | ≤.05 |
| | + GROUP | .43 | .03 | 0.57 | 1,11 | ns |
| | + PRE-x-GROUP | .45 | .02 | 0.34 | 1,10 | ns |
| Math Posttest 5th Graders | MATH PRETEST | .65 | .65 | 22.73 | 1,12 | ≤.01 |
| | + GROUP | .66 | .00 | 0.03 | 1,11 | ns |
| | + PRE-x-GROUP | .68 | .02 | 0.03 | 1,10 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Science Posttest 4th Graders | SCIENCE PRETEST | .53 | .53 | 13.71 | 1,12 | ≤.01 |
| | + GROUP | .63 | .10 | 3.00 | 1,11 | ≤.10 |
| | + PRE-x-GROUP | .68 | .05 | 1.45 | 1,10 | ns |
| Science Posttest 5th Graders | SCIENCE PRETEST | .01 | .01 | 0.06 | 1,12 | ns |
| | + GROUP | .07 | .06 | 0.74 | 1,11 | ns |
| | + GPA-x-GROUP | .09 | .02 | 0.22 | 1,10 | ns |

All models were analyzed as two-tailed tests except for the GROUP model which was analyzed as one-tailed test.

**Figure 5**

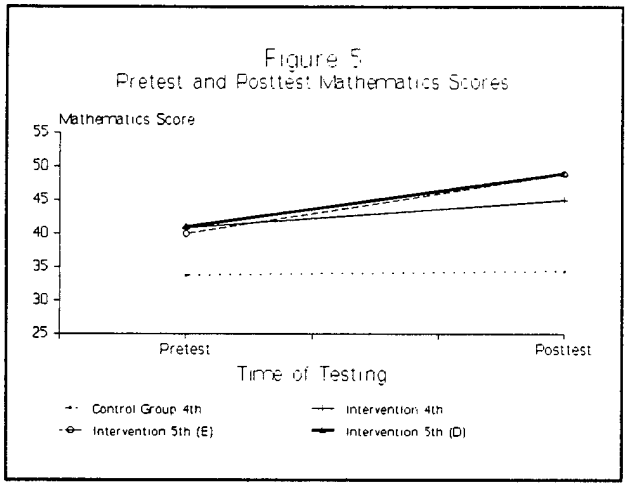



**Figure 6**

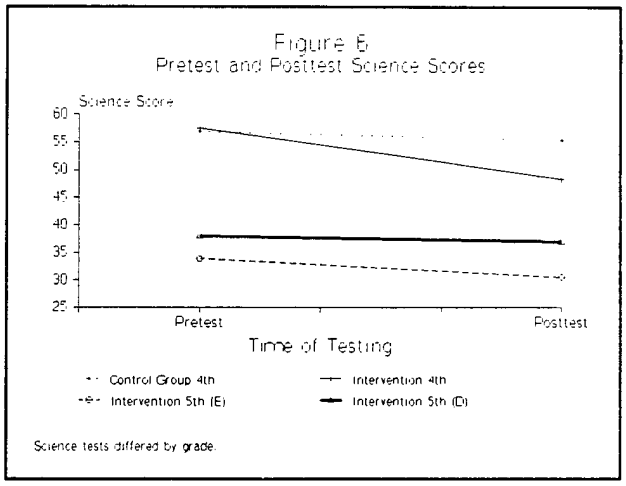



Table 6, of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding the first and each subsequent variable to the multiple regression equation (one variable per row), and the significance test of each variable's contribution toward explaining the dependent variable. The columns of the table include the cumulative percentage of explained variance (cum $R^2$), the variable's contribution to explained variance ($sR^2$), the test of the variable's contribution ($F(sR^2)$), and the test's degrees of freedom (df). Because the hypothesis was directional -- improvement for the intervention group -- the test statistics for the group variable were compared to one-tailed probability levels; for F statistics, this involved converting from F to t statistics ($F = t^2$), and comparison to the corresponding one-tailed critical values. All of the other tests were compared to two-tailed values.

*Within-subjects t-tests.* To obtain a different perspective on the changes in each group's performance level from preintervention to post, a series of within-subjects t-tests were made, and the results are shown in Figure 5 (mathematics) and Figure 6 (science).

On the math tests, all three intervention groups showed significant gains from pretest to post, and the control group did not change significantly.

On the science test, only the fourth-grade intervention-group students showed a significant change from pretest to posttest, $t$ (5) = -2.10, $p \leq .10$ two-tailed; unfortunately, the change was a significant drop in science scores.

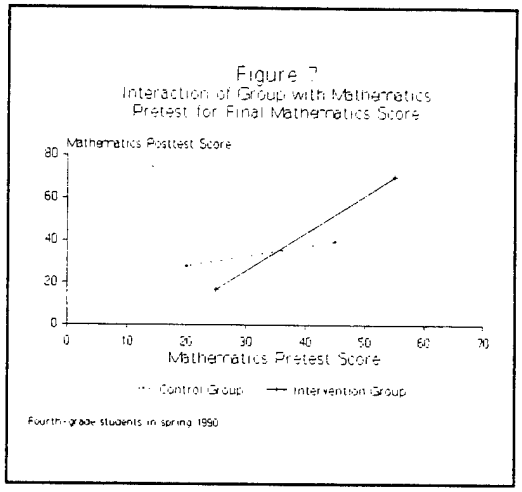
*Performance ANCOVAs with additional demographic covariates.* The ANCOVAs reported in Table 6 had been adjusted for pretest performance before testing for the effects of the intervention. Though such an analysis may have controlled for some preexisting differences, additional covariates were added to the analyses to insure that demographic differences between the groups did not obscure any effects of the intervention.

**Figure 7**

For the fourth-grade students, the number of math/science activities was included before testing the intervention's effect on mathematics and science performance. For the mathematics posttest, adding this variable significantly increased the importance of the interaction between mathematics pretest score and group membership, $F(1,9)$ = 6.38, $p \leq .05$, two-tailed.

Figure 7 shows that fourth graders who scored above average on the math pretest (overall pretest $M$ = 37.06) did better in the intervention group than in the control group.

For the science posttest, adding the extra covariate did not significantly change the results: The intervention had no significant main effect, $F(1,10)$ = 1.66, or interaction for science performance, $F(1,9)$ = 1.56.




For the fifth graders, the addition of support items in the home and number of previous math/science activities as covariates had more dramatic effects on the analysis of the role of the intervention. For mathematics performance, the additional covariates boosted the cumulative explained variance to 92 percent and made the intervention effect significant, $F(1,10)$ = 5.71, $p \leq .05$, two-tailed; the adjusted means indicated that the summer-only group ($M$ = 51.45) outperformed the spring-summer group ($M$ = 44.77). For science performance, the additional covariates increased the total explained variance by 42 percent, but the intervention had no significant main effect, $F(1,8)$ = 0.53, or interaction effect, $F(1,7)$ = 0.53.

The additional covariates added significantly to the explanation of students' performance and indicated that the groups of students differed in important ways prior to the intervention. Unfortunately, the small sample sizes severely weakened confidence in the conclusiveness of these analyses.

*Intercorrelations among performance measures.* Tables 7 and 8 present the intercorrelations among the five performance measures for fourth- and fifth-grade students. The magnitude of the correlation coefficients in Table 7 for the fourth graders indicated that the mathematics pretest and posttest correlated with each other, and that both mathematics tests were correlated with the Stanford Achievement Test. The science tests were correlated with each other, the pretest was correlated with the mathematics test and the Stanford Achievement Test, but the science posttest was not correlated significantly with either mathematics test or the Stanford Achievement Test.

**Table 7**

| INTERCORRELATIONS AMONG PERFORMANCE MEASURES: FOURTH GRADERS[a] | | | | |
|---|---|---|---|---|
| | **Stanford Achievement Test Sig. p** | **Math Pretest Sig. p** | **Math Posttest Sig. p** | **Science Pretest Sig. p** |
| Math Pre (15) | .65<br>≤.01 | 1.00 | | |
| Math Post (14) | .70<br>≤.01 | .63<br>≤.01 | 1.00 | |
| Science Pre (15) | .43<br>≤.10 | .59<br>≤.01 | .54<br>≤.05 | 1.00 |
| Science Post (14) | .28<br>ns | .32<br>ns | .26<br>ns | .73<br>≤.01 |
| [a] All correlations were analyzed as two-tailed tests. | | | | |

Table 8 gives the fifth-grade students' performance test intercorrelations. The mathematics tests were significantly correlated with each other and with the Stanford Achievement Test. The science tests were not correlated significantly with each other, nor were they correlated with the Stanford Achievement Test, but the two posttests -- mathematics and science -- were significantly correlated with one another.

**Table 8**

| INTERCORRELATIONS AMONG PERFORMANCE MEASURES: FIFTH GRADERS[a] | | | | |
|---|---|---|---|---|
| | **Stanford Achiev. Test Sig. p** | **Math Pretest Sig. p** | **Math Posttest Sig. p** | **Science Pretest Sig. p** |
| Math Pre (15) | .74<br>≤.01 | 1.00 | | |
| Math Post (14) | .71<br>≤.01 | .81<br>≤.01 | 1.00 | |
| Science Pre (18) | .08<br>(ns) | .15<br>ns | .29<br>ns | 1.00 |
| Science Post (12) | .16<br>ns | .32<br>ns | .44<br>≤.10 | -.07<br>ns |
| [a] All correlations were analyzed as two-tailed tests. | | | | |

*Participation correlated with performance.* Class attendance served as an index of the level of participation in the intervention and was correlated with postintervention performance. The correlations for all students, fourth and fifth graders, are given in Table 9. None of the correlations were significant; the implications of these results for the internal validity of the design will be discussed after presentation of the opinion results.

**Table 9**

| CORRELATIONS BETWEEN PERFORMANCE AND PARTICIPATION MEASURES | | | |
|---|---|---|---|
| | **4th + 5th Math Science Comp Classes (N)** | **4th Class Attendance (N)** | **5th Class Attendance (N)** |
| Math Post | .03 (19) | .00 (6) | .07 (13) |
| Science Post | .13 (20) | -.56 (6) | .07 (14) |
| Note: Class attendance was perfectly correlated with participation in the computer labs. | | | |

Opinion Results

Three sets of analyses tested the hypothesis that the intervention enhanced opinions about SET fields and careers: (a) between-group t-tests on postintervention opinion; (b) ANCOVAs on postintervention opinion adjusting for proxy pretest opinion score; and (c) correlations between level of participation in the intervention and postintervention performance.

*Between-group t-tests.* Table 10 presents the group differences for the fourth-grade students' proxy preintervention and postintervention opinion results. The control group had significantly higher opinion scores on 6 of the 7 proxy preintervention measures, and the control group had higher opinion scores on 10 of the 17 postintervention t-tests.

**Table 10**

| GROUP DIFFERENCES ON POSTTEST AND PROXY PRETEST OPINION CONSTRUCTS AND SCALES 4TH GRADE STUDENTS | | | | | | |
|---|---|---|---|---|---|---|
| **POSTTEST CONSTRUCT/Scale** | **CONTROL** | | **INTERVENTION** | | **t-Test** | **Sig. p** |
| | **Mean** | **SD** | **Mean** | **SD** | | |
| OPINION, Total | 1.83 | .09 | 1.70 | .14 | -2.12 | ≤.05 |
| SET GOAL | 1.88 | .10 | 1.73 | .12 | -2.62 | ≤.05 |
| Value | 1.97 | .09 | 1.92 | .13 | -0.90 | ns |

**GROUP DIFFERENCES ON POSTTEST AND PROXY PRETEST OPINION CONSTRUCTS AND SCALES 4TH GRADE STUDENTS**

| POSTTEST CONSTRUCT/Scale | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| Cultural Value | 1.91 | .13 | 1.79 | .19 | -1.35 | ≤.10 |
| Self-Concept | 1.88 | .12 | 1.67 | .15 | -2.93 | ≤.01 |
| Aspiration | 1.80 | .18 | 1.63 | .20 | -1.62 | ≤.10 |
| ATTITUDE | 1.81 | .14 | 1.67 | .17 | -1.58 | ≤.10 |
| Math/Science Attitude | 1.93 | .11 | 1.83 | .23 | -1.04 | ns |
| Locus of Control | 1.58 | .34 | 1.67 | .21 | 0.52 | ns |
| Persistence | 1.84 | .19 | 1.38 | .14 | -5.19 | ≤.01 |
| Study Habits | 1.88 | .13 | 1.67 | .38 | -1.46 | ≤.10 |
| Anxiety | 1.70 | .30 | 1.69 | .12 | -0.07 | ns |
| ENVIRONMENTAL SUPPORT | 1.81 | .09 | 1.71 | .18 | -1.44 | ≤.10 |
| Academic Support | 1.92 | .15 | 1.94 | .14 | 0.35 | ns |
| Career Awareness | 1.92 | .15 | 1.94 | .14 | 0.35 | ns |
| Role Model | 1.46 | .30 | 1.33 | .21 | -0.86 | ns |
| Equal Opportunity | 1.96 | .12 | 1.72 | .25 | -2.36 | ≤.05 |

| PROXY PRETEST CONSTRUCT/Scale | CONTROL | | INTERVENTION | | t - Test | Sig. p |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| Proxy OPINION | 1.92 | .08 | 1.58 | .17 | -4.93 | ≤.01 |
| Proxy SET GOAL | 1.90 | .12 | 1.47 | .22 | -4.57 | ≤.01 |
| Proxy Cultural Value | 1.91 | .11 | 1.52 | .22 | -4.45 | ≤.01 |
| Proxy Aspiration | 1.91 | .09 | 1.55 | .18 | -4.99 | ≤.01 |
| Proxy ATTITUDE | 1.96 | .12 | 1.83 | .18 | -1.56 | ns |

| GROUP DIFFERENCES ON POSTTEST AND PROXY PRETEST OPINION CONSTRUCTS AND SCALES 4TH GRADE STUDENTS | | | | | | |
|---|---|---|---|---|---|---|
| POSTTEST CONSTRUCT/Scale | CONTROL | | INTERVENTION | | t-Test | Sig. p |
| | Mean | SD | Mean | SD | | |
| Proxy Persistence | 1.98 | .12 | 1.51 | .10 | -6.23 | ≤.05 |
| Proxy Study habits | 1.88 | .12 | 1.51 | .10 | -6.23 | ≤.01 |
| All posttests were analyzed as one tailed tests.<br>Posttest n's: Control = 8; Intervention = 6 | | | | | | |

The preexisting advantages in opinion for the control group may have persisted throughout the intervention; this possibility was controlled for partially by ANCOVA techniques, the results of which are reported below.

Table 11 gives the results of the comparisons of the spring-summer with the summer-only fifth-grade students' opinion scores. The spring-summer group had advantages on 2 of the 7 proxy pre- intervention opinion measures and on 6 of the 17 postintervention opinion measures.

The preexisting advantages for the spring-summer group may have persisted throughout the intervention, and ANCOVAs were used to control for prior opinion via the proxy measures.

**Table 11**

| GROUP DIFFERENCES ON POSTTEST AND PROXY PRETEST OPINION CONSTRUCTS AND SCALES 5TH GRADE STUDENTS | | | | | | |
|---|---|---|---|---|---|---|
| CONSTRUCT/Scale | SUMMER-ONLY | | SPRING AND SUMMER | | t-Test | Sig. p |
| | Mean | SD | Mean | SD | | |
| OPINION, Total | 1.68 | .13 | 1.79 | .14 | 1.43 | ≤.10 |
| SET GOAL | 1.71 | .15 | 1.83 | .15 | 1.49 | ≤.10 |
| Value | 1.78 | .23 | 1.90 | .14 | 1.07 | ns |
| Cultural Value | 1.72 | .20 | 1.90 | .14 | 1.79 | ≤.05 |
| Self-Concept | 1.70 | .22 | 1.73 | .25 | 0.23 | ns |
| Aspiration | 1.64 | .26 | 1.84 | .09 | 1.60 | ≤.10 |
| ATTITUDE | 1.64 | .16 | 1.74 | .15 | 1.12 | ns |

**GROUP DIFFERENCES ON POSTTEST AND PROXY PRETEST OPINION CONSTRUCTS AND SCALES 5TH GRADE STUDENTS**

| CONSTRUCT/Scale | SUMMER-ONLY | | SPRING AND SUMMER | | t-Test | Sig. p |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | | |
| Math/Science Attitude | 1.76 | .23 | 1.89 | .16 | 1.08 | ns |
| Locus of Control | 1.74 | .28 | 1.64 | .33 | 0.45 | ns |
| Persistence | 1.50 | .31 | 1.55 | .11 | 0.35 | ns |
| Study Habits | 1.61 | .33 | 1.90 | .14 | 1.83 | ≤.05 |
| Anxiety | 1.57 | .33 | 1.63 | .22 | 0.35 | ns |
| Environmental Support | 1.71 | .13 | 1.80 | .15 | 1.14 | ns |
| Academic Support | 1.93 | .15 | 1.93 | .15 | 0.09 | ns |
| Career Awareness | 1.70 | .31 | 1.93 | .15 | 1.54 | ≤.10 |
| Role Model | 1.37 | .39 | 1.40 | .36 | 0.14 | ns |
| Equal Opportunity | 1.85 | .18 | 1.93 | .15 | 0.87 | ns |
| **PROXY PRETEST CONSTRUCT/Scale** | **SUMMER-ONLY** | | **SPRING AND SUMMER** | | **t - Test** | **Sig. p** |
| | **Mean** | **SD** | **Mean** | **SD** | | |
| Proxy OPINION | 1.62 | .21 | 1.76 | .09 | 1.39 | ns |
| Proxy SET GOAL | 1.52 | .28 | 1.63 | .14 | 0.84 | ns |
| Proxy Cultural Value | 1.59 | .24 | 1.69 | .12 | 0.84 | ns |
| Proxy ATTITUDE | 1.81 | .18 | 2.00 | .00 | 2.32 | ≤.10 |
| Proxy Persistence | 1.72 | .20 | 0.93 | .09 | 2.17 | ≤.05 |
| Proxy Study Habits | 1.61 | .20 | 1.70 | .08 | 0.93 | ns |

All posttests were analyzed as one tailed tests.
Posttest n's: Summer-only = 9; Spring-Summer = 5

*ANCOVAs adjusting for proxy preintervention opinion scores.* Table 12 reports the ANCOVAs for fourth-grade students' postintervention opinion measures, covarying proxy measures of preintervention opinion. The control- and intervention-group students differed on five measures, - four favored the intervention-group (Locus of Control, Anxiety, Environmental Support, and Academic Support); and one favored the control group (Persistence).

**Table 12**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTTEST OPINION MEASURES COVARYING PROXY PRETEST OPINION MEASURES: FOURTH GRADE STUDENTS**

| POSTTEST OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLES MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| SET GOAL | PROXY PRETEST | .51 | .51 | 12.24 | 1,12 | ≤.01 |
| | +GROUP | .51 | .00 | 0.08 | 1,11 | ns |
| | +PRE-x-GROUP | .51 | .00 | 0.08 | 1,10 | ns |
| Value | PROXY PRETEST | .14 | .14 | 1.94 | 1,12 | ns |
| | +GROUP | .15 | .01 | 0.11 | 1,11 | ns |
| | +PRE-x-GROUP | .15 | .00 | 0.04 | 1,10 | ns |
| Cultural Value | PROXY PRETEST | .27 | .27 | 4.48 | 1,12 | ≤.10 |
| | +GROUP | .28 | .01 | 0.09 | 1,11 | ns |
| | +PRE-x-GROUP | .47 | .20 | 3.74 | 1,10 | ≤.10 |
| Self-Concept | PROXY PRETEST | .35 | .35 | 6.40 | 1,12 | ≤.05 |
| | +GROUP | .43 | .08 | 1.55 | 1,11 | ns |
| | +PRE-x-GROUP | .43 | .00 | 0.01 | 1,10 | ns |
| Aspiration | PROXY PRETEST | .33 | .33 | 5.97 | 1,12 | ≤.05 |
| | +GROUP | .34 | .01 | 0.12 | 1,11 | ns |
| | +PRE-x-GROUP | .34 | .00 | 0.07 | 1,10 | ns |
| ATTITUDE | PROXY PRETEST | .09 | .09 | 1.13 | 1,12 | ns |
| | +GROUP | .19 | .10 | 1.42 | 1,11 | ns |
| | +PRE-x-GROUP | .31 | .12 | 1.70 | 1,10 | ns |
| Math/Science Attitude | PROXY PRETEST | .41 | .41 | 8.31 | 1,12 | ≤.05 |
| | +GROUP | .58 | .17 | 4.34 | 1,11 | ≤.05 |
| | +PRE-x-GROUP | .72 | .15 | 5.31 | 1,10 | ≤.05 |
| Locus of Control | PROXY PRETEST | .01 | .01 | 0.10 | 1,12 | ns |
| | +GROUP | .16 | .15 | 1.97 | 1,11 | ≤.10 |
| | +PRE-x-GROUP | .24 | .08 | 1.08 | 1,10 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTTEST OPINION MEASURES COVARYING PROXY PRETEST OPINION MEASURES: FOURTH GRADE STUDENTS**

| POSTTEST OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLES MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Persistence | PROXY PRETEST | .25 | .25 | 4.00 | 1,12 | ≤.10 |
| | +GROUP | .69 | .44 | 15.82 | 1,11 | ≤.01 |
| | +PRE-x-GROUP | .72 | .03 | 1.12 | 1,10 | ns |
| Study Habits | PROXY PRETEST | .21 | .21 | 3.25 | 1,12 | ≤.10 |
| | +GROUP | .21 | .00 | 0.01 | 1,11 | ns |
| | +PRE-x-GROUP | .57 | .35 | 8.11 | 1,10 | ≤.05 |
| Anxiety | PROXY PRETEST | .09 | .09 | 1.25 | 1,12 | ns |
| | +GROUP | .25 | .16 | 2.36 | 1,11 | ≤.10 |
| | +PRE-x-GROUP | .40 | .15 | 2.51 | 1,10 | ns |
| ENVIRONMENTAL SUPPORT | PROXY PRETEST | .45 | .45 | 10.00 | 1,12 | ≤.01 |
| | +GROUP | .54 | .09 | 2.03 | 1,11 | ≤.10 |
| | +PRE-x-GROUP | .58 | .04 | 0.85 | 1,10 | ns |
| Academic Support | PROXY PRETEST | .25 | .25 | 4.10 | 1,12 | ≤.10 |
| | +GROUP | .39 | .13 | 2.39 | 1,11 | ≤.10 |
| | +PRE-x-GROUP | .42 | .04 | 0.61 | 1,10 | ns |
| Career Awareness | PROXY PRETEST | .01 | .01 | 0.09 | 1,12 | ns |
| | +GROUP | .10 | .09 | 1.07 | 1,11 | ns |
| | +PRE-x-GROUP | .22 | .13 | 1.65 | 1,10 | ns |
| Role Model | PROXY PRETEST | .16 | .16 | 2.29 | 1,12 | ns |
| | +GROUP | .18 | .02 | 0.31 | 1,11 | ns |
| | +PRE-x-GROUP | .26 | .08 | 1.07 | 1,10 | ns |
| Equal Opportunity | PROXY PRETEST | .49 | .49 | 4.37 | 1,12 | ≤.01 |
| | +GROUP | .49 | .00 | 0.00 | 1,11 | ns |
| | +PRE-x-GROUP | .66 | .18 | 5.27 | 1,10 | ≤.05 |

All models were analyzed as two-tailed tests, except for GROUP, which was analyzed as a one-tailed test.

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $\underline{F}(sR^2)$ is the test of significance for that proportion of variance.

Also from Table 12, proxy preintervention score interacted with group membership for four measures; these four interactions are shown in Figures 8 through 11.

These figures appear peculiar because of the significant advantage of the control group on six of the seven proxy preintervention measures, (from Table 10). In the four figures, the range of scores for the two groups did not overlap.

So, although the slopes of the regression lines for the intervention and control groups were different, these regression lines were based on subjects whose proxy preintervention opinion scores fell at different points on the proxy scale. If the groups' proxy scores had overlapped, the nonparallel regression lines would have been interpretable.

**Figure 8**

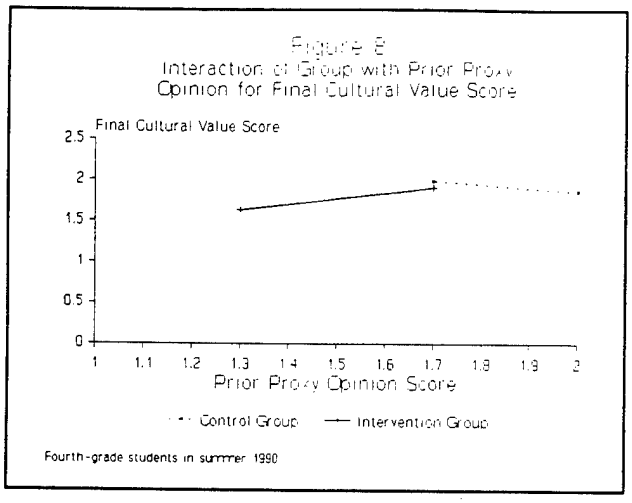



**Figure 9**

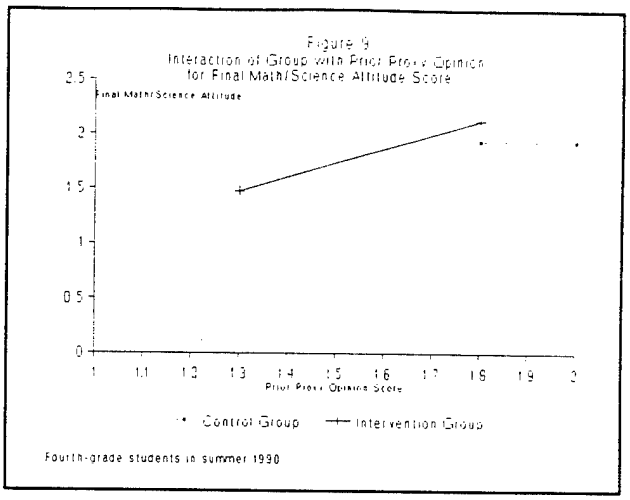



**Figure 10**

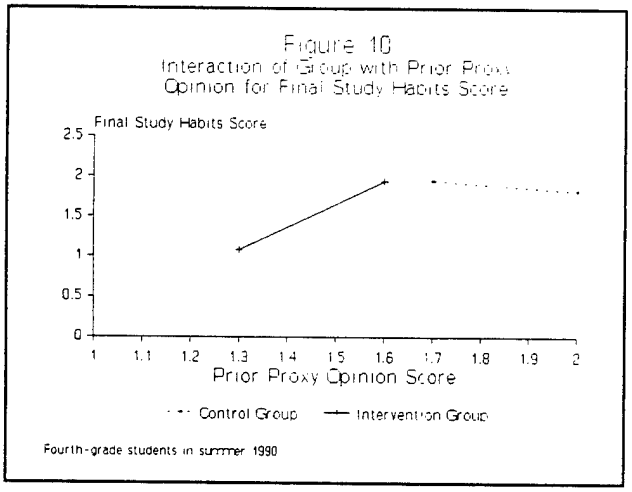



**Figure 11**

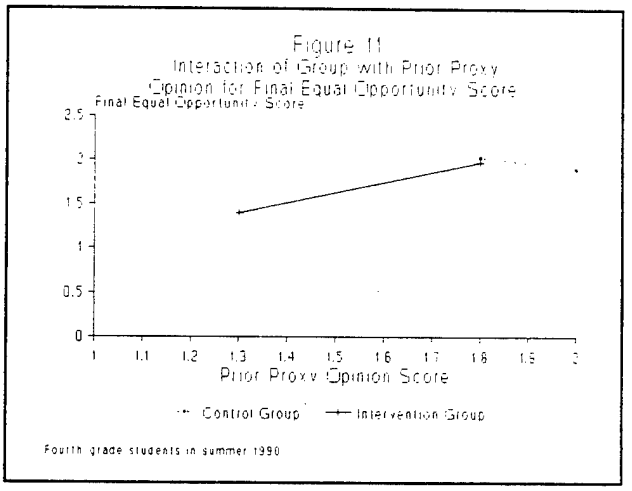



Table 13 gives the results of the ANCOVAs for fifth graders' postintervention opinion measures, adjusting for proxy measures of preintervention opinion. The spring-summer group had higher opinion scores on two measures (Cultural Value and Study Habits), and group membership interacted with proxy score on the Environmental Support measure.

Table 13

HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTTEST OPINION MEASURES COVARYING PROXY PRETEST OPINION MEASURES: FIFTH GRADE STUDENTS

| POSTTEST OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| SET GOAL | PROXY PRETEST | .16 | .16 | 2.34 | 1,12 | ns |
| | +GROUP | .26 | .09 | 1.40 | 1,11 | ns |
| | +PRE-x-GROUP | .34 | .08 | 1.28 | 1,10 | ns |
| Value | PROXY PRETEST | .11 | .11 | 1.53 | 1,12 | ns |
| | +GROUP | .15 | .03 | 0.43 | 1,11 | ns |
| | +PRE-x-GROUP | .21 | .07 | 0.86 | 1,10 | ns |
| Cultural Value | PROXY PRETEST | .25 | .25 | 4.06 | 1,12 | ≤.10 |
| | +GROUP | .38 | .12 | 2.16 | 1,11 | ≤.10 |
| | +PRE-x-GROUP | .38 | .00 | 0.00 | 1,10 | ns |
| Self-Concept | PROXY PRETEST | .18 | .18 | 2.55 | 1,12 | ns |
| | +GROUP | .18 | .01 | 0.12 | 1,11 | ns |
| | +PRE-x-GROUP | .28 | .10 | 1.36 | 1,10 | ns |
| Aspiration | PROXY PRETEST | .04 | .04 | 0.50 | 1,12 | ns |
| | +GROUP | .18 | .14 | 1.86 | 1,11 | ns |
| | +PRE-x-GROUP | .18 | .00 | 0.00 | 1,10 | ns |
| ATTITUDE | PROXY PRETEST | .05 | .05 | 0.61 | 1.12 | ns |
| | +GROUP | .10 | .05 | 0.60 | 1.11 | ns |
| | +PRE-x-GROUP | .24 | .00 | 0.00 | 1,10 | ns |
| Math/Science Attitude | PROXY PRETEST | .01 | .01 | 0.11 | 1,12 | ns |
| | +GROUP | .09 | .09 | 0.96 | 1,11 | ns |
| | +PRE-x-GROUP | .24 | .15 | 2.00 | 1,10 | ns |
| Locus of Control | PROXY PRETEST | .14 | .14 | 1.96 | 1,12 | ns |
| | +GROUP | .22 | .08 | 1.17 | 1,11 | ns |
| | +PRE-x-GROUP | .29 | .07 | 0.94 | 1,10 | ns |
| Persistence | PROXY PRETEST | .22 | .22 | 3.37 | 1,12 | ≤.10 |
| | +GROUP | .25 | .03 | 0.45 | 1,11 | ns |
| | +PRE-x-GROUP | .25 | .00 | 0.03 | 1,10 | ns |
| Study Habits | PROXY PRETEST | .22 | .22 | 3.39 | 1,12 | ≤.10 |
| | +GROUP | .35 | .13 | 2.16 | 1,11 | ≤.10 |
| | +PRE-x-GROUP | .35 | .00 | 0.00 | 1,10 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTTEST OPINION MEASURES COVARYING PROXY PRETEST OPINION MEASURES: FIFTH GRADE STUDENTS**

| POSTTEST OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Anxiety | PROXY PRETEST | .09 | .09 | 1.12 | 1,12 | ns |
| | +GROUP | .09 | .00 | 0.00 | 1,11 | ns |
| | +PRE-x-GROUP | .12 | .04 | 0.43 | 1,10 | ns |
| ENVIRONMENTAL SUPPORT | PROXY PRETEST | .33 | .33 | 5.82 | 1,12 | ≤.05 |
| | +GROUP | .34 | .01 | 0.19 | 1,11 | ns |
| | +PRE-x-GROUP | .52 | .18 | 3.77 | 1,10 | ≤.10 |
| Academic Support | PROXY PRETEST | .11 | .11 | 1.42 | 1,12 | ns |
| | +GROUP | .12 | .01 | 0.13 | 1,11 | ns |
| | +PRE-x-GROUP | .16 | .05 | 0.58 | 1,10 | ns |
| Career Awareness | PROXY PRETEST | .24 | .24 | 3.88 | 1,12 | ≤.10 |
| | +GROUP | .30 | .06 | 0.91 | 1,11 | ns |
| | +PRE-x-GROUP | .30 | .00 | 0.03 | 1,10 | ns |
| Role Model | PROXY PRETEST | .01 | .01 | 0.09 | 1,12 | ns |
| | +GROUP | .01 | .00 | 0.00 | 1,11 | ns |
| | +PRE-x-GROUP | .24 | .23 | 3.06 | 1,10 | ns |
| Equal Opportunity | PROXY PRETEST | .42 | .42 | 8.81 | 1,12 | ≤.05 |
| | +GROUP | .42 | .00 | 0.00 | 1,11 | ns |
| | +PRE-x-GROUP | .43 | .01 | 0.14 | 1,10 | ns |

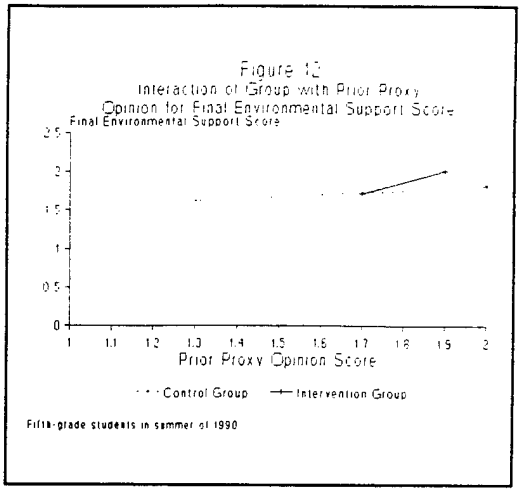
All models were analyzed as two-tailed tests, except for GROUP, which was analyzed as a one-tailed test.

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

*Three models of independent variables were tested for each dependent variable (posttest opinion measure): (1) PROXY PRETEST OPINION SCORE; (2) PROXY PRETEST OPINION SCORE and GROUP; (3) PROXY PRETEST OPINION SCORE and GROUP and PRE-by-GROUP INTERACTION.

Figure 12 graphs the interaction indicating that students with higher scores on the proxy measure of preintervention opinion did better in the spring-summer group. It is possible that this interaction was due to positive carry-over effects from the first (Spring) intervention.

Figure 12




*Participation correlated with opinion.* Table 14 gives the correlations between attendance at the intervention's classes and postintervention opinion scores for the combined group of fourth and fifth graders and separately for the two groups. For the combined group, a higher level of participation was associated with more favorable opinion on only 1 of 17 scales: The students who attended more classes had less anxiety about math/science courses. The correlations between participation and opinions for the 6 fourth graders were unusual; 14 of the 17 opinion measures were correlated negatively with participation, and 2 of the 14 were significantly correlated -- Value and Cultural Value. (At the $p$ = .10 level, approximately 2 of 17 comparisons should be significant by chance.)

For fifth-grade students, level of participation in the intervention was correlated positively with postintervention opinion scores on 6 of 17 measures: Total Opinion, Attitude construct, Study Habits, Anxiety, Environmental Support construct, and Academic Support. These positive correlations suggest that better attendance by fifth-grade students resulted in more positive opinions about SET fields and careers, but the same results can be interpreted also as the students with more positive attitudes having had better attendance. Without a pretest of opinion measured before the intervention activities, this question cannot be resolved.

The pattern of correlations between participation and postintervention performance were not similar for fourth- and fifth-grade students. Again, the fourth-grade students' opinion results seemed peculiar.

**Table 14**

| CORRELATION BETWEEN OPINION MEASURES AND PARTICIPATION[a] | | | |
|---|---|---|---|
| **CONSTRUCT / Scale** | **M/S/Comp. Classes Attendance** | **4th Graders Class Attend. & Post-Op** | **5th Graders Class Attend. & Post-Op** |
| OPINION, Total | .19 | -.50 | .51<br>≤.05 |
| SET GOAL | .11 | -.59 | .35 |
| Value | .09 | -.71<br>≤.10 | .25 |
| Cultural Value | -.01 | -.73 | .28 |
| Self Concept | .18 | .00 | .27 |
| Aspiration | -.01 | -.56 | .22 |

CORRELATION BETWEEN OPINION MEASURES AND PARTICIPATION[a]

| CONSTRUCT / Scale | M/S/Comp. Classes Attendance | 4th Graders Class Attend. & Post-Op | 5th Graders Class Attend. & Post-Op |
|---|---|---|---|
| ATTITUDE | .23 | -.48 | .57<br>≤.05 |
| Math/Science Attitude | -.02 | -.57 | .20 |
| Locus of Control | -.16 | .00 | -.19 |
| Persistence | .13 | -.33 | .34 |
| Study Habits | .11 | -.49 | .44<br>≤.10 |
| Anxiety | .52<br>≤.01 | -.24 | .67<br>≤.01 |
| Environmental Support | .13 | -.25 | .38<br>≤.10 |
| Academic Support | .11 | -.22 | .48<br>≤.05 |
| Career Awareness | .07 | -.45 | .10 |
| Role Model | .14 | .00 | .20 |
| Equal Oportunity | .00 | -.24 | .28 |

[a] All one-tailed tests.

M/S/Comp. = Math/Science/Computer Science

NOTE: Each r, the Pearson correlation coefficient, was computed on 6 cases for fourth graders and 14 cases for fifth graders.

Summary of Performance and Opinion Results

Table 15 summarizes the performance and opinion results as effect sizes from the between-group t-tests of postintervention measures and from the ANCOVAs covarying preintervention scores. For the fourth-grade students' performance results (based on the ANCOVA findings), there was a small positive effect on mathematics test scores and a moderate negative effect on science test scores. For fifth-grade students' performance, the extra Spring semester seems to have had no positive effect on for mathematics test scores and only a slight positive effect on science test scores.

Table 15

| INTERVENTION EFFECT SIZES | | | |
|---|---|---|---|
| **VARIABLE** | **POSTTEST** | **ADJUSTED POSTTEST** | **GROUP-BY-PRETEST INTERACTION** |
| **PERFORMANCE** *Fourth Grade* | | | |
| Mathematics Test | .81<br>≤.10 | .41 | .31 |
| Science Test | -.58 | -.94 | .65 |
| *Fifth Grade* | | | |
| Mathematics Test | .01 | .10 | .44 |
| Science Test | .45 | .48 | .26 |
| **OPINION** *Fourth Grade* | | | |
| **Total Opinion** | **-1.14**<br>**≤.05** | **na** | **na** |
| SET GOAL | -1.41<br>≤.05 | .15 | .15 |
| Attitude | -.85 | .64 | .70 |
| Environmental Support | -.78<br>≤.10 | .77<br>≤.10 | .50 |
| *Fifth Grade* | | | |
| **Total Opinion** | **.80**<br>**≤.10** | **na** | **na** |
| SET Goal | .83<br>≤.10 | .66 | .63 |
| Attitude | .62 | .43 | .00 |
| Environmental Support | .64 | .24 | -1.08 |

All probabilities were one-tailed, except for the interactions which were tested against two-tailed probabilities.
**NOTE:** The measure of effect size for the posttest was calculated as: (intervention mean - control mean)/pooled standard deviation. In the "Adjusted Posttest" and "Interaction" columns, the effect size was calculated from the F statistics. A positive sign on a significant effect size in the "Posttest" or "Adjusted Posttest" columns indicates that the intervention group outperformed the control group; a negative sign indicates that the control group had the higher score. For a significant interaction effect size, a positive sign indicates that the intervention helped students scoring lower on the pretest more than it helped the higher scoring students; a negative sign on a significant interaction effect size indicates that the intervention helped students scoring higher on the pretest more than it helped lower scoring students.

The opinion findings (the ANCOVA results) were consistent from the fourth- and fifth-grade samples. The effect sizes of Table 15 indicated that the intervention had small-to-moderate effects on the opinion constructs for the fourth-grade students (comparing an intervention and control group) and for the fifth-grade students (comparing a two-semester and a one-semester intervention).

The small samples of this intervention weakened the probability of meeting the criterion of statistical significance with the test statistics of this analysis. For example, the probabilities of finding a significant difference (small-to-moderate effect) between the groups on the mathematics or science posttests after adjusting for preintervention performance were less than or equal to 25 percent (based on the tables in Gatsonis & Sampson, 1989). This means that there was only a 25 percent chance that each statistical test would detect a genuine, small-to-moderate effect of the intervention on performance or opinion. Expressed differently, the probability was 75 percent or higher in favor of the conclusion that if the intervention did produce a small-to-moderate effect on performance, the samples were too small to detect such an effect. Larger samples of fourth- and fifth-grade students would have provided a more powerful statistical test of the hypotheses; for example, a sample of at least 70 to 150 would have provided the often-recommended power of .80 for detecting a small-to-moderate effect.

## DISCUSSION

The hypotheses evaluated in this report were that the intervention would have two major benefits: it would improve mathematics and science performance, and it would enhance students' opinions about SET fields and careers.

The ANCOVAs for opinion measures of the Spring semester intervention found 2 of 17 main effects of participation were significant and 2 of 17 interactions between participation and preintervention opinion were significant. One of the two main effects found that more positive opinions were associated with greater participation (Self-Concept), but the other effect found that higher Role Model scores were associated with lower participation levels. In addition, for two measures--Value and Cultural Value--level of participation interacted with preintervention opinion; unfortunately, greater participation was not associated with more positive opinions. Because the findings were obtained from a weak design and a small sample, and because the number of significant differences was not greater than the number expected by chance, the results from the Spring semester were not considered important. It was expected that the results of the better designed Summer intervention would provide better tests of the hypotheses of enhanced performance and opinion.

The hypothesis about improved performance was evaluated separately for fourth- and fifth-grade students. The intervention seemed to have had a moderate, positive effect on the mathematics performance of fourth-grade intervention-group students compared to the control-group students, but the intervention had a large, negative effect on the science performance of the fourth-grade students. For the fifth-grade spring-summer students compared to the summer-only students, the intervention seems to have had no effect on mathematics performance, but a moderate, positive effect on science performance. The fourth-grade students' performance results were unexpected, and speculative explanations about these results are explored below.

The tests of the hypothesis about enhanced opinions as a result of the intervention produced findings that were consistent for the fourth- and fifth-grade students: The intervention seems to have produced small-to-moderate positive effects (Table 15) on opinion measures for both fourth-grade students (relative to a control group) and fifth-grade students (a two-semester group relative to a one-semester group). Unfortunately, the sample sizes were small, and most of the tests were not statistically significant.

The three designs (Spring's one-group pretest-posttest, Summer's fourth-grade intervention-control, and Summer's fifth-grade two-semester versus one-semester) each had weaknesses that on an individual basis would have made it difficult to interpret the findings. Before completing the analyses, it seemed that sufficient data existed to test the hypotheses adequately. For example, the weaknesses of the design of the Spring intervention were compensated for by the design

of the Summer; and the weaknesses of the design featuring the fifth graders were compensated for by the design featuring the fourth graders. Unfortunately, these analyses revealed several problems that made this initial assessment seem overly optimistic.

The strongest design seemed to be the fourth-grade students composed of control and intervention groups. Unfortunately, the demographic analysis revealed that students in the two groups presented quite different profiles prior to the intervention. The control group seemed to have had some important advantages on the demographic measures: Their parents had more education, and the students had participated in more mathematics and science activities prior to the intervention. In addition, the control-group students had large advantages on the proxy measures of preintervention opinion; the advantages were so great that the intervention- and control-group students' ranges of scores did not overlap! In other words, the score of the highest scoring intervention-group students was lower than that of the lowest scoring control-group student. One peculiarity of the fourth-grade results was the intervention-group students' significant decline on the science test from pretest to posttest; the control group did not change significantly. When the demographic differences were controlled for by adjusting for pretest and prior math/science activities, the intervention appeared to have succeeded in improving the mathematics performance of students who had begun as above average in mathematics. The correlations between level of participation and final performance and opinion produced other, peculiar results: The correlations were negative or zero, and most would have been significant with a slightly larger sample. It is unusual that higher levels of participation in the intervention were associated with lower levels of performance and lower opinions about SET fields and careers. These results raised questions about how students were recruited into the two groups.

The fifth-grade students' results were more problematic because there was no baseline of performance and opinion changes for an untreated group. It was hoped that the fourth-grade students' results would strengthen the findings from the fifth-grade students; unfortunately, the peculiarities of the fourth-grade students' results eliminated that possibility.

Because of the preexisting differences between groups, statistical adjustments were planned to reduce these prior differences. Unfortunately, the small samples reduced the potential value of such adjustments. Due to the small samples, the statistical tests of the hypotheses had little power to detect the small-to-moderate effects that the intervention may have produced on the opinion measures. The performance results were inconsistent, which may have reflected preexisting differences between groups as much as it reflected the effects of the intervention. In conclusion, deficiencies in the two semesters' designs and the small and different samples obscured the evaluations of the intervention's effects. Only a replication with larger samples and more comparable groups would provide an adequate test of the hypotheses about the intervention's effects.

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Population figures, geographical data, and other background information reported in the CASET Consortium reports were drawn from the following sources:

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# APPENDICES

# APPENDIX A

# MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

Participant Number: _____

## MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

Thank you for agreeing to participate in this important project. It is geared to help us develop new programs for students and improve existing programs.

Your opinions and experience are important to us. Please read each question carefully and answer completely and accurately to the best of your ability. All of your answers will be kept in confidence. Your answers will be grouped with those of other students in other places, and together they will help us better understand students' needs and preferences today.

Please ask your administrator if any of these questions are unclear to you.

Thanks for your help!

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ___ _____ _____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. American Indian (Please specify the tribe which best describes your heritage.)

   _____
   ___ e. Hispanic (Which of the following best describes your heritage?)
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

   City: _____ State: _____

6. Class:
   ___ a. 4th grade
   ___ b. 5th grade
   ___ c. 6th grade
   ___ d. 7th grade
   ___ e. 8th grade

7. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Less than high school graduation
   ___ b. High school graduation
   ___ c. Two-year college degree (community college or junior college)
   ___ d. Four-year college degree
   ___ e. Education beyond four years of college
   ___ f. Other Specify _____

8. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

9. What is or are the occupation(s) of the person(s) with whom you live? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")
   _____ _____

10. Would you say that your family's income is:
   ___ a. Below the U.S. average
   ___ b. About average
   ___ c. Above average
   ___ d. Don't know

11. Are you:
   ___ a. An only child (skip to question 13)
   ___ b. The oldest child
   ___ c. The youngest child
   ___ d. An in-between child

12. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

13. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

14. What was the highest level of school your mother completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

15. What is the language spoken most often by adults in your household? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe (What is that language?) _____
___ d. Another language - Specify _____

16. Which of the following did your parent(s) or guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Help you with your homework

17. Which of the following comes closest to describing how much your parent(s) or guardian(s) read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

18. Which of the following comes closest to describing how much you read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

19. Which of these items do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

20. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL ITEMS WITH

# DIRECTIONALITY AND SCALES

## Opinion Protocol Items with Directionality and Scales

Legend:

| | |
|---|---|
| **SH Study Habits** | **PS Persistence** |
| **AT Attitude toward math/science** | **CV Cultural Value** |
| **SC Self-Concept** | **AS Academic Support** |
| **AX Anxiety** | **AP Aspiration** |
| **VL Value** | **EO Equal Opportunity** |
| **LC Locus of Control** | **RM Role Model** |
| **CA Career Awareness** | |

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | Do you study each day rather than just before exams? |
| 2. | + | AT | Are scientists smarter than most people? |
| 3. | + | SC | Can you imagine yourself as a scientist? |
| 4. | - | AX | Do word problems in mathematics make you nervous? |
| 5. | + | VL | Do you think mathematics is needed in most jobs? |
| 6. | + | VL | Is science important to our country? |
| 7. | + | LC | When you make plans, can you usually make them work? |
| 8. | + | CA | Do girls have a good chance of becoming scientists when they grow up? |
| 9. | + | PS | Do you usually finish the things you start? |
| 10. | + | CV | Is it important to you that your people be proud of you? |

| | | | |
|---|---|---|---|
| 11. | - | SH | Do you prefer to study alone? |
| 12. | - | AT | Do scientists do boring work? |
| 13. | + | AS | If you have problems at school, is there someone who will help you? |
| 14. | - | AX | Do tests make you nervous? |
| 15. | + | SH | Do you get your homework done on time? |
| 16. | - | SC | Are science experiments hard for you to understand? |
| 17. | + | AP | Do you want to take any more mathematics courses? |
| 18. | + | CV | Are your friends good at mathematics? |
| 19. | - | EO | Does a person's color make a difference in whether or not they get to be a scientist? |
| 20. | - | PS | Do you get bored with your school work by the middle of the school year? |
| 21. | - | PS | Do you have trouble keeping your mind on your homework? |
| 22. | + | EO | Do people care if a good scientist is a man or a woman? |
| 23. | + | AP | Are you thinking of becoming a scientist? |
| 24. | - | AT | Is mathematics boring? |
| 25. | + | RM | Are many people of your ethnic/racial group successful scientists? |
| 26. | + | AP | Do you try to get good grades in science? |
| 27. | - | LC | Is success mostly a matter of luck? |
| 28. | + | AT | Do most scientists enjoy their work? |

| | | | |
|---|---|---|---|
| 29. | + | AT | Do you enjoy solving mathematics problems? |
| 30. | + | VL | Does mathematics come in handy outside of class? |
| 31. | - | AX | Do you feel scared when you have to work a mathematics problem? |
| 32. | + | CA | Can you really become a scientist if you want to? |
| 33. | + | CA | Do you think there are a lot of jobs for scientists? |
| 34. | - | AX | Do tests scare you even when you have studied for them? |
| 35. | + | SC | Do you think you are a good science student? |
| 36. | + | SH | Do you like to read about science? |
| 37. | + | RM | Have you ever met a scientist? |
| 38. | + | VL | Is science an important subject? |
| 39. | + | SC | Are you good at figuring out mathematics problems? |
| 40. | + | AP | Do you want to improve your mathematics skills? |
| 41. | + | AS | Do the teachers in your school care how well you do in school? |
| 42. | + | CV | Do your people think highly of scientists? |
| 43. | - | AP | Would you like to spend less time on science in school? |
| 44. | - | AS | Do your teachers think you don't do very well? |
| 45. | + | CV | Does your family care a lot about education? |
| 46. | - | AT | Are scientists unfriendly? |

| | | | |
|---|---|---|---|
| 47. | - | AX | Do you worry about being able to understand your science assignments? |
| 48. | + | RM | Is there a scientist you look up to? |
| 49. | - | EO | Are boys better in science than girls? |
| 50. | + | LC | Can you control whether or not you have a good day? |
| 51. | - | SC | Is science too hard for you? |
| 52. | - | PS | Do you often quit when things get tough? |
| 53. | - | AX | Do you get scared when you are called on to answer a question in mathematics? |
| 54. | + | AT | Is science interesting? |
| 55. | + | SC | Are you very good at mathematics? |

56. What do you want to be when you grow up?

a. _____

b. _____

c. _____

57. Please describe the work you feel scientists do in a typical work day. If you don't know, just use your imagination.

# APPENDIX C

# SCALES AND CONSTRUCTS OF

# THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF

# THE MIDDLE/JUNIOR HIGH STUDENT PROTOCOL

# FOURTH GRADERS

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 8 | CONTROL n = 9 |
| 1. Sex | | |
| Women | 62% | 56% |
| Men | 38% | 44% |
| 2. Age | 8.94 | 9.18 |
| 6. Class | 100% | 100% |
| .Fourth grade | | |
| 7. Higher education expected: | | |
| .Less than high school | 0% | 0% |
| .High school graduation | 0% | 0% |
| .Two-year college | 25% | 11% |
| .Four-year college | 38% | 44% |
| .One or more years after college | 25% | 33% |
| .Missing | 12% | 11% |
| 8. Studies most influenced by | | |
| .Parents | 100% | 89% |
| .Another family member | 0% | 0% |
| .Teacher | 0% | 11% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 0% |
| .Friend | 0% | 0% |
| .Science professional | 0% | 0% |
| .Nonscience professional | 0% | 0% |
| .No one at all | 0% | 0% |
| 9. Sources of outside income | | |
| .None | 12% | 0% |
| .One | 12% | 33% |
| .Two | 75% | 67% |
| 10. Family income: | | |
| .Below U.S. average | 0% | 11% |
| .About average | 12% | 22% |
| .Above average | 0% | 0% |
| .Unknown | 88% | 67% |
| 11. Birth order of student: | | |
| .Only child | 0% | 22% |
| .Oldest child | 50% | 22% |
| .Youngest child | 38% | 56% |
| .In-between child | 12% | 0% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 8 | CONTROL n = 9 |
| 12. Number of siblings: | | |
| .None | 0% | 22% |
| .One | 38% | 44% |
| .Two | 25% | 22% |
| .Three or more | 38% | 11% |
| 13. Father's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 0% | 0% |
| .High school graduate | 12% | 0% |
| .Some college | 0% | 1% |
| .College degree or more | 12% | 78%[a] |
| .Missing $p \leq .05$ | 75% | 11% |
| chi-square(3, N=17) = 10.05 | | |
| 14. Mother's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 0% | 0% |
| .High school graduate | 25% | 0% |
| .Some college | 0% | 33% |
| .College degree or more | 25% | 44% |
| .Missing $p \leq .10$ | 50% | 22%[a] |
| chi-square(3, N=17) = 6.30 | | |
| 15. Language spoken most at home: | | |
| .English | 100% | 78% |
| .Spanish | 0% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| .Missing | 0% | 22% |
| 16. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 75% | 78% |
| .Attend parent-teacher conferences | 50% | 33% |
| .Visit student's class | 50% | 67% |
| .Phone/visit if there's a problem | 38% | 56% |
| .Do volunteer work | 50% | 78% |
| .Assist in student's homework | 100% | 89% |
| Number of parental involvements * | 3.62 | 4.00 |
| 17. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 50% | 11% |
| .A lot | 50% | 89% |
| .Missing | 0% | 0% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 8 | CONTROL n = 9 |
| 18. Student reads: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 50% | 33% |
| .A lot | 50% | 67% |
| 19. Items in student's home:[b] | | |
| .Desk | 50% | 78% |
| .Daily newspaper | 88% | 78% |
| .Encyclopedia | 75% | 100% |
| .Typewriter | 62% | 56% |
| .Calculator | 100% | 89% |
| .Television | 100% | 100% |
| .Computer | 38% | 22% |
| .Video Cassette Recorder (VCR) | 100% | 89% |
| Number of support items * | 6.12 | 6.11 |
| 20. All activities student took part in:[b] | | |
| .Math/science club | 38% | 33% |
| .Field trip | 75% | 89% |
| .Watching science programs on TV | 38% | 100%[a] |
| .Listen to talk by scientist | 12% | 100%[a] |
| .Science/math fair | 25% | 67% |
| .Other science/math competition | 25% | 0% |
| .Play/work in computer lab | 75% | 100% |
| Number of activities * | 2.88 | 4.89[a] |
| t(15) = 2.94, p≤.01 | | |

[a] Significant at p ≤ .10
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# APPENDIX E

# PERCENT RESPONSE ON ITEMS OF THE MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

# FIFTH GRADERS

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | SPRING-SUMMER n = 9 | SUMMER-ONLY n = 11 |
| 1. Sex | | |
| Women | 44% | 64% |
| Men | 56% | 36% |
| 2. Age | 10.52 | 10.41 |
| 6. Class | | |
| .Fifth grade | 100% | 100% |
| 7. Higher education expected: | | |
| .Less than high school | 0% | 0% |
| .High school graduation | 0% | 18% |
| .Two-year college | 22% | 18% |
| .Four-year college | 44% | 27% |
| .One or more years after college | 22% | 36% |
| .Missing | 11% | 0% |
| 8. Studies most influenced by | | |
| .Parents | 67% | 91% |
| .Another family member | 11% | 0% |
| .Teacher | 11% | 9% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 0% |
| .Friend | 0% | 0% |
| .Science professional | 0% | 0% |
| .Nonscience professional | 0% | 0% |
| .No one at all | 0% | 0% |
| .Missing | 11% | 0% |
| 9. Sources of outside income | | |
| .None | 0% | 18% |
| .One | 56% | 46% |
| .Two | 11% | 27% |
| .Missing | 33% | 9% |
| 10. Family income: | | |
| .Below U.S. average | 0% | 0% |
| .About average | 11% | 9% |
| .Above average | 11% | 9% |
| .Unknown | 78% | 81% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | SPRING-SUMMER n = 9 | SUMMER-ONLY n = 11 |
| 11. Birth order of student: | | |
| .Only child | 0% | 0% |
| .Oldest child | 44% | 27% |
| .Youngest child | 33% | 54% |
| .In-between child | 22% | 18% |
| 12. Number of siblings | | |
| .Only child | 0% | 0% |
| .Oldest child | 44% | 36% |
| .Youngest child | 44% | 18% |
| .In-between child | 11% | 46% |
| 13. Father's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 0% | 0% |
| .High school graduate | 0% | 18% |
| .Some college | 0% | 9% |
| .College degree or more | 11% | 9% |
| .Missing | 89% | 54% |
| 14. Mother's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 0% | 9% |
| .High school graduate | 0% | 0% |
| .Some college | 11% | 9% |
| .College degree or more | 33% | 18% |
| .Missing | 56% | 64% |
| 15. Language spoken most at home: | | |
| .English | 89% | 100% |
| .Spanish | 0% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| .Missing | 11% | 0% |
| 16. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 56% | 27% |
| .Attend parent-teacher conferences | 22% | 27% |
| .Visit student's class | 22% | 54% |
| .Phone/visit if there's a problem | 33% | 46% |
| .Do volunteer work | 33% | 27% |
| .Assist in student's homework | 56% | 82% |
| Number of parental involvements * | 2.22 | 2.64 |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | SPRING-SUMMER n = 9 | SUMMER-ONLY n = 11 |
| 17. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 44% | 64% |
| .A lot | 56% | 46% |
| 18. Student reads: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 67% | 73% |
| .A lot | 33% | 27% |
| 19. Items in student's home:[b] | | |
| .Desk | 44% | 27% |
| .Daily newspaper | 78% | 46% |
| .Encyclopedia | 89% | 54% |
| .Typewriter | 78% | 36% |
| .Calculator | 78% | 73% |
| .Television | 100% | 82% |
| .Computer | 67% | 18% |
| .Video Cassette Recorder (VCR) | 100% | 64% |
| Number of support items * | 6.33 | 4.00[a] |
| $t(18) = 3.00$, $p \leq .01$ | | |
| 20. All activities student took part in:[b] | | |
| .Math/science club | 11% | 18% |
| .Field trip | 78% | 82% |
| .Watching science programs on TV | 67% | 46% |
| .Listen to talk by scientist | 33% | 27% |
| .Science/math fair | 44% | 9% |
| .Other science/math competition | 44% | 18% |
| .Play/work in computer lab | 100% | 54% |
| Number of activities * | 3.78 | 2.55[a] |
| $t(18) = 2.11$, $p \leq .05$ | | |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# HUSTON-TILLOTSON COLLEGE

# INTERVENTIONS

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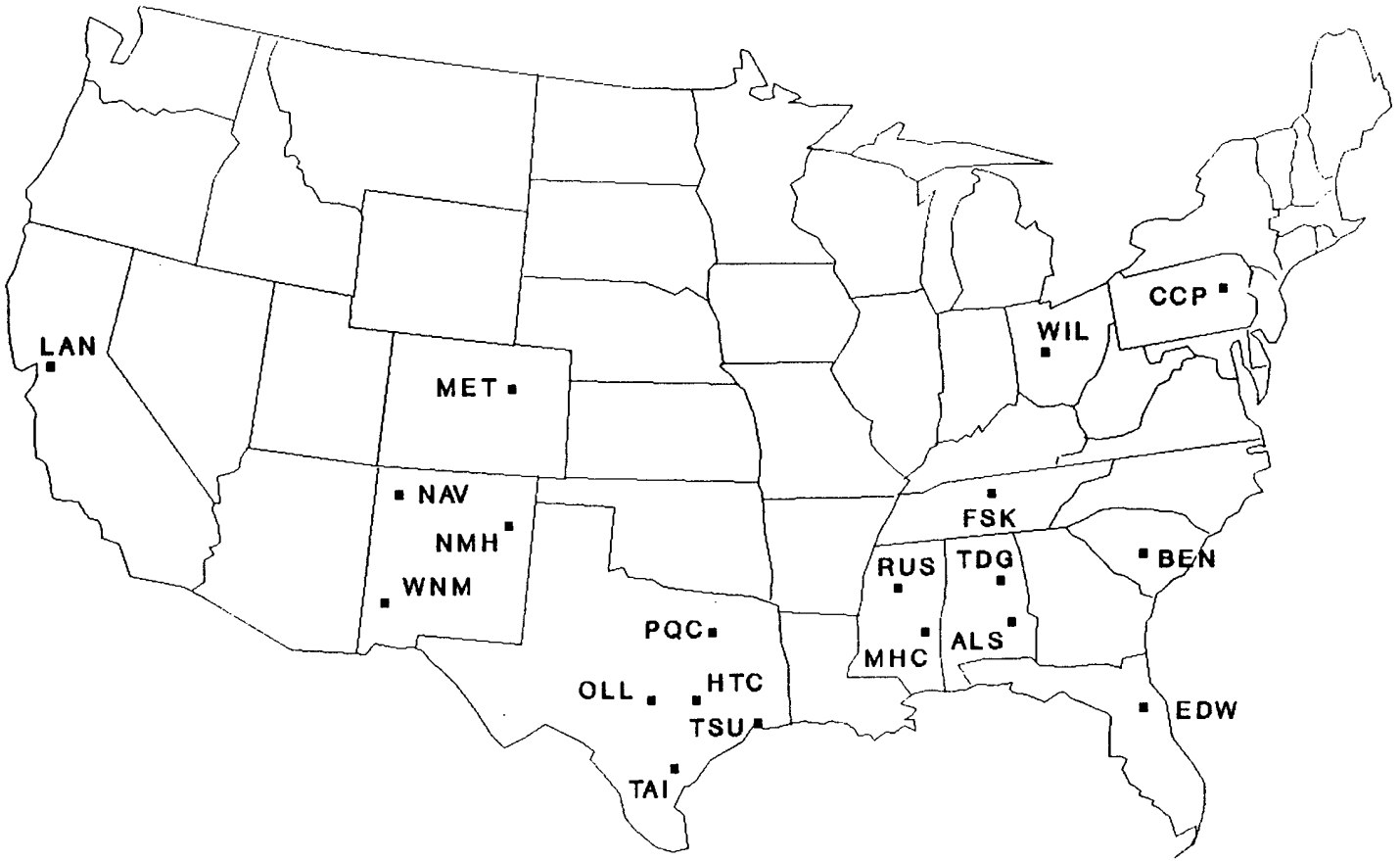
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected come from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention-group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his or her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research will be described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF HUSTON-TILLOTSON COLLEGE

Huston-Tillotson College is a historically Black, four-year, private, coeducational institution located in Austin, Texas. The College serves approximately 539 students and employs 51 faculty members. The College, organized into the Division of Education, Division of Humanities, Division of Natural Sciences, and Division of Social Sciences, offers undergraduate degrees. The student body is approximately 55 percent female and 45 percent male. Approximately 2 percent of the students are Anglos (non-Hispanic Whites), 68 percent are Black, 2 percent are Hispanic, and 28 percent are international students representing 24 countries.

The president of Huston-Tillotson College is Dr. Joseph T. McMillan, Jr. The Chancellor and President Emeritus is Dr. John Q. Taylor King, who is also Director and Chair of The Center for the Advancement of Science, Engineering, and Technology (CASET).

Degrees offered by Huston-Tillotson College in quantitative subjects include Bachelor of Arts and Bachelor of Science degrees in chemistry, computer science, and mathematics.

Austin has a population of approximately 465,000 in its metropolitan area. The state of Texas has a population of just over 17 million. According to U.S. Census Bureau estimates, the adult population of Texas is 66 percent Anglo, 11 percent Black, 21 percent Hispanic, and 2 percent other ethnic origins. Austin has a number of other institutions of higher education, including Austin Community College, St. Edward's University, and the University of Texas.

# PART II

# SUMMARY OF THE

# HUSTON-TILLOTSON COLLEGE (HTC)

# INTERVENTIONS

This report summarizes two interventions conducted by Huston-Tillotson College, a historically Black, four-year, private institution located in Austin, Texas. Huston-Tillotson College is a member of a consortium formed by The Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Huston-Tillotson Intervention Activities:

For 10 weeks in the fall of 1990 and 12 weeks in the spring of 1991, Huston-Tillotson College conducted a Science, Engineering, and Technology Academy designed to provide cognitive and affective experiences for lower division students in an effort to reduce students' anxiety toward mathematics and science. The Academy, held on Tuesday evenings, provided self-improvement activities, seminars, tutoring sessions, computer applications, and field trips to local scientific facilities. The spring intervention also included student presentations of original reports on mathematical topics; students received training in presentation and public speaking for this activity. Participants were students attending Huston-Tillotson College who were enrolled in entry-level mathematics courses.

Findings:

- Mathematics performance improved in both semesters for those students who participated in the intervention group; students moved from a failing to a mid-range level of performance.
- Based on results of an opinion protocol given to intervention- and control-group students in the spring semester, the intervention was associated with enhanced opinions.
- Tutoring was an effective component of this intervention, especially in the fall semester; the project director reported that the motivational and character-building exercises were also effective.
- The attendance rate for the Academy was high in both semesters; this fact is especially impressive considering the sessions were held on Tuesday evenings, in addition to students' other academic and work commitments.

Recommendations:

- Offering a program that provides enrichment, self-improvement activities, and professionalism development to beginning mathematics students could provide the encouragement they need to continue their SET studies and ultimately begin SET careers.
- Based on the level of performance improvement demonstrated in this intervention, it is recommended that students attend two semesters of the Academy rather than one to more effectively improve performance.

# PART III

# CASE STUDY OF THE HTC

# 1991 SPRING SEMESTER INTERVENTION

## ABSTRACT

In 1991 Huston-Tillotson College, Austin, Texas, conducted and tested against a control group a twelve-week enrichment intervention program designed to provide cognitive and affective experiences for its lower division students. Participants in the spring intervention were 34 Black and 2 Hispanic college students (21 women and 15 men) enrolled in entry-level mathematics courses. The intervention was initially conducted in the fall of 1990.

The Huston-Tillotson College program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance as measured by an institution-specific mathematics test, and (b) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* The primary components of the intervention were problem-solving and tutoring sessions, augmented by speakers addressing such topics as goal setting, stress management, test taking skills, critical thinking, and financial aid; these sessions were held on Tuesday evenings. A key activity was the presentation by student groups of original reports on mathematical topics; students were taught elements of presentation and public speaking for this activity. Additional activities were field trips to IBM and Texas Instruments and a brown bag luncheon and awards banquet.

*DATA:* All the participants furnished demographic data through the CASET College Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were college GPAs and pretest and posttest scores on a content test of mathematics.

The outcome measure of performance was the posttest score on a content test of mathematics. The preintervention measure of performance was the pretest score on the same content test of mathematics.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design; analyses of preintervention measures indicated that the intervention group had a number of demographic and opinion advantages over the control group.

*FINDINGS:* The intervention had some positive effect on the participants and can be considered a success based on slight support of the stated hypotheses of enhanced mathematics performance and opinions about SET fields. The difference in mathematics performance between the two groups fell short of statistical significance. The effects on opinion were selective: There were beneficial effects on opinions for students entering the intervention with lower SET Goal and Value scores and for students entering with higher Career Awareness scores. Additional analyses suggested that tutoring may have been the most effective intervention component.

## DESCRIPTION OF THE INTERVENTION

Huston-Tillotson College developed a Science, Engineering and Technology Academy to offer lower-division college students enrolled in entry-level mathematics (General Mathematics) challenging cognitive and affective enrichment experiences to:

1. Enhance awareness, understanding, levels of motivation, and preparation for careers in science, engineering, and technology.

2. Assist students with making effective academic decisions that will positively affect their scientific or technologic achievement, persistence levels, and retention in college.

Intervention-group students met on Tuesday evenings from 6:00 p.m. to 9:00 p.m. for sessions which included motivation- and character-building work as well as logic and problem-solving exercises, along with tutoring sessions. Participating students had been divided into four groups; and a key activity was the development and presentation of a report on a mathematical topic. Each student made some part of their group's presentation, which included computer-generated visual aids. Before the presentation of the reports, the students had a special session on professional presentation including how to dress and to speak. The reports were judged on creativity, originality, accuracy, and oral presentation, with a trophy presented to each member of the winning group(s).

Ms. Shirley Stevenson, who holds a bachelor's degree in Mechanical Engineering and is pursuing a master's degree in Material Science Engineering, was recruited to serve as Project Director for this CASET project of Huston-Tillotson College. The instructors were Mr. Ahmad Kamalvand, Assistant Professor in mathematics; Mr. John R. Dierdorf, an IBM employee on loan to Huston-Tillotson College, Instructor in computer science, and Mrs. Nasrin Mobani, Part-time Instructor for the CASET project. The tutors were Ms. Vivan Mackey, Mr. Richard Gadlin, Mr. Lewis Jackson, and Ms. Monica Roquemore. The consultants were Mrs. Pamelia Hunter, Campus Counselor; Dr. Rosalee Wingate, Chairperson of Social Sciences; Mrs. Jenefred Davies, Assistant Professor in Education; Dr. General Marshall, Chairperson of Natural Sciences; and Ms. Jackie Wilson, Director of Financial Aid. The Project Secretary was Miss Ozella Walton.

The intervention's two major hypotheses were that the intervention activities would enhance: (a) performance in mathematics, and (b) opinions about SET fields and careers.

The Tuesday-night meetings were conducted over the course of twelve weeks beginning February 5, 1991 and ending April 30, 1991. Each meeting featured speakers addressing the following topics, in addition to tutoring and problem-solving and logic exercises.

| | |
|---|---|
| *February 5, 1991:* | *"Commitment and Choices" presented by Dr. Rosalee Wingate*<br>*Computer Applications* |
| *February 12, 1991:* | *"Goal Setting" presented by Mrs. Pamelia Hunter, Campus Counselor*<br>*Computer Applications* |
| *February 19, 1991:* | *"Goal Setting" presented by Ms. Shirley Stevenson and Ms. Pamelia Hunter, Critical Thinking exercise presented by Dr. General Marshall* |
| *February 26, 1991:* | *"Stress Management" presented by Mrs. Pamelia Hunter, Computer Applications* |
| *March 5, 1991:* | *"Test-taking Skills" presented by Mrs. Jenefred Davies, Professor of Education Computer Applications* |

| | |
|---|---|
| *March 12, 1991:* | *"Self-esteem" presented by Mrs. Pamelia Hunter, Preparation for Group Projects* |
| *March 19, 1991:* | *"Test-taking Skills" presented by Ms. Shirley Stevenson Computer Applications Update on Group Projects* |
| *April 2, 1991:* | *"Financial Aid" presented by Ms. Jackie Wilson, Financial Aid Director Update on Group Projects* |
| *April 9, 1991:* | *"Stress Management" presented by Mrs. Pamelia Hunter, Update on Group Projects Computer Applications* |
| *April 16, 1991:* | *"Critical Thinking" presented by Dr. General Marshall Explanation of judging criteria for student presentations* |
| *April 23, 1991:* | *"Hints for Effective Presentations" presented by Mrs. Pamelia Hunter Computer Applications.* |

Other intervention activities were a brown bag luncheon with Dr. Stanley Schneider, Adjunct Assistant Professor Education/Government, as the speaker, field trips to IBM, and Texas Instruments, Inc., and an awards banquet featuring as speaker Mr. Michael Brown, a chemical engineer with IBM.

## METHOD

### Subjects

The subjects were minority and female college students, primarily freshmen, enrolled in entry-level mathematics courses at Huston-Tillotson College in the spring semester of 1991. A control group of students enrolled in the same mathematics courses in the same semester was identified. Control-group students filled out the same protocols and provided the same information as the intervention-group students, but did not participate in any intervention activities. Table 1 shows the ethnic and sex breakdown for the intervention- and control-group students whose data are reported here.

**Table 1**

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | 0 | 0 | 0 | 0 | 0 | 0 |
| Anglo | 0 | - | 0 | - | 0 | - |
| Black | 7 | 7 | 14 | 6 | 21 | 13 |

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| Hispanic | 0 | 1 | 0 | 1 | 0 | 2 |
| Unknown | 0 | - | 0 | - | 0 | - |
| **TOTAL** | **7** | **8** | **14** | **7** | **21** | **15** |

Data were submitted for a total of 39 students who participated in the research as intervention-group or control-group members in the spring of 1991. Three control-group students were eliminated from the sample because they were not United States citizens (noncitizens are not a target population for this study).

Data from the 21 intervention-group students and the remaining 15 control-group students were analyzed, and the findings are presented in this report.

## CASET Protocols and Other Instruments

The intervention's two major hypotheses were that the intervention activities would enhance: (a) performance in mathematics, and (b) opinions about SET fields and careers.

Demographic and descriptive data about the subjects were developed through the CASET College Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

To assess opinion information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gives a scalar measurement for that variable. Thus the completed Opinion Protocol provides a scale measuring each of the thirteen variables. The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B. The Opinion Protocol was administered to intervention- and control-group students before and after the intervention.

To assess performance, a test of mathematical performance was administered to intervention- and control-group students before and after the intervention. The test consisted of 40 multiple-choice items requiring solution of word problems and knowledge of algebraic techniques and information. The test was developed, administered and scored by Huston-Tillotson project staff, and the scores were submitted to CASET for analysis.

## Procedure

At the beginning of the intervention, intervention- and control- group members signed consent forms and transcript release forms. The CASET College Student Protocol and the preintervention Opinion Protocol were administered to intervention- and control-group students. The first measures of opinion, and the measures of demographic information were made on February 4, 1991. Intervention activities proceeded as scheduled. After the intervention, the postintervention Opinion Protocol was administered to intervention- and control-group students, along with the institution's own test of content mastery. This was done during the last week in April, 1991. The content tests were scored by Huston-Tillotson personnel and the scores were forwarded to CASET, along with the completed CASET instruments. The college also supplied college transcripts for intervention- and control-group students. The items of

the Opinion Protocol were coded by CASET according to the thirteen scales they represent. Items on the Opinion Protocol were scored in such a way that a larger number reflected a positive outcome (see Appendix B). The scales were organized into three constructs -- SET Goal, Environmental Support, and Attitude -- as shown in Appendix C.

# RESULTS

## Methodological Issues

The two major hypotheses were that the intervention activities would enhance: (a) performance on the mathematics test, and (b) opinions about SET fields and careers. Most students had preintervention and postintervention measures of performance and opinion, and their data were analyzed as a *nonequivalent control group* design. This type of quasi-experimental design has one common weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Postintervention group differences may have been due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty was addressed by analyzing the influence of preexisting characteristics on students' performance and opinion; the analysis of covariance (ANCOVA), adjusting for preintervention performance or opinion, was used to improve the likelihood of detecting group differences and to reduce group differences that existed prior to the intervention.

## Demographic Results

The comparability of the intervention and control groups was examined by testing for differences on the items of the College Student Protocol. The complete results are given in Appendix D. Of the 64 comparisons, the groups differed significantly ($p \leq .10$) on only seven, six of which favored the intervention group: (a) More students in the intervention group wanted help with reading (35%) than did control-group students (0%); (b) more parents of intervention-group students had visited their child's class (70%) than had the parents of control-group students (31%); (c) more parents of intervention-group students had done volunteer work at the school (55%) than had parents of the control-group students (8%); (d) more parents of intervention-group students had assisted their child in course selection (65%) than had the parents of control-group students (15%); (e) the parents of intervention-group students had a greater number of involvements with their child ($M = 4.65$) than did the parents of control-group students ($M = 2.54$); (f) more intervention-group students had participated in a math or science fair (55%) than had control-group students (15%); and (g) intervention-group students had participated in more math and science activities ($M = 2.6$) than had control-group students ($M = 1.62$). The seven differences between the groups on preexisting characteristics (11%) were not significantly different from the number of differences expected by chance at the 10-percent probability level, and some of the differences were interrelated, e.g., the total number of parental involvements reflects visits to class, volunteer work, and assistance with course selection. Nevertheless, the pattern of differences described above that favored the intervention-group students before the intervention suggested that the groups were not comparable on demographic characteristics prior to the intervention.

## Performance Results

*Group differences in performance.* The preintervention measure and the postintervention measure of mathematics performance were tested for differences between the intervention and control groups; the results of the $t$-tests are given in Table 2. Note that the intervention- and control-group students did not differ significantly on either of the measures. A further analysis seemed necessary due to potential preintervention differences between the groups, so ANCOVAs that adjusted for preintervention score for all students were completed.

Table 2

DIFFERENCES ON GROUP PERFORMANCE MEASURES

| MEASURE | GROUP | n | MEAN | SD | t-TEST (df) | SIG P |
|---|---|---|---|---|---|---|
| Mathematics Pretest | Control | 15 | 30.07 | 21.28 | 1.29(34) | ns |
| | Intervention | 21 | 38.43 | 17.43 | | |
| Mathematics Posttest | Control | 13 | 44.77 | 18.17 | 1.26 | ns |
| | Intervention | 17 | 54.00 | 21.10 | (28) | |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

Group differences after adjusting for pretest scores. Hierarchical ANCOVAs adjusted for preintervention mathematics test scores before comparing groups on the postintervention measure of mathematics performance; the results are given in Table 3. This table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding each variable to the multiple regression equation (one variable per row), and the significance test of each variable's contribution toward explaining the dependent variable. The columns of the table include the cumulative percentage of explained variance (cum $R^2$), added contribution in explained variance of the variable ($sR^2$), test of the contribution of the new variable ($F(sR^2)$), and the degrees of freedom (df) for the test.

Table 3

HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION - PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE

| DEPENDENT VARIABLE | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Mathematics Posttest | MATH PRETEST | .34 | .34 | 14.49 | 1,28 | ≤.01 |
| | + GROUP | .36 | .01 | 0.62 | 1,27 | ns |
| | + PRE-x-GROUP | .39 | .04 | 1.56 | 1,26 | ns |

NOTE:$sR^2$ is the proportion of variance attributed to the last entered independent variable: $F(sR^2)$ is the value of the test of significance for that proportion of variance.

Three models of independent variables were tested for each dependent variable. (1) PRETEST: (2) PRETEST and GROUP: (3) PRETEST and GROUP and PRE-by-GROUP INTERACTION.

All models were analyzed as two-tailed tests.

The results in Table 3 demonstrated that the difference between the groups fell short of statistical significance, and that there was no significant interaction between prior mathematics test score and group membership for postintervention mathematics test score. These results were consistent with the result of the t-test reported in Table 2.

*Relationship between participation and performance.* Table 4 gives the correlations between performance and level of participation in the five components of the intervention. Note that level of participation in the five components was not

correlated significantly with preintervention or postintervention measures of performance at the $p \leq .10$ one-tailed probability level. These results are consistent with finding no difference between the mean mathematics performance of the intervention- and control-group students.

**Table 4**

| CORRELATIONS BETWEEN PERFORMANCE AND PARTICIPATION MEASURES[a] | | | | | | |
|---|---|---|---|---|---|---|
| | **Logic Classes Sig. p** | **Computer Classes Sig. p** | **Seminars Sig. p** | **Tutoring Sig. p** | **Field Trip Sig. p** | **N** |
| Math Pretest | -.14 | .22 | -.19 | -.14 | -.02 | 21 |
| Math Posttest | .08 | .01 | -.36 | -.22 | -.44 | 17 |
| [a] All correlations were analyzed as one-tailed tests. | | | | | | |

Opinion Results

*Group differences on pre- and postintervention measures.* The means of the intervention- and control-group students were compared for the 13 opinion variables, three constructs, and total opinion score, before and after the intervention. These results are given in Table 5. Before the intervention began, the intervention and control groups differed significantly on 3 of the 17 opinion measures: The intervention-group students had a higher Total Opinion score, a higher Attitude construct score, and a higher Math and Science Attitude score than did the control-group students. These preintervention opinion advantages for the intervention-group students were consistent with the preintervention demographic advantages for this group.

After the intervention ended, the intervention-group students had higher mean opinion scores than did the control-group students on 6 of the 17 measures: Total Opinion, SET Goal Construct, Value, Cultural Value, Math and Science Attitude, and Role Model. The postintervention differences may have been due to the continuation or maturation of preexisting differences and not due to the intervention. In order to adjust for preexisting differences, the effects of the intervention on the final opinion measures were tested after adjusting for preexisting differences via ANCOVA.

Table 5

GROUP DIFFERENCES ON PRETEST AND POSTTEST
OPINION CONSTRUCTS AND SCALES

| CONSTRUCT/Scale | TIME | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| OPINION, Total | Pretest<br>Posttest | 2.65<br>2.66 | .21<br>.22 | 2.78<br>2.81 | .23<br>.25 | 1.73<br>1.85 | ≤.10<br>≤.05 |
| SET GOAL | Pretest<br>Posttest | 2.77<br>2.74 | .28<br>.34 | 2.86<br>2.93 | .34<br>.25 | 0.81<br>1.86 | ns<br>≤.05 |
| Value | Pretest<br>Posttest | 3.06<br>3.06 | .37<br>.46 | 3.24<br>3.41 | .46<br>.49 | 1.19<br>2.13 | ns<br>≤.05 |
| Cultural Value | Pretest<br>Posttest | 3.40<br>3.30 | .40<br>.38 | 3.38<br>3.51 | .44<br>.37 | -0.10<br>1.65 | ns<br>ns |
| Self-Concept | Pretest<br>Posttest | 2.36<br>2.35 | .47<br>.45 | 2.44<br>2.47 | .56<br>.41 | 0.44<br>0.83 | ns<br>ns |
| Aspiration | Pretest<br>Posttest | 2.53<br>2.51 | .56<br>.55 | 2.67<br>2.58 | .43<br>.38 | 0.77<br>0.44 | ≤.05<br>ns |
| ATTITUDE | Pretest<br>Posttest | 2.54<br>2.57 | .23<br>.28 | 2.71<br>2.69 | .21<br>.26 | 2.19<br>1.27 | ≤.05<br>≤.10 |
| Math/Science Attitude | Pretest<br>Posttest | 2.65<br>2.72 | .31<br>.33 | 2.95<br>2.90 | .36<br>.40 | 2.52<br>1.46 | ns<br>ns |
| Locus of Control | Pretest<br>Posttest | 2.95<br>3.09 | .49<br>.46 | 2.98<br>3.16 | .44<br>.50 | 0.20<br>0.41 | ns<br>ns |
| Persistence | Pretest<br>Posttest | 2.60<br>2.60 | .50<br>.62 | 2.75<br>2.63 | .48<br>.52 | 0.91<br>0.16 | ns<br>ns |
| Study Habits | Pretest<br>Posttest | 2.58<br>2.65 | .31<br>.32 | 2.76<br>2.68 | .41<br>.39 | 1.33<br>0.27 | ns<br>ns |
| Anxiety | Pretest<br>Posttest | 2.14<br>2.07 | .50<br>.51 | 2.22<br>2.25 | .43<br>.58 | 0.46<br>0.95 | ns<br>ns |
| ENVIRONMENTAL SUPPORT | Pretest<br>Posttest | 2.66<br>2.74 | .36<br>.29 | 2.84<br>2.88 | .42<br>.41 | 1.22<br>1.16 | ns<br>ns |
| Academic Support | Pretest<br>Posttest | 2.90<br>2.79 | .60<br>.66 | 3.00<br>2.92 | .62<br>.74 | 0.47<br>0.54 | ns<br>ns |

| GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | | |
|---|---|---|---|---|---|---|---|
| CONSTRUCT/Scale | TIME | CONTROL | | INTERVENTION | | t-Test | Sig. p |
| | | Mean | SD | Mean | SD | | |
| Career Awareness | Pretest | 2.69 | .44 | 2.75 | .33 | 0.46 | ns |
| | Posttest | 2.82 | .21 | 2.89 | .56 | 0.48 | ns |
| Role Model | Pretest | 2.31 | .40 | 2.64 | .71 | 1.53 | ns |
| | Posttest | 2.42 | .43 | 2.81 | .71 | 1.84 | ≤.05 |
| Equal Opportunity | Pretest | 2.74 | .49 | 2.93 | .65 | 0.87 | ns |
| | Posttest | 2.93 | .44 | 2.89 | .39 | -0.27 | ns |
| All pretests were analyzed as two-tailed tests.<br>All posttests were analyzed as one tailed tests.<br>Pretests n's: Control = 13; Intervention = 20<br>Posttest n's: Control = 15; Intervention = 19 | | | | | | | |

*Group differences on final opinion adjusting for prior scores.* Table 6 reports the tests of the effects of group membership on opinion after adjusting for preintervention opinion scores. By this analysis, the groups did not differ overall on any opinion measure. After adjusting for preintervention scores, the intervention-group students' final opinion scores were no longer significantly higher than the control-group students' scores. However, preintervention opinion scores interacted with group membership for three opinion measures: SET Goal, Value, and Career Awareness.

**Table 6**

| HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTINTERVENTION OPINION MEASURES COVARYING PREINTERVENTION OPINION MEASURES | | | | | | |
|---|---|---|---|---|---|---|
| POSTTEST CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig p |
| OPINION, Total | SCORE | .51 | .51 | 30.45 | 1,29 | ≤.01 |
| | +GROUP (GP) | .53 | .01 | 0.77 | 1,28 | ns |
| | +SCORE-x-GP | .54 | .01 | 0.71 | 1,27 | ns |
| SET GOAL | SCORE | .36 | .36 | 16.26 | 1,29 | ≤.01 |
| | +GROUP (GP) | .39 | .03 | 1.41 | 1,28 | ns |
| | +SCORE-x-GP | .51 | .12 | 6.34 | 1,27 | ≤.05 |
| Value | SCORE | .47 | .47 | 25.49 | 1,29 | ≤.01 |
| | +GROUP (GP) | .52 | .06 | 3.31 | 1,28 | ≤.01 |
| | +SCORE-x-GP | .57 | .05 | 3.09 | 1,27 | ≤.01 |
| Cultural Value | SCORE | .24 | .24 | 8.90 | 1,28 | ≤.01 |
| | +GROUP (GP) | .29 | .05 | 1.95 | 1,27 | ns |
| | +SCORE-x-GP | .34 | .05 | 2.01 | 1,26 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTINTERVENTION OPINION MEASURES COVARYING PREINTERVENTION OPINION MEASURES**

| POSTTEST CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig p |
|---|---|---|---|---|---|---|
| Self-Concept | SCORE | .38 | .38 | 17.56 | 1,29 | ≤.01 |
| | +GROUP (GP) | .38 | .00 | 0.21 | 1,28 | ns |
| | +SCORE-x-GP | .44 | .05 | 2.63 | 1,27 | ns |
| Aspiration | SCORE | .29 | .29 | 11.29 | 1,281,2 | ≤.01 |
| | +GROUP (GP) | .29 | .00 | 0.11 | 7 | ns |
| | +SCORE-x-GP | .33 | .04 | 1.56 | 1,26 | ns |
| ATTITUDE | SCORE | .46 | .46 | 24.52 | 1,29 | ≤.01 |
| | +GROUP (GP) | .46 | .00 | 0.14 | 1,28 | ns |
| | +SCORE-x-GP | .48 | .092 | 1.14 | 1,27 | ns |
| Math/Science Attitude | SCORE | .42 | .42 | 20.99 | 1,29 | ≤.01 |
| | +GROUP (GP) | .42 | .00 | 0.02 | 1,28 | ns |
| | +SCORE-x-GP | .42 | .00 | 0.01 | 1,27 | ns |
| Locus of Control | SCORE | .41 | .41 | 19.43 | 1,28 | ≤.01 |
| | +GROUP (GP) | .43 | .02 | 1.05 | 1,27 | ns |
| | +SCORE-x-GP | .44 | .01 | 0.57 | 1,26 | ns |
| Persistence | SCORE | .34 | .34 | 14.67 | 1,28 | ≤.,01 |
| | +GROUP (GP) | .35 | .00 | 0.11 | 1,27 | ns |
| | +SCORE-x-GP | .38 | .03 | 1.39 | 1,26 | ns |
| Study Habits | SCORE | .35 | .35 | 14.76 | 1,28 | ≤.01 |
| | +GROUP (GP) | .35 | .00 | 0.07 | 1,27 | ns |
| | +SCORE-x-GP | .36 | .01 | 0.44 | 1,26 | ns |
| Anxiety | SCORE | .30 | .30 | 12.68 | 1,29 | ≤.01 |
| | +GROUP (GP) | .32 | .01 | 0.59 | 1,28 | ns |
| | +SCORE-x-GP | .32 | .00 | 0.03 | 1,27 | ns |
| ENVIRONMENTAL SUPPORT | SCORE | .33 | .33 | 13.71 | 1,28 | ≤.01 |
| | +GROUP (GP) | .34 | .01 | 0.50 | 1,27 | ns |
| | +SCORE-x-GP | .34 | .00 | 0.12 | 1,26 | ns |
| Academic Support | SCORE | .05 | .05 | 1,35 | 1,28 | ns |
| | +GROUP (GP) | .07 | .02 | 0.60 | 1,27 | ns |
| | +SCORE-x-GP | .11 | .05 | 1.34 | 1,26 | ns |
| Career Awareness | SCORE | .25 | .25 | 9.51 | 1,28 | ≤.01 |
| | +GROUP (GP) | .27 | .01 | 0.51 | 1,27 | ns |
| | +SCORE-x-GP | .34 | .08 | 3.05 | 1,26 | ≤.10 |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTINTERVENTION OPINION MEASURES COVARYING PREINTERVENTION OPINION MEASURES**

| POSTTEST CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig p |
|---|---|---|---|---|---|---|
| Role Model | SCORE | .42 | .42 | 20.65 | 1,28 | ≤.01 |
| | +GROUP (GP) | .44 | .02 | 0.73 | 1,27 | ns |
| | +SCORE-x-GP | .45 | .01 | 0.36 | 1,26 | ns |
| Equal Opportunity | SCORE | .12 | .12 | 3.88 | 1,28 | ≤.10 |
| | +GROUP (GP) | .15 | .03 | 0.93 | 1,27 | ns |
| | +SCORE-x-GP | .18 | .03 | 1.03 | 1,26 | ns |

All models were analyzed as two-tailed tests.

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure), (1) Pretest Opinion Score; (2) Pretest Opinion Score and Group; (3) Pretest Opinion Score and Group and Score-by-Group Interaction

The three significant interactions indicated that the relationships between prior opinion and postintervention opinion scores were different in the two groups. The interactions were analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of pretest scores for which the groups differed at the 90-percent confidence interval. Figures 1, 2, and 3 show the nonparallel regression lines that illustrate the significant interactions.

Figures 1 and 2 both indicate that for students with lower opinions before the intervention, the intervention-group students had higher final opinion scores on SET Goal and Value scales than did the control-group students.

In Figure 1, for students with prior opinion scores at or below 2.7, the students in the intervention group had higher final SET Goal opinion scores than did the control-group students.

**Figure 1**

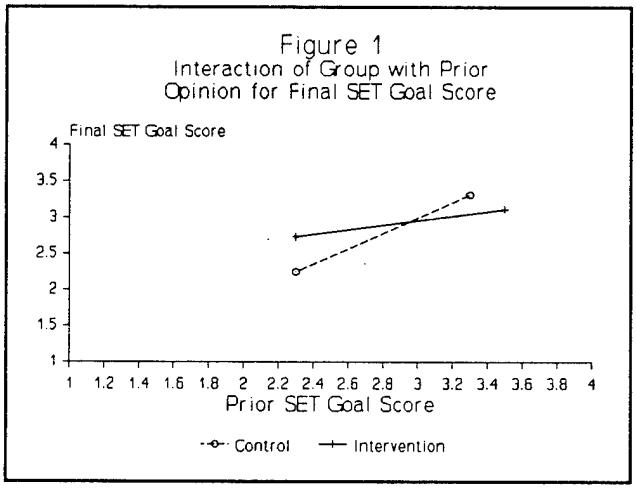



**Figure 2**

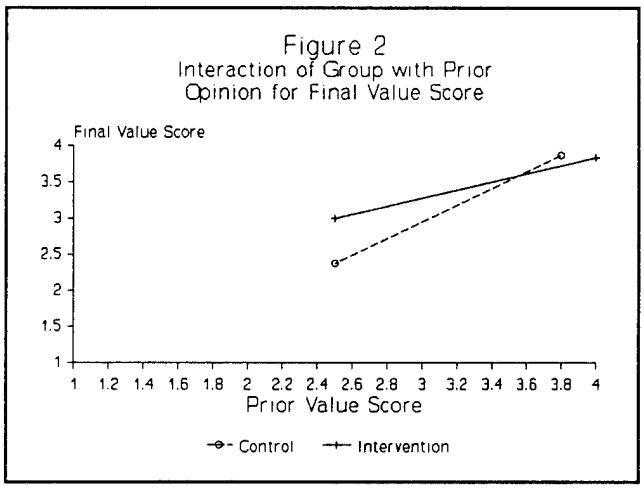
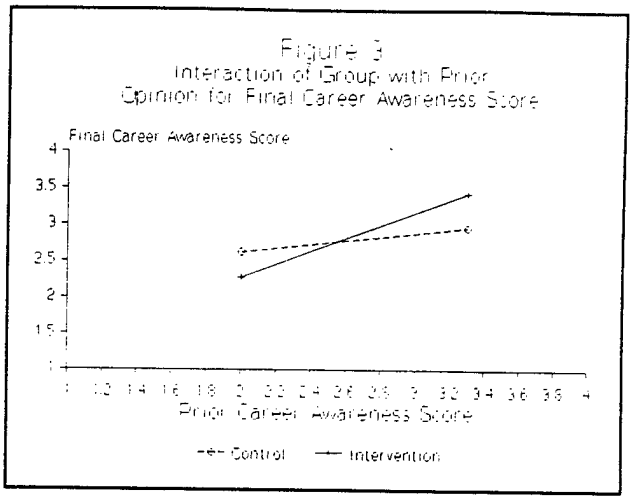


Figure 2 indicates that for those students with prior Value opinion scores less than 3.15, the intervention-group students had higher final Value opinion scores than did the control-group students.

Figure 3 reports that for students who had prior Career Awareness scores at or above 2.8, the intervention-group students had higher final Career Awareness scores than did the control-group students; for students who had prior Career Awareness scores at or below 2.3, the control-group students had higher final Career Awareness scores than did the intervention-group students.

**Figure 3**




In summary, the intervention activities had beneficial effects on the opinions of students with lower prior SET Goal and Value opinion scores, and for students with higher Career Awareness opinion scores, relative to the control group.

*Correlation between Opinion Measures and Participation.* Table 7 presents the correlations between opinion measures and the level of participation in the 5 components of the intervention. Of the 17 opinion measures correlated with participation in the 5 components, 9 correlations were significant at $p \leq .10$ one-tailed. Of these 9 significant positive correlations, better attendance at the 11 tutoring sessions was associated with higher scores on 7 opinion measures: Total Opinion, Self-Concept, Attitude construct, Persistence, Anxiety (lower levels), Environmental Support construct, and Equal Opportunity scores. However, the total of 9 significant positive correlations at the $p \leq .10$ level were approximately equal to the number expected by chance (8.5, 10 percent of 85 correlations). These results suggested that the level of participation in tutoring possibly was related to postintervention opinion scores, but the correlational results might be interpreted as suggesting that students with higher scores on these opinion measures had better attendance at the tutoring sessions. In other words, the correlations may not indicate that opinions were causally influenced by the intervention tutoring sessions.

**Table 7**

**CORRELATIONS BETWEEN OPINION MEASURES AND PARTICIPATION**

| CONSTRUCT/ SCALE | LOGIC CLASSES | COMPUTER CLASSES | SEMINARS | TUTORING | FIELD TRIP |
|---|---|---|---|---|---|
| OPINION, Total | -.02 | .25 | .23 | .36 ≤.10 | -.16 |
| SET GOAL | .05 | .10 | .20 | .25 | -.23 |
| Value | .17 | .00 | -.15 | -.11 | -.56 |
| Cultural Value | -.12 | -.01 | .04 | .12 | -.19 |
| Self Concept | .05 | .13 | .37 ≤.10 | .34 ≤.10 | .29 |
| Aspiration | .03 | .16 | .29 | .29 | -.19 |
| ATTITUDE | -.01 | .25 | .15 | .33 ≤.10 | -.13 |

| CORRELATIONS BETWEEN OPINION MEASURES AND PARTICIPATION | | | | | |
|---|---|---|---|---|---|
| CONSTRUCT/ SCALE | LOGIC CLASSES | COMPUTER CLASSES | SEMINARS | TUTORING | FIELD TRIP |
| Math/Science Attitude | .00 | .10 | -.15 | -.07 | -.44 |
| Locus of Control | -.10 | .08 | -.15 | -.01 | -.27 |
| Persistence | -.27 | .22 | .29 | .38 ≤.10 | .04 |
| Study Habits | -.08 | .26 | .22 | .28 | -.03 |
| Anxiety | .14 | .12 | .21 | .34 ≤.10 | .24 |
| ENVIRONMENTAL SUPPORT | -.09 | .27 | .24 | .33 ≤.10 | -.03 |
| Academic Support | -.09 | -.05 | -.04 | .13 | .07 |
| Career Awareness | -.09 | .25 | .19 | .26 | .08 |
| Role Model | -.08 | .46 ≤.05 | .23 | .23 | -.31 |
| Equal Opportunity | .10 | .02 | .24 | .32 ≤.10 | .20 |

[a] All one-tailed tests.

NOTE: Each r, the Pearson correlation coefficient, was computed on 19 cases for Postintervention measures.

Summary of Results

The performance and opinion results of the intervention are summarized in Table 8 as effect sizes. The effect sizes can provide additional information about the importance of results other than that provided by tests of statistical significance (Cook & Campbell, 1979). Overall, the intervention had small-to-moderate positive effects on performance and opinion. Note that the adjusted posttest effect sizes were smaller than the unadjusted posttest effect sizes; this shrinkage was due to adjustments for the preintervention advantages of the intervention-group students.

**Table 8**

| EFFECT SIZES OF THE INTERVENTION | | | |
|---|---|---|---|
| VARIABLE | POSTTEST | ADJUSTED POSTTEST | GROUP-BY-PRETEST INTERACTION |
| **PERFORMANCE** | | | |
| Math Posttest | .45 | .28 | .44 |

EFFECT SIZES OF THE INTERVENTION

| VARIABLE | POSTTEST | ADJUSTED POSTTEST | GROUP-BY-PRETEST INTERACTION |
|---|---|---|---|
| **OPINION** | | | |
| Total Opinion | .62 ≤.10 | .31 | .30 |
| SET Goal | .63 ≤.10 | .42 | .88 ≤.10 |
| Attitude | .43 | .13 | .37 |
| Environmental Support | .39 | .25 | .12 |

Note. The measure of effect size was calculated according to B.T. Johnson (1989). A positive sign in the "Posttest" or "Adjusted Posttest" columns indicates that the intervention group outperformed the control group; a negative sign indicates that the control group had the higher score. For a significant interaction effect size, a positive sign indicates that the intervention helped students scoring lower on the pretest more than it helped the higher scoring students; a negative sign on the interaction effect size indicates that the intervention helped students scoring higher on the pretest more than it helped lower scoring students.

## DISCUSSION

The hypotheses that the intervention activities would enhance performance and opinion received slight support; the test of the performance hypothesis fell short of statistical significance, and the opinion hypothesis was supported only for students entering with extreme opinion scores on 3 of 17 scales about SET fields and careers. The effects of the intervention on opinion were three selective advantages of the intervention for higher SET Goal and Value scores for students with lower prior opinion scores, and higher Career Awareness scores for students with higher prior opinion scores. Correlations between level of participation in the components of the intervention and postintervention opinion measures suggested that tutoring may have been the most influential component of the intervention activities.

The intervention was analyzed as a quasi-experiment with the ensuing caution about causal conclusions; in this intervention, the groups appeared to differ on important variables prior to the start of intervention activities. Comparisons on 82 preintervention measures found significant differences on 12 percent, which included a broad range of demographic (7 of 64), and opinion measures (3 of 17). As a result, confidence is weakened in the causal role of the intervention in the three, significant interactions between prior opinion and group membership. Careful consideration of the methods used to select students for the intervention and control groups might reveal more about the preintervention differences between students in the two groups.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins.

# APPENDICES

# APPENDIX A

# COLLEGE STUDENT PROTOCOL

College Student Protocol

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. Am. Indian (Please specify the tribe which best describes your heritage.) _____
   ___ e. Hispanic Which of the following best describes your heritage?
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

6. Class:
   ___ a. College freshman
   ___ b. College sophomore
   ___ c. College junior
   ___ d. College senior
   ___ e. Other (e.g., special or temporary student, etc.)
      Specify _____

7. Have you declared a college major?
   ___ a. No
   ___ b. Yes ..... Please specify your major. _____

8. Have you taken any advanced placement tests for college credit?
   ___ a. No
   ___ b. Yes ..... Please list tests taken. _____

9. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Two years of college
   ___ b. Four years of college
   ___ c. One or more years after college
   ___ d. Other Specify _____

10. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
      Specify occupation _____
   ___ i. No one at all

11. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)
   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Work-study
   ___ d. Job other than work-study
   ___ e. Tuition or other scholarship
   ___ f. Loan
   ___ g. Previous personal earnings and savings
   ___ h. GI Bill, ROTC, or other governmental assistance (other than scholarship or loan)
   ___ i. Family trust fund, insurance plan, or other similar arrangement
   ___ j. Other Specify _____

12. You may want to receive help outside your regular college course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems
   ___ f. Increasing reading ability
   ___ g. Developing good study habits
   ___ h. Improving writing ability

13. What is or was the occupation of the person(s) with whom you lived during the years you were growing up? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

_____ _____

14. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average

15. Are you:
___ a. An only child (skip to question 17)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

16. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

17. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

18. Indicate the extent of your mother's education. (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

19. What was the language spoken most often by adults in the household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe .... What is that language? _____
___ d. Other
Specify _____

20. Which of the following did your parent(s)/guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

21. Which of the following comes closest to describing your parent(s)/guardian(s)?
___ a. Do(es) not read at all
___ b. Sometimes read(s)
___ c. Read(s) a lot

22. Which of the following comes closest to describing you?
___ a. Do not read at all
___ b. Sometimes read
___ c. Read a lot

23. How many of these do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

24. From what kind of high school or secondary school did you graduate?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

25. Were you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes.....Please list the math and/or science clubs you belonged to.

_____

_____

_____

_____

26. Have you ever taken part in any of these activities? (Check all that apply)
    ___ a. Math and science clubs
    ___ b. Field trip to science museum, laboratory, or other place where scientists work
    ___ c. Watching science programs on TV
    ___ d. A talk by a scientist
    ___ e. Science/math fair
    ___ f. Other science/math competition
    ___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL WITH DIRECTIONALITY AND SCALES OF ITEMS

Legend:

| | |
|---|---|
| **SH Study Habits** | **PS Persistence** |
| **AT Attitude toward math/science** | **CV Cultural Value** |
| **SC Self-Concept** | **AS Academic Support** |
| **AX Anxiety** | **AP Aspiration** |
| **VL Value** | **EO Equal Opportunity** |
| **LC Locus of Control** | **RM Role Model** |
| **CA Career Awareness** | |

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of any ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |

| | | | |
|---|---|---|---|
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

    i. _____

    ii. _____

    iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE COLLEGE STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 20 | CONTROL n = 13 |
| 1. Sex | | |
| Women | 70% | 54% |
| Men | 30% | 46% |
| 2. Age | 21.14 | 21.30 |
| 6. Class | | |
| .Freshmen | 60% | 77% |
| .Sophomores | 25% | 23% |
| .Juniors | 10% | 0% |
| .Seniors | 0% | 0% |
| .Missing | 5% | 0% |
| 7. Declared SET majors | 5% | 0% |
| .Missing or undeclared | 5% | 0% |
| 8. Students taken an advanced placement test | 20% | 8% |
| .Missing | 5% | 0% |
| 9. Higher education expected: | | |
| .Two years of college | 0% | 0% |
| .Four years of college | 45% | 31% |
| .One or more years after college | 50% | 69% |
| .Missing | 5% | 0% |
| 10. Studies most influenced by | | |
| .Parents | 50% | 69% |
| .Another family member | 15% | 0% |
| .Teacher | 0% | 0% |
| .Counselor | 0% | 0% |
| .Minister | 5% | 0% |
| .Friend | 0% | 0% |
| .Science professional | 5% | 0% |
| .Nonscience professional | 5% | 0% |
| .No one at all | 20% | 31% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 20 | CONTROL n = 13 |
| 11. Sources of income[b] | | |
| .Parents/guardians | 60% | 69% |
| .Spouse | 5% | 0% |
| .Work study | 10% | 23% |
| .Job other than work study | 50% | 23% |
| .Tuition or scholarship | 25% | 15% |
| .Loan | 60% | 62% |
| .Grant | 65% | 46% |
| .Personal savings | 10% | 8% |
| .GI Bill, ROTC, etc. | 0% | 0% |
| .Family trust, etc. | 5% | 0% |
| .Other | 0% | 0% |
| Number of sources of income * | 2.90 | 2.46 |
| 12. Student needs help in:[b] | | |
| .Counseling on educational plans | 40% | 46% |
| .Counseling on career plans | 35% | 23% |
| .Improving math ability | 75% | 62% |
| .Finding part-time work | 40% | 31% |
| .Counseling on personal problems | 15% | 8% |
| .Increasing reading ability | 35% | 0%[a] |
| .Developing good study habits | 60% | 38% |
| .Improving writing ability | 45% | 23% |
| Number of areas needing help * | 3.45 | 2.31 |
| 13. Sources of outside income | | |
| .None | 0% | 0% |
| .One | 40% | 38% |
| .Two | 40% | 23% |
| .Missing | 20% | 38% |
| 14. Family income: | | |
| .Below U.S. average | 15% | 23% |
| .About average | 35% | 46% |
| .Above average | 15% | 8% |
| .Unknown | 35% | 23% |
| 15. Birth order of student: | | |
| .Only child | 5% | 8% |
| .Oldest child | 30% | 38% |
| .Youngest child | 20% | 15% |
| .In-between child | 40% | 38% |
| .Missing | 5% | 0% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 20 | CONTROL n = 13 |
| 16. Number of siblings: | | |
| .None | 5% | 8% |
| .One | 10% | 38% |
| .Two | 35% | 15% |
| .Three or more | 45% | 38% |
| .Missing | 5% | 0% |
| 17. Father's education: | | |
| .Grade school or less | 10% | 0% |
| .Some high school | 10% | 8% |
| .High school graduate | 20% | 15% |
| .Some college | 30% | 15% |
| .College degree or more | 10% | 54% |
| .Missing | 20% | 8% |
| 18. Mother's education: | | |
| .Grade school or less | 5% | 8% |
| .Some high school | 5% | 0% |
| .High school graduate | 25% | 38% |
| .Some college | 20% | 15% |
| .College degree or more | 40% | 31% |
| .Missing | 5% | 8% |
| 19. Language spoken most at home: | | |
| .English | 95% | 85% |
| .Spanish | 0% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 5% | 8% |
| 20. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 60% | 38% |
| .Attend parent-teacher conferences | 50% | 38% |
| .Visit student's class | 70% | 31%[a] |
| .Phone/visit if there's a problem | 75% | 54% |
| .Do volunteer work | 55% | 8%[a] |
| .Assist student in course selection | 65% | 15%[a] |
| .Assist in student's homework | 90% | 69% |
| Number of parental involvements * | 4.65 | 2.54[a] |
| t(31) = 2.87 | | |
| 21. Parent(s) read: | | |
| .Not at all | 0% | 8% |
| .Sometimes | 20% | 15% |
| .A lot | 75% | 69% |
| .Missing | 5% | 8% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 20 | CONTROL n = 13 |
| 22. Student reads: | | |
| .Not at all | 0% | 8% |
| .Sometimes | 75% | 62% |
| .A lot | 20% | 23% |
| .Missing | 5% | 8% |
| 23. Items in student's home:[b] | | |
| .Desk | 70% | 54% |
| .Daily newspaper | 85% | 77% |
| .Encyclopedia | 65% | 92% |
| .Typewriter | 65% | 62% |
| .Calculator | 90% | 77% |
| .Television | 90% | 92% |
| .Computer | 45% | 15% |
| .Video Cassette Recorder (VCR) | 85% | 85% |
| Number of support items * | 5.95 | 5.54 |
| 24. Type of high school attended | | |
| .Public | 90% | 85% |
| .Private | 5% | 0% |
| .No formal high school | 0% | 8% |
| .Missing | 5% | 8% |
| 25. Member math/science club in high school | 10% | 8% |
| 26. All activities student took part in:[b] | | |
| .Math/science club | 0% | 0% |
| .Field trip | 65% | 38% |
| .Watching science programs on TV | 50% | 38% |
| .Listen to talk by scientist | 15% | 15% |
| .Science/math fair | 55% | 15%[a] |
| .Other science/math competition | 5% | 8% |
| .Play/work in computer lab | 70% | 46% |
| Number of activities * | 2.60 | 1.62 |
| t(31) = 1.77 | | |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# LANEY COLLEGE

# INTERVENTIONS

Prepared by:

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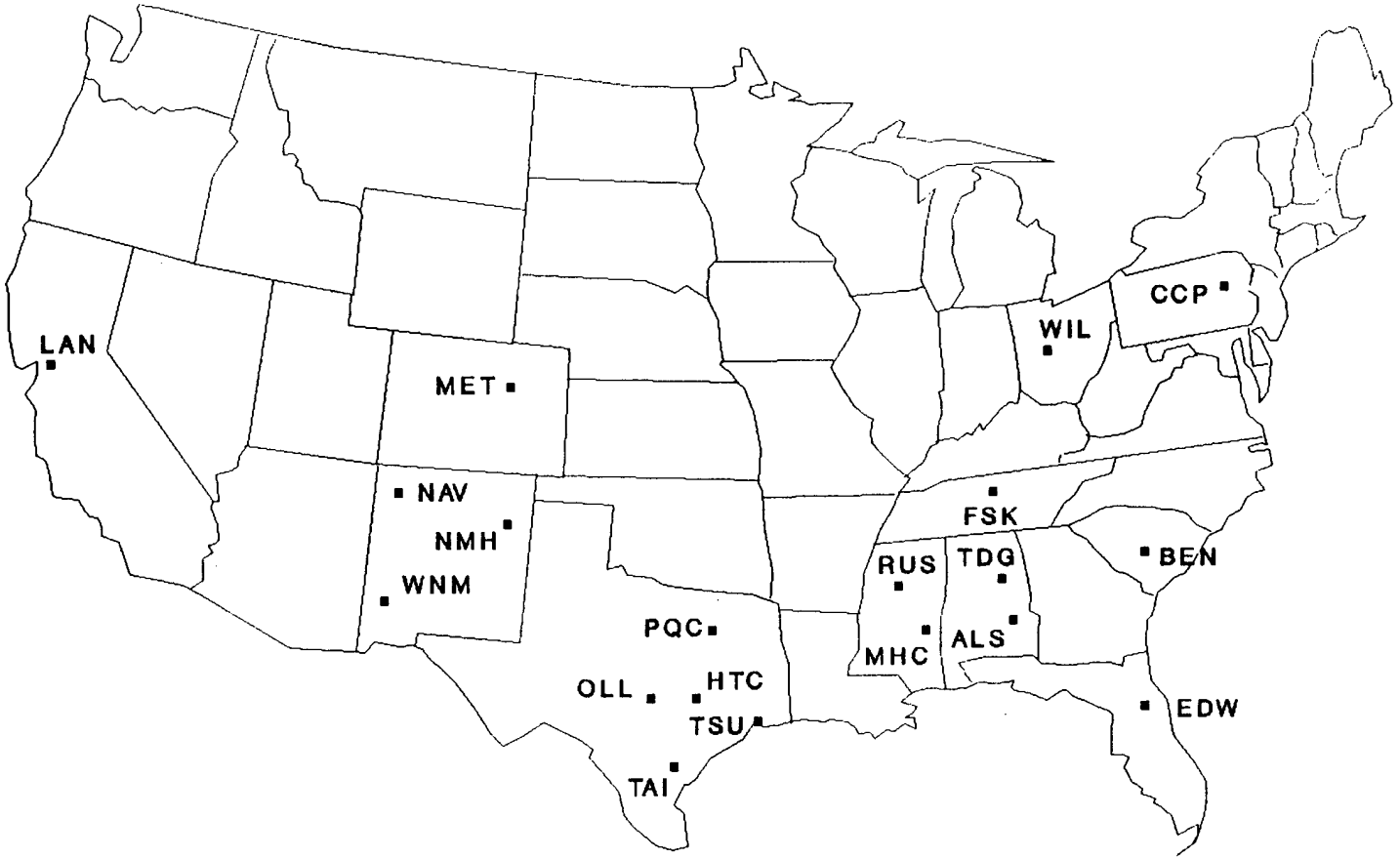
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected came from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention- group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his or her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF LANEY COLLEGE

Laney College, a two-year, public, coeducational institution located in Oakland, California, is the largest of the colleges in the Peralta Community College District. The Peralta Community College District includes the schools of Laney College and Merritt College in Oakland, Alameda College in Alameda, Vista College in Berkeley, and Feather River College in Quincy; total enrollment for the district is over 27,000. Laney College has an enrollment of around 10,000 students and employs around 350 faculty members. The student body of Laney College is approximately 50 percent female and 50 percent male. About 27 percent of the students are Anglo (non-Hispanic Whites), 22 percent are Asian, 31 percent of the students are Black, 7 percent are Hispanic, and 13 percent are of other ethnic origins. The president of Laney College is Mr. Odell Johnson.

Degrees offered at Laney College in quantitative subjects are Associate in Arts degree in computer information systems and mathematics, and Associate in Science degree in natural sciences and a variety of technology fields, including architectural and engineering, electronics, and materials technology.

Oakland has a population of about 357,000 in its metropolitan area, with nearly half of the population being Black. The state of California has a population of over 28 million. According to U.S. Census Bureau estimates, the adult population of California is 61 percent Anglo, 8 percent Black, 22 percent Hispanic, and 9 percent other ethnic origins. Oakland has a number of other institutions of higher education including Holy Names College, Merritt College, and Mills College.

# PART II

# SUMMARY OF THE LANEY COLLEGE (LC)

# INTERVENTIONS

This report summarizes the two interventions conducted by Laney College, a two-year, public college which is a member of the Peralta Community College District. Located in Oakland, California, the college is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Laney College Intervention Activities:

In Spring and Summer of 1989, and again in Spring and Summer of 1990, Laney College conducted two intervention programs in mathematics for high school students. The goal of the program was to get high school sophomore students on a college-bound track by taking geometry in their sophomore year so that they could enroll in advanced mathematics courses their junior year. The primary activity of the program was the teaching of geometry for credit; however, algebra instruction was provided as well, when it was discovered that some of the students lacked the skills to perform the algebraic operations necessary to work geometry problems. Students received instruction after school at their high schools in collaborative learning groups three days per week, as well as Saturday classes at Laney College. In addition, students received counseling and made field trips to California senior colleges. Participants were high school students who were enrolled in Algebra I during their sophomore year in high school. The majority of the students were Black and/or female.

Findings:

- Virtually all the participants successfully completed their geometry course, for which they received college as well as high school credit.
- Over half the intervention participants in the first year program enrolled in and passed higher level mathematics courses in the following Fall semester. In the second year of the intervention, about a quarter of the intervention participants went on to higher mathematics.
- Effects on opinion appeared to be variable.

Recommendations:

- This intervention demonstrated that getting off-track high school students back on track can be done; it points up the importance of adequate counseling so that so many students would not be off-track to begin with.
- Before undertaking an intervention with students who have already been in school for a number of years, it is necessary to test them to find what their present competency is.
- The practical difficulties of dealing with urban high-school students, who in many cases are already fairly far along a non-academic, non-SET track, suggest that a younger age may be more productive for intervention.

# PART III

# CASE STUDY OF THE LANEY COLLEGE

# 1991 SPRING SEMESTER INTERVENTION

## ABSTRACT

In late 1989 and 1990 Laney College, Oakland, California, conducted and tested against a control group a collaborative learning program called ASET (Achievement in Science, Engineering, and Technology) to teach geometry to high school students and prepare them for advanced mathematics and entrance into college. Participants were 44 Black and 9 Hispanic high school sophomores and juniors (37 women and 16 men) from three high schools in Oakland. All students were enrolled in first-year algebra and were considered to be off the college-bound track. There were no "ability" requirements to enter the program, but students had to demonstrate motivation: students were accepted into the ASET program based solely on written applications and personal interviews. This intervention was initially conducted in the spring of 1989.

The Laney College program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance in geometry and algebra, (b) increase enrollment in higher-level mathematics courses, and (c) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* Major components of the seven-month intervention were instruction in geometry for college credit, with algebra instruction as needed, and collaborative learning group meetings. Additional activities included field trips to a number of California colleges and universities, and a camping trip retreat that included discussions of academic and career topics.

*DATA:* All the participants furnished demographic data through the CASET High School Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were algebra and geometry test grades, algebra and geometry course grades, and followup information on enrollment and grades taken the semester after the intervention.

The outcome measures of performance were a 50-item geometry final examination and the letter grade in geometry for the intervention group only, and the course grade in the subsequent mathematics course taken in the fall of 1990 for the intervention and control groups. The preintervention measure of performance was the score on a 50-item algebra test which was administered to the intervention group only.

*RESEARCH DESIGN:* The research design was quasi-experimental. Intervention and control groups were formed by matching: Intervention-group students identified and recruited algebra students demographically similar to themselves for the control group. Demographic and opinion data were analyzed in the context of a nonequivalent control group design; performance data were analyzed in a preexperimental design. Through analyses of preintervention measures it appeared that the intervention and control groups were comparable.

*FINDINGS:* In general, the intervention had little positive effect on the participants; the program's success was not clearly demonstrated for the variables that were measured. The hypothesis that the intervention would increase enrollment in advanced mathematics courses received partial support. The stated goal of the program was to have 80 percent of the intervention-group students enroll in advanced mathematics after the intervention. Seventy-six percent enrolled in advanced classes; however, these students performed at a less than satisfactory level--on average, D-level--in these classes. The intervention did not lead to significantly higher grades in mathematics. The hypothesis that the intervention would enhance opinions about SET fields and careers received no support: Although the intervention-group students began the intervention with higher opinion scores in general, after adjusting for the difference, the intervention-group students did not express more favorable opinions.

## DESCRIPTION OF THE INTERVENTION

Laney College conducted an intervention program using a collaborative learning approach and targeted minority high school students at high risk of dropping out. Achievement in Science, Engineering, and Technology (ASET) was designed to make students who were off the college-bound track, and thus ineligible for college, eligible for entrance into SET tracks of study at local colleges and universities.

The first implementation of this intervention was during academic year 1988-1989, with students from two Laney College feeder high schools: Berkeley High School, and Fremont High School. During the second year of implementation, academic year 1989-1990, a third high school, Oakland Technical High School, was added to the original two; students from all three high schools were eligible to participate. This is the report of the second year of the intervention, conducted during academic year 1989-1990 with students from Berkeley, Fremont, and Oakland Technical High Schools.

The program recruited and enrolled female and minority 10th- and 11th-grade students who were enrolled in math courses below the minimum acceptable level for University of California and California State University admissions requirements (that is, the students were enrolled in first-year algebra as 10th or 11th graders, one year behind their "regular" classmates). The students studied geometry, and some algebra as needed, in a collaborative learning setting. After passing the geometry course students received credit from their high schools in geometry and were eligible to enroll in the second year of algebra the following year. In addition, students completing the ASET program were eligible to participate in the Mathematics, Engineering, Science Achievement (MESA) program at University of California at Berkeley for the remainder of their high school careers. All successful ASET students received a full scholarship covering MESA's $450 educational fee.

Each student was required to attend three of the four weekly collaborative learning study group meetings offered after school on each of the three high school campuses, and to attend twice a month the Saturday College meetings held on the Laney College campus to work on mathematics skills, especially in geometry.

The ASET classroom environment was designed to be very different from the traditional high school classroom. The concept of collaborative learning was seen as crucial and was stressed from the first class session. The concept of team work was emphasized: the success of the group, not just the individuals within the group, was promoted.

The collaborative learning study groups at each high school met each Monday, Tuesday, Wednesday and Thursday from 3:30 to 5:30p.m. At each high school, the groups were led by two tutors, college students from the University of California at Berkeley and from Laney College.

The Saturday College meetings were held three Saturdays per month on the Laney College campus, from 10:00 a.m. to 1:30 p.m. Each Saturday class was divided into several components. First the instructor lectured on a particular topic for approximately one hour. Students were then asked to form small groups of three to four students to review the lecture material. The instructor and several facilitators monitored and assisted the groups in their work. The class then reconvened for an additional hour of lecture. The remaining half-hour of class was devoted again to the study groups.

Besides receiving instruction and participating in group work in mathematics, students received counseling and visited college campuses. Students met at Laney College three Saturdays each month; in addition, weekend field trips were scheduled to other colleges and universities (University of California at Davis, University of California at Santa Cruz, University of California at Berkeley, and Stanford University), and students took a three-day weekend trip to the southern California campuses of the University of California at Los Angeles and California State University at San Luis Obispo. The program also sponsored a combined weekend retreat and camping trip. The retreat, held at a camping site near the Russian River, focused on college admissions, financial aid, study skills, and careers in science and engineering.

The program began on October 14, 1989 with the first Saturday College session. The first workshops at the three high school campuses were held on Monday, October 16, 1989. An awards dinner was held in December, with a number of parents present. The final Saturday College session was held on May 19, 1990. Final examinations and graduation ceremonies were held on May 26, 1990. The final event of the term was the camping trip, held on the weekend of June 1-3, 1990.

The intervention's two hypotheses were that the intervention would: (a) increase the number of intervention-group students enrolling in advanced mathematics courses, and (b) enhance intervention-group students' opinions about SET fields and careers.

The Project Director for this CASET project at Laney College was Dr. Eugene S. Long, Ph.D., Assistant Dean, Math, Sciences, and Related Technologies. The Project Coordinator was Mr. Blas Guerrero, a doctoral candidate in the Graduate School of Education of the University of California at Berkeley.

## METHOD

### Subjects

Subjects were minority and female 10th- and 11th-grade students enrolled in first-year algebra at their high schools. The only other requirement for admission to the intervention program was the commitment to meet the program's attendance requirements and to work hard. Previous grades, counselor or teacher recommendations, and standardized test scores did not determine a student's eligibility for the program. Acceptance was based on a student's written application and personal interview.

In order to monitor the effects of the intervention, a control group of students was identified. These students were demographically similar to the intervention participants and were also enrolled in first-year algebra later than the freshman year of high school. Control-group students were solicited, by their peers in the intervention group. Each intervention-group student was asked to identify and recruit one control-group student similar to himself or herself in ethnicity, sex, grade in school, and mathematics course enrollment. Control-group students filled out the same protocols and provided the same information as the intervention-group students, but did not participate in any intervention activities.

Data were submitted for a total of 33 intervention-group and 32 control-group students. Eleven students were eliminated from the sample: five intervention-group students and five control-group students who were not U.S. citizens, and one control-group student who was an Asian-American female. Non-U.S. citizens and Asian-Americans are not among the target populations which are the subjects of this study. Data from two additional intervention students and five additional control students were eliminated because of anomalies in the data, (such as unclear or problematic responses on the protocols, and inconsistent birth dates that made the identity of the students questionable), or registration in an advanced geometry course, making a student ineligible for the program. Data from 30 intervention-group and 23 control-group students were analyzed and are included in this report.

Table 1 shows the ethnic and sex breakdown for the intervention and control groups.

Table 1

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | 0 | 0 | 0 | 0 | 0 | 0 |
| Anglo | 0 | - | 0 | - | 0 | - |
| Black | 16 | 3 | 18 | 7 | 34 | 10 |
| Hispanic | 1 | 3 | 2 | 3 | 3 | 6 |
| Unknown | 0 | - | 0 | - | 0 | - |
| **TOTAL** | **17** | **6** | **20** | **10** | **37** | **16** |

CASET Protocols and Other Instruments

The intervention's two hypotheses were that the intervention would (a) increase the number of intervention-group students enrolling in advanced mathematics courses, and (b) enhance intervention-group students' opinions about SET fields and careers. Demographic and descriptive data about the subjects were developed through the CASET High School Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gives a scalar measurement for that variable. Thus the completed Opinion Protocol provides a scale measuring each of the thirteen variables. The Opinion Protocol was designed to be administered to intervention- and control-group students before and after the intervention. The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B.

The preintervention measure of performance was the score on a 50-problem algebra test, which was administered to intervention-group students only. The three postintervention performance measures were 1) the scores on a 50-item geometry final examination (7 true-or-false items, 6 completion items, 27 word problems and 10 proofs), administered to intervention-group students only; 2) the letter grade in geometry, assigned to intervention-group students only; and 3) the course grade in the subsequent mathematics course taken in the fall 1990, available for intervention- and control-group students. The grade earned in Algebra I while the intervention was in progress was examined as a concurrent-post measure, available for intervention-group and control-group students.

Procedure

At the beginning of the intervention, intervention- and control-group students signed consent forms and transcript release forms. The first measures of opinion and the measures of demographic information were taken during November and December of 1989. Intervention activities were conducted with the intervention group; the participation of each student in the various intervention activities was recorded and submitted to CASET for analysis. The intervention-group and control-group students continued with their regular Algebra I course taught at their high schools. Performance of the intervention-group students in geometry and of the intervention- and control-group students in algebra, was monitored and recorded. As a postintervention measure, the CASET Opinion Protocol was administered a second time to intervention-and control-group students during May and June of 1990. The performance measures, and Fall 1990 transcripts for both groups were forwarded to CASET for analysis, along with the CASET Student Protocol and the preintervention and postintervention Opinion Protocols.

The items of the Opinion Protocol were coded by CASET according to the thirteen scales they represent. Items on the Opinion Protocol were scored in such a way that a larger number reflected a positive outcome (see Appendix B). The scales were organized into three constructs -- SET Goal, Environmental Support, and Attitude -- as shown in Appendix C.

## RESULTS

Methodological Issues

The intervention's two hypotheses were that the intervention would (a) increase the number of intervention-group students enrolling in advanced mathematics courses, and (b) enhance intervention-group students' opinions about SET fields and careers.

The students' preintervention and postintervention measures of opinion were analyzed as a nonequivalent control-group design. This type of quasi-experimental design has one common weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty about causal influence may be addressed by analyzing the influence of preexisting characteristics on students' opinion; the analysis of covariance (ANCOVA), adjusting for preintervention opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that existed before the intervention.

Demographic Results

The comparability of the intervention and control groups was examined by testing for differences on the items of the High School Student Protocol. The complete results are given in Appendix D. The groups differed on only one of the 58 comparisons: More of the intervention-group students had typewriters, (one of the academic support items listed in the High School Student Protocol), in their home (77%) than did the control-group students (48%). Based on these results, the groups were judged to be comparable on demographic characteristics before the intervention.

Performance Measures

*Enrollment in advanced mathematics courses.* The primary stated goal of the college in conducting this intervention was to have 80% of the intervention-group students enroll in advanced mathematics classes in the fall of 1990. Of the 30 intervention-group students, this enrollment information was available for 21 intervention-group students; 16 of which (76%) were enrolled in advanced mathematics courses in the fall of 1990. In a sample of this size, this is not statistically different from 80%, so the goal of 80% enrollment was achieved.

A stricter interpretation of the intervention's goal would be to require 80 percent of the intervention-group students not only to enroll, but to earn a passing grade in the advanced mathematics course. Of the 16 intervention-group students who enrolled in advanced mathematics courses in the fall of 1990, 4 students earned grades of "C", 8 earned grades of "D", and 4 failed. Thus, 57 percent (12 of 21) of the intervention-group students met this more demanding criterion. But only 19% earned a satisfactory (average) grade of "C" or better.

*Group differences in performance.* Grades in the mathematics courses the students took in the fall of 1990, were available for both intervention-group and control-group students, making possible a comparison of their achievement in their respective mathematics courses after the intervention was completed. The results of that comparison are given in Table 2. Note that the two groups did not differ significantly for all courses combined or for the non-advanced courses considered separately. Also, the two groups' algebra grades from the spring of 1990 did not differ significantly. One other interesting comparison was between the grades earned in high school mathematics classes in the fall of 1990 and the grades earned in the Laney College geometry course; the college geometry grade ($\underline{M}$ = 2.66) was more than twice as large as the following semester's high school mathematics grade ($\underline{M}$ = 1.19). In summary, the intervention did not lead to significantly higher grades in mathematics.

**Table 2**

**DIFFERENCES ON GROUP PERFORMANCE MEASURES**

| MEASURE | GROUP | n | MEAN | SD | t-TEST (df) | SIG P |
|---|---|---|---|---|---|---|
| Fall 1990 Math Grade | Control<br>Intervention | 16<br>21 | 1.56<br>1.19 | 0.89<br>0.87 | -1.27<br>(35) | ns |
| Fall 1990 Math Advanced | Control<br>Intervention | 1<br>16 | 3.00<br>1.00 | 0.00<br>0.73 | - | |
| Fall 1990 Math Non-Advanced | Control<br>Intervention | 15<br>5 | 1.47<br>1.80 | 0.83<br>1.10 | 0.72<br>(18) | ns |
| Geometry Exam | Control<br>Intervention | -<br>28 | -<br>58.71 | -<br>19.42 | - | |
| Geometry Grade | Control<br>Intervention | -<br>19 | -<br>2.66 | -<br>0.94 | - | |
| Spring 1990 Algebra Grade | Control<br>Intervention | 16<br>20 | 1.56<br>1.95 | 1.36<br>1.15 | 0.93<br>(34) | ns |

| DIFFERENCES ON GROUP PERFORMANCE MEASURES | | | | | | |
|---|---|---|---|---|---|---|
| **MEASURE** | **GROUP** | **n** | **MEAN** | **SD** | **t-TEST (df)** | **SIG p** |
| Algebra Pretest | Control<br>Intervention | -<br>28 | -<br>62.00 | -<br>15.50 | - | |
| For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level. | | | | | | |

*Tests of the intervention components.* Hierarchical ANCOVAs adjusted for algebra pretest scores before testing the significance of attendance at the 18 Saturday classes, 6 field trips, and 4 workshops, and their interactions with the algebra pretest scores. The intervention components were entered in the order shown in the table -- Saturday classes, field trips, workshops -- based on expectations about the importance of each component. The results are given in Table 3.

For the fall 1990 mathematics grade, no intervention component was a significant predictor; however, attendance at field trips approached significance. For grades in the geometry course and geometry exam scores, attendance at Saturday classes and level of participation in field trips were significant predictors.

This table (adapted from Cohen & Cohen, 1975) presents the results from adding each variable to the multiple regression equation (one variable per row), and the significance test of each variable's contribution toward explaining the dependent measure. The columns of the table include the cumulative percentage of explained variance (cum $R^2$), added contribution in explained variance of the variable ($sR^2$), test of the contribution of the new variable ($F(sR^2)$), and the degrees of freedom (df) for the test.

**Table 3**

| HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR EFFECTS OF THE INTERVENTION COMPONENTS ON POSTINTERVENTION - PERFORMANCE COVARYING ALGEBRA PRETEST SCORES | | | | | | |
|---|---|---|---|---|---|---|
| **DEPENDENT VARIABLE** | **INDEPENDENT VARIABLE** | **Cumul. $R^2$** | **$sR^2$** | **F ($sR^2$)** | **df** | **Sig. p** |
| GRADE FALL 1990 | PRETEST ALGEBRA | .01 | .01 | 0.11 | 1,17 | ns |
| | +SAT CLASSES SC | .01 | .00 | 0.00 | 1,16 | ns |
| | +FIELD TRIPS FT | .16 | .15 | 2.75 | 1,15 | ns |
| | +WORKSHOPS WS | .21 | .05 | 0.94 | 1,14 | ns |
| | +SC-by-PRETEST | .22 | .00 | 0.03 | 1,13 | ns |
| | +FT-by-PRETEST | .22 | .00 | 0.00 | 1,12 | ns |
| | +WS-by-PRETEST | .25 | .04 | 0.56 | 1,11 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR EFFECTS OF THE INTERVENTION COMPONENTS ON POSTINTERVENTION - PERFORMANCE COVARYING ALGEBRA PRETEST SCORES**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLE | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| GEOMETRY GRADE | PRETEST ALGEBRA | .17 | .17 | 4.90 | 1,24 | ≤.05 |
| | +SAT CLASSES SC | .55 | .38 | 19.23 | 1,23 | ≤.01 |
| | +FIELD TRIPS FT | .60 | .06 | 3.16 | 1,22 | ≤.10 |
| | +WORKSHOPS WS | .63 | .03 | 1.48 | 1,21 | ns |
| | +SC-by-PRETEST | .63 | .00 | 0.20 | 1,20 | ns |
| | +FT-by-PRETEST | .64 | .01 | 0.47 | 1,19 | ns |
| | +WS-by-PRETEST | .66 | .02 | 0.93 | 1,18 | ns |
| GEOMETRY EXAM | PRETEST ALGEBRA | .32 | .31 | 11.27 | 1,24 | ≤.01 |
| | +SAT CLASSES SC | .51 | .19 | 8.73 | 1,23 | ≤.01 |
| | +FIELD TRIPS FT | .57 | .06 | 3.05 | 1,22 | ≤.10 |
| | +WORKSHOPS WS | .58 | .02 | 0.88 | 1,21 | ns |
| | +SC-by-PRETEST | .59 | .00 | 0.11 | 1,20 | ns |
| | +FT-by-PRETEST | .63 | .00 | 0.22 | 1,19 | ns |
| | +WS-by-PRETEST | | .04 | 2.12 | 1,18 | ns |

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

Seven models of independent variable were tested for each dependent variable: (1) Pretest Algebra, (2) Pretest & Saturday Classes, (3) Pretest & Saturday Classes & Field Trips, (4) Pretest and Saturday Classes & Field Trips & Workshops, (5) Pretest & Saturday Classes and Field Trips & Workshops & Saturday Classes-by-Pretest, etc.

*Interrelationships among the performance measures.* Table 4 presents the intercorrelations among the 5 performance measures: algebra pretest, geometry exam score, geometry grade, fall 1990 mathematics grade, and spring 1990 algebra grade. Note that the algebra pretest was significantly correlated with geometry and algebra performance, but that only the algebra grade was a significant predictor of the mathematics grade in the fall of 1990. As expected, the two geometry measures were highly correlated.

**Table 4**

**INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a]**

| | Algebra Pretest (n) Sig. p | Geometry Exam (n) Sig. p | Geometry Grade (n) Sig. p | Fall '90 Math Grade (n) Sig. p |
|---|---|---|---|---|
| Geometry Exam | .57<br>(27)<br>≤.01 | 1.00 | | |

| INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a] | | | | |
|---|---|---|---|---|
| | **Algebra Pretest (n) Sig. p** | **Geometry Exam (n) Sig. p** | **Geometry Grade (n) Sig. p** | **Fall '90 Math Grade (n) Sig. p** |
| Geometry Grade | .38<br>(28)<br>≤.05 | .86<br>(28)<br>≤.01 | 1.00 | |
| Fall 1990 Math Grade | -.09<br>(20)<br>ns | -.07<br>(21)<br>ns | -.05<br>(21)<br>ns | 1.00 |
| Spring '90 Algebra I Grade | .43<br>(19)<br>≤.05 | .43<br>(20)<br>≤.03 | .57<br>(20)<br>≤.01 | .25<br>(35)<br>≤.10 |
| [a] All correlations were analyzed as one-tailed tests. | | | | |

*Relationships between performance and participation.* Table 5 presents the unadjusted correlations between the 4 postintervention performance measures and the level of participation in each component of the intervention. Note that participation was not related to fall 1990 mathematics grades. All other correlations were positive and significantly greater than zero.

**Table 5**

| CORRELATIONS BETWEEN PERFORMANCE AND PARTICIPATION MEASURES | | | |
|---|---|---|---|
| | **Saturday Coll. Sig. p (n)** | **Field Trips Sig. p (n)** | **Workshops Sig. p (n)** |
| Geometry Exam | .48<br>≤.01 (28) | .48<br>≤.01 (28) | .37<br>≤.05 (27) |
| Geometry Grade | .62<br>≤.05 (29) | .54<br>≤.01 (29) | .66<br>≤.01 (27) |
| Fall 1990 Math Grade | -.01<br>ns (21) | -.25<br>ns (21) | .08<br>ns (20) |
| Spring 1990 Algebra I Grade | .50<br>≤.01 (20) | .34<br>≤.10 (20) | .45<br>≤.05 (19) |

Opinion Measures

*Group differences on pre- and postintervention measures.* The means of the intervention- and control-group students were compared for the 13 opinion scales, three constructs, and total opinion score, measured before and after the intervention. The results of the 34 t-tests are given in Table 6.

Before the intervention began, the students in the intervention group had significantly higher scores on four of the seventeen opinion measures: The SET Goal construct scores, Value scores, and Career Awareness scores for the intervention-group students indicated more favorable opinions about SET fields and careers, and the Locus of Control scores for the intervention-group students were more internal.

Following the intervention, the intervention-group students had higher scores on four measures of opinion: The intervention-group students' scores on the Aspiration, Environmental Support construct, Career Awareness, and Role Model measures were higher. However, these results may have been due to preexisting differences.

**Table 6**

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT/Scale | TIME | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| OPINION, Total | Pretest | 2.84 | .22 | 2.95 | .26 | 1.58 | ns |
| | Posttest | 2.88 | .21 | 2.94 | .33 | 0.56 | ns |
| SET GOAL | Pretest | 3.06 | .25 | 3.21 | .32 | 1.79 | ≤.10 |
| | Posttest | 3.14 | .29 | 3.14 | .38 | -0.05 | ns |
| Value | Pretest | 3.24 | .47 | 3.53 | .39 | 2.35 | ≤.05 |
| | Posttest | 3.52 | .32 | 3.26 | .51 | -1.84 | ns |
| Cultural Value | Pretest | 3.40 | .31 | 3.43 | .35 | 0.22 | ns |
| | Posttest | 3.48 | .42 | 3.41 | .38 | -0.61 | ns |
| Self-Concept | Pretest | 2.91 | .45 | 2.98 | .47 | 0.51 | ns |
| | Posttest | 2.96 | .43 | 2.98 | .48 | 0.10 | ns |
| Aspiration | Pretest | 2.84 | .46 | 3.08 | .50 | 1.66 | ns |
| | Posttest | 2.79 | .43 | 3.00 | .52 | 1.36 | ≤.10 |
| ATTITUDE | Pretest | 2.71 | .27 | 2.80 | .34 | 1.00 | ns |
| | Posttest | 2.74 | .26 | 2.78 | .38 | 0.40 | ns |
| Math/Science Attitude | Pretest | 2.83 | .34 | 2.97 | .42 | 1.26 | ns |
| | Posttest | 2.87 | .35 | 2.94 | .42 | 0.56 | ns |

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT/Scale | TIME | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| Locus of Control | Pretest | 2.91 | .51 | 3.22 | .53 | 2.04 | ≤.05 |
| | Posttest | 3.15 | .46 | 3.07 | .37 | -0.56 | ns |
| Persistence | Pretest | 2.76 | .69 | 2.90 | .66 | 0.72 | ns |
| | Posttest | 2.55 | .49 | 2.77 | .70 | 1.13 | ns 3 |
| Study Habits | Pretest | 2.54 | .39 | 2.68 | .46 | 1.15 | ns |
| | Posttest | 2.78 | .46 | 2.72 | .50 | -0.35 | ns |
| Anxiety | Pretest | 2.56 | .46 | 2.42 | .60 | -0.83 | ns |
| | Posttest | 2.50 | .60 | 2.51 | .68 | 0.06 | ns |
| ENVIRONMENTAL SUPPORT | Pretest | 2.73 | .29 | 2.83 | .32 | 1.12 | ns |
| | Posttest | 2.77 | .38 | 2.92 | .33 | 1.43 | ≤.10 |
| Career Awareness | Pretest | 2.70 | .36 | 2.95 | .46 | 2.05 | ≤.05 |
| | Posttest | 2.83 | .52 | 3.11 | .39 | 1.99 | ≤.05 |
| Role Model | Pretest | 2.24 | .70 | 2.51 | .51 | 1.52 | ns |
| | Posttest | 2.40 | .56 | 2.67 | .53 | 1.58 | ≤.10 |
| Equal Opportunity | Pretest | 2.83 | .45 | 2.86 | .66 | 0.17 | ns |
| | Posttest | 2.77 | .71 | 2.99 | .50 | 1.17 | ns |

All pretests were analyzed as two-tailed tests.
All posttests were analyzed as one tailed tests.
Pretests n's: Control = 20; Intervention = 28
Posttest n's: Control = 16; Intervention = 27

To adjust for preexisting differences and provide a more sensitive test of the intervention's effects on opinion, the final opinion measures were adjusted for preexisting opinion scores via ANCOVA.

*Group differences on opinion adjusting for prior scores.* A hierarchical ANCOVA adjusted for preintervention opinion scores before comparing groups on the postintervention measures of opinion; the results are given in Table 7. By these analyses, the groups differed on only one opinion measure: The control-group students placed higher Value on SET fields and careers (adjusted M = 3.54) than did the intervention-group students (adjusted M = 3.16). Thus, tests did not support the hypothesis of enhanced opinions about SET fields due to the intervention.

Table 7

HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLE MODELS | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| OPINION, Total | SCORE | .38 | .38 | 21.45 | 1,35 | ≤.01 |
| | +GROUP (GP) | .39 | .01 | 0.32 | 1,34 | ns |
| | +SCORE-x-GP | .39 | .00 | 0.00 | 1,33 | ns |
| SET GOAL | SCORE | .36 | .36 | 19.42 | 1,35 | ≤.01 |
| | +GROUP (GP) | .37 | .01 | 0.67 | 1,34 | ns |
| | +SCORE-x-GP | .38 | .01 | 0.47 | 1,33 | ns |
| Value | SCORE | .04 | .04 | 1.40 | 1,35 | ns |
| | +GROUP (GP) | .16 | .12 | 4.86 | 1,34 | ≤.05 |
| | +SCORE-x-GP | .16 | .01 | 0.25 | 1,33 | ns |
| Cultural Value | SCORE | .00 | .00 | 0.05 | 1,35 | ns |
| | +GROUP (GP) | .01 | .01 | 0.27 | 1,34 | ns |
| | +SCORE-x-GP | .01 | .00 | 0.00 | 1,33 | ns |
| Self-Concept | SCORE | .43 | .43 | 26.32 | 1,35 | ≤.01 |
| | +GROUP (GP) | .43 | .00 | 0.01 | 1,34 | ns |
| | +SCORE-x-GP | .44 | .01 | 0.50 | 1,33 | ns |
| Aspiration | SCORE | .29 | .29 | 14.02 | 1,35 | ≤.01 |
| | +GROUP (GP) | .29 | .01 | 0.26 | 1,34 | ns |
| | +SCORE-x-GP | .29 | .00 | 0.10 | 1,33 | ns |
| ATTITUDE | SCORE | .54 | .54 | 40.95 | 1,35 | ≤.01 |
| | +GROUP (GP) | .54 | .00 | 0.26 | 1,34 | ns |
| | +SCORE-x-GP | .55 | .01 | 0.55 | 1,33 | ns |
| Math/Science Attitude | SCORE | .40 | .40 | 23.01 | 1,35 | ≤.01 |
| | +GROUP (GP) | .40 | .00 | 0.00 | 1,34 | ns |
| | +SCORE-x-GP | .43 | .03 | 1.89 | 1,33 | ns |
| Locus of Control | SCORE | .05 | .05 | 1.76 | 1,35 | ns |
| | +GROUP (GP) | .09 | .04 | 1.48 | 1,34 | ns |
| | +SCORE-x-GP | .09 | .00 | 0.15 | 1,33 | ns |
| Persistence | SCORE | .39 | .39 | 22.74 | 1,35 | ≤.01 |
| | +GROUP (GP) | .39 | .00 | 0.03 | 1,34 | ns |
| | +SCORE-x-GP | .41 | .01 | 0.81 | 1,33 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLE MODELS | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Study Habits | SCORE | .26 | .26 | 12.27 | 1,35 | ≤.01 |
| | +GROUP (GP) | .26 | .00 | 0.08 | 1,34 | ns |
| | +SCORE-x-GP | .28 | .02 | 0.87 | 1,33 | ns |
| Anxiety | SCORE | .45 | .45 | 28.93 | 1,35 | ≤.01 |
| | +GROUP (GP) | .45 | .00 | 0.00 | 1,34 | ns |
| | +SCORE-x-GP | .47 | .02 | 0.99 | 1,33 | ns |
| ENVIRONMENTAL SUPPORT | SCORE | .04 | .04 | 1.46 | 1,35 | ns |
| | +GROUP (GP) | .04 | .00 | 0.07 | 1,34 | ns |
| | +SCORE-x-GP | .04 | .00 | 0.03 | 1,33 | ns |
| Academic Support | SCORE | .13 | .13 | 5.02 | 1,35 | ≤.05 |
| | +GROUP (GP) | .17 | .04 | 1.63 | 1,34 | ns |
| | +SCORE-x-GP | .18 | .02 | 0.62 | 1,33 | ns |
| Career Awareness | SCORE | .00 | .00 | 0.13 | 1,35 | ns |
| | +GROUP (GP) | .05 | .05 | 1.67 | 1,34 | ns |
| | +SCORE-x-GP | .05 | .00 | 0.05 | 1,33 | ns |
| Role Model | SCORE | .26 | .26 | 12.22 | 1,35 | ≤.05 |
| | +GROUP (GP) | .26 | .00 | 0.10 | 1,34 | ns |
| | +SCORE-x-GP | .31 | .05 | 2.16 | 1,33 | ns |
| Equal Opportunity | SCORE | .14 | .14 | 5.55 | 1,35 | ≤.05 |
| | +GROUP (GP) | .15 | .01 | 0.43 | 1,34 | ns |
| | +SCORE-x-GP | .15 | .00 | 0.09 | 1,33 | ns |

All models were analyzed as one-tailed tests.

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure). (1) PRETEST OPINION SCORE; (2) PRETEST OPINION SCORE and GROUP; (3) PRETEST OPINION SCORE and GROUP and SCORE-by-GROUP INTERACTION

*Relationships between postintervention opinions and participation.* The correlations between postintervention opinion scores and level of participation in the three components of the intervention are given in Table 8. Participation in the field trips was positively correlated with 15 of the 17 measures, attendance at the 4 workshops was positively correlated with 9 of the 17 opinion measures, and Saturday class attendance was correlated with 5 of the 17 measures. However, rather than indicating effects due to the intervention, these results might indicate that students with more favorable attitudes had better attendance.

Table 8

| CORRELATION BETWEEN OPINION MEASURES AND PARTICIPATION[a] | | | |
|---|---|---|---|
| **OPINION CONSTRUCT/Scale** | **Saturday College n = 27** | **Field Trips n = 27** | **Workshops n = 26** |
| OPINION, Total | .26 ≤.10 | .54 ≤.01 | .41 ≤.05 |
| SET GOAL | .23 ns | .49 ≤.01 | .41 ≤.05 |
| Value | .19 ns | .33 ≤.05 | .46 ≤.01 |
| Cultural Value | .16 ns | .48 ≤.01 | .55 ≤.01 |
| Self-Concept | .09 ns | .38 ≤.05 | .22 ns |
| Aspiration | .31 ≤.10 | .43 ≤.05 | .25 ns |
| ATTITUDE | .32 ≤.10 | .46 ≤.01 | .44 ≤.05 |
| Math/Science Attitude | .23 ns | .44 ≤.05 | .36 ≤.05 |
| Locus of Control | .21 ns | .14 ns | .16 ns |
| Persistence | .17 ns | .40 ≤.05 | .37 ≤.05 |
| Study Habits | .33 ≤.05 | .26 ≤.10 | .26 ≤.10 |
| Anxiety | .21 ns | .27 ≤.10 | .31 ≤.10 |
| ENVIRONMENTAL SUPPORT | .02 ns | .51 ≤.01 | .13 ns |
| Academic Support | .27 ≤.10 | .40 ≤.05 | .05 ns |
| Career Awareness | .06 ns | .41 ≤.05 | .26 ns |
| Role Model | .07 ns | .34 ≤.05 | .12 ns |
| Equal Opportunity | -.40 ns | .12 ns | -.05 ns |

[a] All one-tailed tests.

Summary of Results

Table 9 summarizes the findings as effect sizes. As the effect sizes indicate, the level of participation in the intervention had a moderate-to-large positive relationship with performance in geometry. The relationship between fall 1990

mathematics grades and attendance was variable: Attendance at Saturday classes was not related, field trip attendance was negatively related, and attendance at workshops was positively related. However, because there was no preintervention measure of performance for both the control-group and intervention-group students, these data were analyzed as a preexperimental research design, and the effects related to the intervention cannot be considered to be caused by the intervention.

**Table 9**

| EFFECT SIZES | | | |
|---|---|---|---|
| **VARIABLE** | **Saturday Classes** | **Field Trips** | **Workshops** |
| **PERFORMANCE** | | | |
| Grade Fall 1990 | .00 | -.76 | .45 |
| Geometry Grade | 1.72 ≤.01 | .70 ≤.10 | .48 |
| Geometry Exam | 1.16 ≤.01 | .68 ≤.10 | -.37 |
| OPINION | | | |
| **Total Opinion** | **.24** | **-.20** | **.00** |
| SET Goal | -.07 | -.29 | .24 |
| Attitude | .20 | -.18 | .26 |
| Environmental Support | .38 ≤.10 | .09 | .28 |

Note. The measure of effect size was calculated according to B.T. Johnson (1989). A positive sign in the "Posttest" or "Adjusted Posttest" columns indicates that the intervention group outperformed the control group; a negative sign indicates that the control group had the higher score. For a significant interaction effect size, a positive sign indicates that the intervention helped students scoring lower on the pretest more than it helped the higher scoring students; a negative sign on the interaction effect size indicates that the intervention helped students scoring higher on the pretest more than it helped lower scoring students.

The performance effect sizes were based on the ANCOVA results of Table 3, i.e. the Algebra pretest was covaried.

The hypothesis of enhanced opinion due to the intervention received no support from these results. The small, positive effects of the intervention on opinion based on the t-test results disappeared when preexisting opinions were controlled for via ANCOVA. Based on these results, the intervention had no positive effects on opinion.

## DISCUSSION

The hypothesis of increased enrollment in advanced mathematics courses as a result of the intervention received partial support: Seventy-six percent of the intervention-group students enrolled in advanced mathematics courses in the fall 1990

semester, and 57 percent of the intervention-group students enrolled in and passed an advanced mathematics course in the fall of 1990. However, grades received in mathematics did not show any significant improvement in spring 1990 or fall 1990 as a result of the intervention.

The hypothesis of enhanced opinion as a result of the intervention received no support: The intervention-group students began with generally higher opinion scores, and when this advantage was adjusted for, the intervention-group students did not have more favorable postintervention attitudes about SET fields and careers.

Though the intervention's opinion results were analyzed as a quasi-experiment with the ensuing caution about causal conclusions, the groups appeared comparable before the intervention. Comparisons on a total of 71 preintervention measures found significant differences on only six percent, which included a broad range of demographic (the groups differed on 1 of 58 measures) and opinion measures (3 of 13). All of the differences favored the intervention-group students.

The goal of the intervention was to get mainly sophomore students on a college-bound track by taking geometry in their sophomore year and enrolling in advanced mathematics courses in their junior year in high school. The intervention met this goal for 76 percent of the students who had transcripts for the fall 1990 semester. However, the advanced mathematics students had low grades in the fall ($\underline{M}$ = 1.00, a "D"); and their future in SET studies appears uncertain. A longer follow-up that could provide evidence of persistence and success in SET courses would strengthen confidence in the intervention's success.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# APPENDICES

# APPENDIX A

# HIGH SCHOOL STUDENT PROTOCOL

Participant Number: _____

## HIGH SCHOOL STUDENT PROTOCOL

Thank you for agreeing to participate in this important project. It is geared to help us develop new programs for students and improve existing programs.

Your opinions and experience are important to us. Please read each question carefully and answer completely and accurately to the best of your ability. All of your answers will be kept in confidence. Your answers will be grouped with those of other students in other places, and together they will help us better understand students' needs and preferences today.

Please ask your administrator if any of these questions are unclear to you.

Thanks for your help!

1. Sex:
   - ___ a. Male
   - ___ b. Female

2. When were you born? _____ _____ _____
   month day year

3. Ethnicity/race:
   - ___ a. Anglo
   - ___ b. Black
   - ___ c. Asian American
   - ___ d. American Indian (Please specify the tribe which best describes your heritage.)

     _____
   - ___ e. Hispanic (Which of the following best describes your heritage?)
     - ___ a. Cuban-American
     - ___ b. Mexican-American
     - ___ c. Puerto Rican
     - ___ d. Other Specify _____
   - ___ f. Other Specify _____

4. Are you a United States citizen?
   - ___ a. Yes
   - ___ b. No

5. Name of your school: _____

   City: _____ State: _____

6. Class:
   ___ a. High School Freshman
   ___ b. High School Sophomore
   ___ c. High School Junior
   ___ d. High School Senior
   ___ e. Other Specify _____

7. Which of the following college entrance exams have you taken?
   ___ a. I haven't taken any
   ___ b. ACT
   ___ c. PSAT or SAT
   ___ d. Other Specify _____
   ___ f. Other Specify _____

8. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Less than high school graduation
   ___ b. High school graduation
   ___ c. Two-year college degree (community college or junior college)
   ___ d. Four-year college degree
   ___ e. Education beyond four years of college
   ___ f. Other Specify _____

9. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

10. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)
   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Job
   ___ d. Previous personal earnings and savings
   ___ e. Family trust fund, insurance plan, or other similar arrangement
   ___ f. Other Specify _____

11. You may want to receive help outside your regular high school course work. If so, check the letter for each area in which you may want help. (Check all that apply)
    ___ a. Counseling about educational plans and opportunities
    ___ b. Counseling about career plans and opportunities
    ___ c. Improving mathematical ability
    ___ d. Finding part-time work
    ___ e. Counseling about personal problems
    ___ f. Increasing reading ability
    ___ g. Developing good study habits
    ___ h. Improving writing ability

12. What is or are the occupation(s) of the person(s) with whom you live? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

    _____ _____

13. Would you say that your family's income is:
    ___ a. Below the U.S. average
    ___ b. About average
    ___ c. Above average
    ___ d. Don't know

14. Are you:
    ___ a. An only child (skip to question 13)
    ___ b. The oldest child
    ___ c. The youngest child
    ___ d. An in-between child

15. How many brothers and sisters do you have?
    ___ a. One
    ___ b. Two
    ___ c. Three or more

16. What was the highest level of school your father completed? (Check only the highest)
    ___ a. Grade school or less
    ___ b. Some high school but did not graduate
    ___ c. High school graduate
    ___ d. Some college but no degree
    ___ e. College degree or more
    ___ f. Don't know

17. What was the highest level of school your mother completed? (Check only the highest)
    ___ a. Grade school or less
    ___ b. Some high school but did not graduate
    ___ c. High school graduate
    ___ d. Some college but no degree
    ___ e. College degree or more
    ___ f. Don't know

18. What is the language spoken most often by adults in your household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe (What is that language?) _____
___ d. Another language - Specify _____

19. Which of the following did your parent(s) or guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

20. Which of the following comes closest to describing how much your parent(s) or guardian(s) read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

21. Which of the following comes closest to describing how much you read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

22. Which of these items do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

23. What kind of high school or secondary school do you attend?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

24. Are you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes (Please list them.)

_____

_____

_____

_____

_____

25. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL ITEMS WITH DIRECTIONALITY AND SCALES

Legend:

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of my ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |

| | | | |
|---|---|---|---|
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

    i. _____

    ii. _____

    iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE HIGH SCHOOL STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 30 | CONTROL n = 23 |
| 1. Sex | | |
| Women | 67% | 74% |
| Men | 33% | 26% |
| 2. Age | 15.79 | 15.66 |
| 6. Class | | |
| .Freshmen | 3% | 13% |
| .Sophomores | 63% | 65% |
| .Juniors | 30% | 22% |
| .Seniors | 3% | 0% |
| 7. Taken college entrance exam | 27% | 22% |
| .Missing | 0% | 9% |
| 8. Higher education expected: | | |
| .Less than high school | 0% | 4% |
| .HS graduate | 0% | 0% |
| .Two years of college | 10% | 17% |
| .Four years of college | 43% | 44% |
| .One or more years after college | 43% | 35% |
| 9. Studies most influenced by | | |
| .Parents | 77% | 78% |
| .Another family member | 3% | 0% |
| .Teacher | 0% | 4% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 0% |
| .Friend | 3% | 4% |
| .Science professional | 3% | 0% |
| .Nonscience professional | 3% | 0% |
| .No one at all | 3% | 9% |
| .Missing | 7% | 4% |
| 10. Sources of income[b] | | |
| .Parents/guardians | 87% | 74% |
| .Spouse | 3% | 4% |
| .Job | 70% | 65% |
| .Personal Savings | 17% | 13% |
| .Family trust, etc. | 17% | 9% |
| .Other | 0% | 4% |
| Number of sources of income * | 2.00 | 1.74 |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 30 | CONTROL n = 23 |
| | | |
| 11. Student needs help in:[b] | | |
| .Counseling on educational plans | 33% | 17% |
| .Counseling on career plans | 47% | 26% |
| .Improving math ability | 37% | 39% |
| .Finding part-time work | 47% | 65% |
| .Counseling on personal problems | 0% | 4% |
| .Increasing reading ability | 7% | 9% |
| .Developing good study habits | 50% | 56% |
| .Improving writing ability | 30% | 17% |
| Number of areas needing help * | 2.50 | 2.35 |
| 12. Sources of outside income | | |
| .None | 3% | 0% |
| .One | 50% | 39% |
| .Two | 27% | 44% |
| .Missing | 20% | 17% |
| 13. Family income: | | |
| .Below U.S. average | 10% | 0% |
| .About average | 53% | 48% |
| .Above average | 27% | 17% |
| .Unknown | 20% | 25% |
| 14. Birth order of student: | | |
| .Only child | 10% | 9% |
| .Oldest child | 50% | 48% |
| .Youngest child | 13% | 13% |
| .In-between child | 27% | 30% |
| .Missing | | |
| 15. Number of siblings: | | |
| .None | 10% | 9% |
| .One | 27% | 13% |
| .Two | 33% | 35% |
| .Three or more | 27% | 44% |
| .Missing | 3% | 0% |
| 16. Father's education: | | |
| .Grade school or less | 7% | 4% |
| .Some high school | 17% | 9% |
| .High school graduate | 23% | 26% |
| .Some college | 30% | 30% |
| .College degree or more | 17% | 30% |
| .Missing | 7% | 0% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 30 | CONTROL n = 23 |
| | | |
| 17. Mother's education: | | |
| .Grade school or less | 3% | 0% |
| .Some high school | 10% | 4% |
| .High school graduate | 17% | 13% |
| .Some college | 30% | 48% |
| .College degree or more | 37% | 35% |
| .Missing | 3% | 0% |
| 18. Language spoken most at home: | | |
| .English | 87% | 87% |
| .Spanish | 13% | 13% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| 19. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 50% | 35% |
| .Attend parent-teacher conferences | 67% | 61% |
| .Visit student's class | 67% | 56% |
| .Phone/visit if there's a problem | 73% | 83% |
| .Do volunteer work | 27% | 35% |
| .Assist student in course selection | 40% | 35% |
| .Assist in student's homework | 77% | 70% |
| Number of parental involvements * | 4.00 | 3.74 |
| 20. Parent(s) read: | | |
| .Not at all | 3% | 0% |
| .Sometimes | 13% | 26% |
| .A lot | 83% | 70% |
| .Missing | 0% | 4% |
| 21. Student reads: | | |
| .Not at all | 7% | 0% |
| .Sometimes | 43% | 61% |
| .A lot | 50% | 39% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 30 | CONTROL n = 23 |
| | | |
| 22. Items in student's home:[b] | | |
| .Desk | 73% | 65% |
| .Daily newspaper | 87% | 78% |
| .Encyclopedia | 77% | 74% |
| .Typewriter | 77% | 48%[a] |
| .Calculator | 87% | 91% |
| .Television | 97% | 100% |
| .Computer | 40% | 22% |
| .Video Cassette Recorder (VCR) | 83% | 91% |
| Number of support items * | 6.20 | 5.70 |
| 23. Type of high school attended | | |
| .Public | 97% | 87% |
| .Private | 0% | 0% |
| .No formal high school | 3% | 0% |
| .Missing | 0% | 13% |
| 24. Member math/science club in high school | 53% | 35% |
| 25. All activities student took part in:[b] | | |
| .Math/science club | 27% | 26% |
| .Field trip | 73% | 78% |
| .Watching science programs on TV | 67% | 48% |
| .Listen to talk by scientist | 17% | 26% |
| .Science/math fair | 50% | 48% |
| .Other science/math competition | 17% | 17% |
| .Play/work in computer lab | 73% | 61% |
| Number of activities * | 3.23 | 3.04 |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# MARY HOLMES COLLEGE

# INTERVENTIONS

Prepared by:

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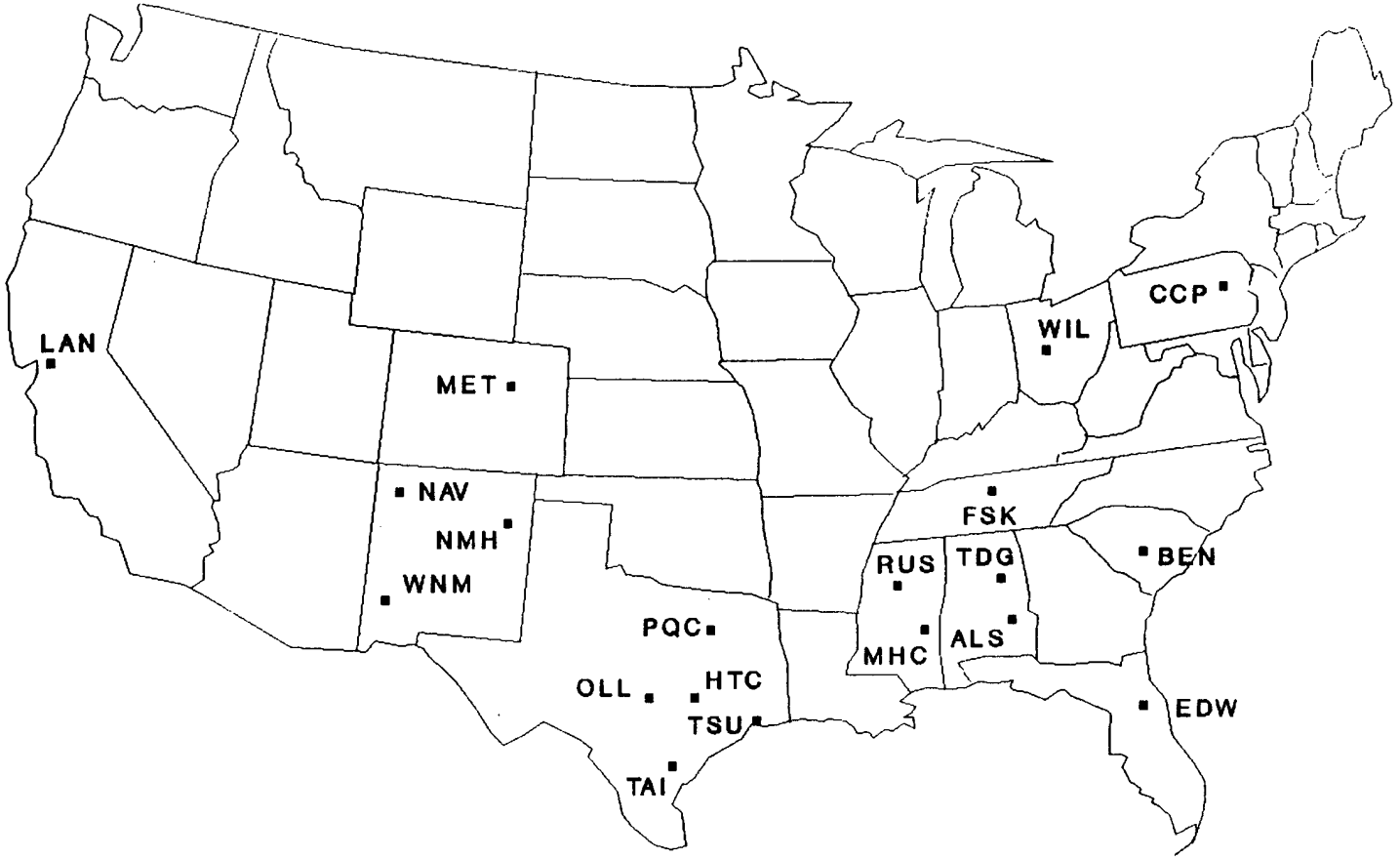
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART 1

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected come from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention-group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF MARY HOLMES COLLEGE

Mary Holmes College is a two-year, private, coeducational institution located in West Point, Mississippi. The community of Mary Holmes College consists of approximately 500 students and 26 faculty members. The College offers associate degrees and is organized into four divisions: Business and Computer Science, Education and Social Science, Humanities, and Natural Sciences and Mathematics. The student body is approximately 56 percent female and 44 percent male. Approximately 99 percent of the students are Black and 1 percent are of other ethnic origins. The president of Mary Holmes College is Dr. Sammie Potts.

Degrees offered at Mary Holmes College in quantitative subjects are Associate in Science in computer science, chemical technology, pre-science, mathematics, and pre-engineering.

West Point has a population of around 10,000 and is about 50 percent Black and 50 percent Anglo. The state of Mississippi has a population of approximately 2.7 million. According to U.S. Census Bureau estimates, the adult population of Mississippi is 68 percent Anglo, 31 percent Black, and 1 percent other ethnic origins. West Point and the towns of Starkville and Columbus make up the Golden Triangle area. The Golden Triangle area has two other institutions of higher learning: Mississippi State University and Mississippi University for Women.

# PART II

# SUMMARY OF THE MARY HOLMES COLLEGE INTERVENTIONS

This report summarizes the four interventions conducted by Mary Holmes College, a two-year private institution located in West Point, Mississippi. Mary Holmes College is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

## Mary Holmes College Intervention Activities:

In Spring and Fall of 1989, and in Spring and Fall of 1990, Mary Holmes College conducted four interventions for college students. Each intervention consisted of Saturday enrichment classes, a motivational seminar, and major out-of-town field trips to such destinations as EPCOT center in Orlando, Florida and NASA/Johnson Space Center in Houston, Texas. Participants were college freshmen and sophomores majoring in natural science, mathematics, and computer science. All intervention participants took enrichment classes in communication skills and mathematics, plus two other enrichment classes according to their majors. Mathematics and natural science majors took biology and chemistry enrichment classes; computer science majors took keyboarding and computer science enrichment classes. A part of the intervention design was that students were expected to participate in several semesters of the intervention. Nearly all students participated in more than one semester of intervention: 58% participated in two semesters, and 36% in three or four.

## Findings:

- Steady gains in performance were achieved through the four semesters of this intervention.
- The positive effect in performance grew from semester to semester, even though the content tests were successively more difficult.
- There were indications that the intervention was particularly helpful for women.
- The intervention overcame the disadvantage of having participated in fewer math and science activities in high school.
- Each intervention component made a unique contribution: Saturday College classes were related to higher postintervention grade point averages and California Achievement Test scores; field trips were related to a higher grade point average and enhanced opinions; and the motivational seminar was related to enhanced opinion.

## Recommendations:

- Students should participate in more than one semester of intervention, for stronger gains in performance.
- Field trips which include out-of-town travel, an experience which may be new for many target students, can have a powerful effect on performance as well as on opinion.

# PART III

# CASE STUDY OF THE MARY HOLMES COLLEGE

# 1988 SPRING INTERVENTION

## ABSTRACT

In the spring of 1989 Mary Holmes College, West Point, Mississippi, conducted and tested against a control group a Saturday College intervention program designed to improve the academic skills and motivation of college freshmen and sophomores. Participants were 69 Black undergraduate college students (38 women and 31 men) majoring in natural science, mathematics, or computer science. The intervention was repeated in the fall of 1989, in the spring of 1990, and in the spring of 1991.

The Mary Holmes College program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES*: Hypotheses were that the intervention would: (a) enhance performance in academic areas important to success in science, engineering, and technology (SET) fields: mathematics and communications for all students; keyboarding and computer science for the computer science majors; chemistry and biology for the mathematics and natural science majors, and (b) enhance opinions about SET fields and careers.

*COMPONENTS*: A major component of the thirteen-week intervention program was instruction in mathematics and communications skills during Saturday College classes; the computer science majors also had classes in computer science and keyboarding, while the mathematics and natural science majors had classes in biology and chemistry. Other important components were field trips to Marshall Space Flight Center and Mississippi State University, and a career counseling and motivational seminar.

*DATA*: All the participants furnished demographic data through the CASET College Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were pretest and posttest scores on a brief, faculty-generated content test, pretest and posttest scores on the California Achievement Test (CAT), college GPAs, and attendance.

The outcome measures of performance were the posttest score on a faculty-generated content test, posttest score on the CAT, and postintervention college GPA. The preintervention measures of performance were the pretest score on a faculty-generated content test and pretest score on the CAT.

*RESEARCH DESIGN*: The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design. Analyses of preintervention measures indicated that two demographic differences related to performance favored the intervention group over the control group; these differences were used as final adjustments to verify the interpretation of group differences.

*FINDINGS*: In general, the intervention had a positive effect on the participants and can be considered a successful intervention. Data analyses indicated that the intervention was associated with higher content test scores in general and was especially helpful for women; the intervention also overcame the disadvantage of having participated in fewer math/science activities in high school. The findings further suggest that two of the intervention components, the field trips and seminar, had significant positive effects on students' opinions. Each of the three intervention components made unique contributions to the overall effectiveness of the program: Saturday College classes were related to better performance, as indicated by GPAs and CAT scores; field trips were related to one higher performance measure (GPA) and four enhanced opinion measures; and the seminar was related to five enhanced opinion measures.

## DESCRIPTION OF THE INTERVENTION

Today, as well as in the past, Mary Holmes College is proud of offering higher educational opportunities, through an open admissions policy, to those students who might otherwise not be served. In keeping with that tradition, the College developed an intervention aimed at increasing the skills and motivation of Black freshmen and sophomores majoring in natural science, mathematics, and computer science. The Saturday College format of the intervention featured work in small classes, two field trips, and a seminar.

The 33 intervention participants were divided into two groups according to their major area of study: Mathematics/Natural Science and Computer Science. To allow work in small groups, the larger groups were subdivided into eight groups of five or fewer students.

While all students took coursework in communication skills and mathematics, the rest of each participant's schedule was structured around her or his major. For example, the Mathematics/Natural Science majors took biology and chemistry; the Computer Science majors also took computer science and keyboarding.

The Mathematics/Natural Science students were in Groups 1-4, and the Computer Science students were Groups 5-8. The groups rotated through the instructional periods as follows:

| | 8:00 - 8:50 | 9:00 - 9:50 | 9:50 - 11:00 | 11:00 - 11:50 | 12:00 - 12:50 |
|---|---|---|---|---|---|
| Biology | Group 1 | Group 2 | Break | Group 3 | Group 4 |
| Chemistry | Group 2 | Group 3 | Break | Group 4 | Group 1 |
| Computer Science | Group 7 | Group 8 | Break | Group 5 | Group 6 |
| Keyboarding | Group 8 | Group 5 | Break | Group 6 | Group 7 |
| Communication Skills | Group 3 & 5 | Group 4 & 6 | Break | Group 1 & 7 | Group 2 & 8 |
| Mathematics | Group 4 & 6 | Group 1 & 7 | Break | Group 2 & 8 | Group 3 & 5 |

CASET intervention-group students and staff members took two off-campus field trips during this intervention. On March 4, 1989, they visited the campus of Mississippi State University. Here they observed experiments, medical and computerized procedures, and obtained information about various divisions of the school.

The second field trip took place on April 22-23, 1989, when CASET participants and staff members visited the Marshall Space Flight Center in Huntsville, Alabama. The purpose of the trip was to explore the educational resources of the center, so that each student could begin to develop more positive attitudes toward technological careers and appreciate the complexities of human endeavors in space.

The intervention also featured a motivational component. CASET participants and staff members attended a seminar given by Dr. William McHenry, a Black research chemist and Assistant Dean at Mississippi State University. He was invited to Mary Holmes College on February 4, 1989. He encouraged students to enter into the science and technological fields of studies.

Activities took place on Saturdays from January 28, 1989 to April 29, 1989. Co-directors for this CASET project at Mary Holmes College were Dr. JoAnn Vicks, Dean of Mathematics and Natural Sciences, and Mrs. Fannie Gibson, Dean of Business and Computer Science.

The two hypotheses tested in this research were that the intervention would: (a) improve participants' performance in academic areas important to success in SET fields, and (b) enhance participants' opinions about SET fields and careers.

## METHOD

### Subjects

Participants were Black freshman and sophomore college students, majoring either in mathematics/natural science or in computer science. Two groups were formed according to major, and each had a corresponding same-major control group consisting of Black freshmen and sophomores. The control-group students did not participate in any of the intervention activities. All demographic, opinion, and performance data were collected from both the intervention and control group.

A total of 72 sets of protocols was received from 36 intervention-group and 36 control-group students. Three intervention-group students were eliminated from the sample because the students did not represent the populations that were the focus of this study: Two of those eliminated were non-U.S. citizens, and one was Asian-American, (not an underrepresented group in the SET fields). Sixty-nine sets of data were analyzed: 33 from the intervention group and 36 from the control group. All students were Black Americans; Table 1 shows the distribution of students in the Computer Science and Mathematics/Natural Science intervention and control groups, by sex.

**Table 1**

**Distribution of Women and Men in the Control and Intervention Groups for Each Concentration**

| | Computer Science | | Math/Natural Science | |
|---|---|---|---|---|
| **SEX** | **CONTROL** | **INTERVENTION** | **CONTROL** | **INTERVENTION** |
| Women | 10 | 9 | 12 | 7 |
| Men | 5 | 13 | 9 | 4 |
| TOTAL | 15 | 22 | 21 | 11 |

## CASET Protocols and Other Instruments

Demographic and descriptive data about the subjects were developed through the CASET College Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of 13 attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. CASET used these 13 attitudinal variables as the basis for the Opinion Protocol. For each of the 13 variables, several question items were developed, varying in directionality. Combining the question items for each variable gave a scalar measurement for that variable. Thus the completed Opinion Protocol provided a scale measuring each of the 13 variables. The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B. The Opinion Protocol was administered to intervention- and control-group students before and after the intervention.

A test of content was given to intervention- and control-group students before and after the intervention. The test addressed the areas covered for each of the two content groupings of students: All students answered the questions on mathematics and communication skills; the mathematics/natural science students answered additional questions on chemistry and biology; and the computer science students answered questions on keyboarding and computer science. The content test was developed and scored by project faculty.

Other performance measures were the California Achievement Test (CAT), a nationally standardized test administered before and after the intervention activities, and the college grade point average (GPA) after the intervention. Pre- and postintervention opinion measures were made with the CASET College Student Opinion Protocol. The demographic measures were portions of the College Student Protocol.

## Procedure

At the beginning of the intervention, intervention- and control- group members signed informed consent forms and transcript release forms. The first measures of opinion, performance, and demographic information were made in January, 1989. After the intervention, the CASET Opinion Protocol was administered a second time to all students, along with the faculty-generated posttests of content in the Saturday College courses.

The pre- and postintervention content tests were scored by the intervention faculty, who forwarded to CASET those scores for the intervention- and control-group students, along with the completed CASET instruments. The college also supplied college transcripts for intervention- and control-group students, and documentation of the extent of participation by each student in each component of the intervention, such as the number of Saturday College classes attended by each student.

The items of the Opinion Protocol were coded by CASET according to the 13 scales they represent. Scoring of the positively worded items on the Opinion Protocol was reversed so that scores could be totaled meaningfully (see Appendix B). The scales were organized into three constructs--SET Goal, Environmental Support, and Attitude--as shown in Appendix C.

# RESULTS

## Methodological Issues

The hypotheses being tested in this research are two: First, that the intervention as conducted in the Spring 1989 semester at Mary Holmes College will improve participants' performance; and second, that this intervention will change participants' opinions in ways thought to be favorable to pursuing SET studies and careers. This intervention had preintervention and postintervention assessments of opinion and performance for most participants, and was analyzed as a *nonequivalent control group* design. This type of quasi-experimental design has one major weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): group differences may be due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty may be addressed through analyses that examine the influence of preexisting characteristics on students' performance and opinion. The analysis of covariance (ANCOVA), adjusting for preintervention performance or opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that existed prior to the intervention.

## Demographic Results

The comparability of the intervention and control groups was examined by testing for differences on the items of the College Student Protocol. The complete results are given in Appendix D. Of the more than 70 comparisons, the groups differed on seven, six of which favored the intervention group: (a) intervention-group students had taken part in more math and science activities than had control-group students (intervention group $\underline{M}$ = 2.36, control group $\underline{M}$ = 1.61); (b) more intervention-group students had heard a talk by a scientist (24%) than had control-group students (3%); (c) more intervention-group students had been members of a math/science club in high school (48%) Than had control-group students (19%); (d) more intervention-group students had taken an advanced placement test (24%) than had control-group students (6%); (e) fewer intervention-group students reported a need for help with reading (3%) than did control-group students (25%); and (f) more intervention-group students were SET majors (46%) than were control-group students (17%), although this difference may not have been important because some non-SET majors may have been majoring in biomedical areas. The seventh difference was that fewer intervention-group students than control-group students were receiving financial support from their parents; this seemed to be ambiguous in its influence. However, five differences between the groups on preexisting characteristics seemed to be potentially related to performance or opinion.

The potential importance of five preexisting characteristics that differed between the groups was evaluated by testing for relationships with three postintervention performance measures: (a) GPA, (b) CAT grade equivalents, and (c) content test scores. (Because a scientist's lecture was included in number of math/science activities, it was not analyzed separately.) The first variable, number of math/science activities, was significantly correlated with GPA, but was not related to postintervention CAT or content test scores. The second variable tested, membership in a math/science club in high school, was significantly related to all three performance measures. Having taken an advanced placement test was related to performance in contradictory ways--not having taken an advanced placement test was related to higher CAT and lower content test scores. The fourth and fifth preexisting differences--needing help in reading and receiving financial support from one's parents--were not related to any of the postintervention performance measures. The two demographic differences that were related consistently to performance--math/science activities and club membership--were used as final demographic adjustments to verify the interpretation of group differences.

Performance Measures

*Group differences in performance.* The two preintervention measures and the three postintervention measures of performance were tested for group differences, and the results are given in Table 2. The only significant differences were that the intervention group outperformed the control group on the pretest and posttest of content. Note also that about one-third of the students with postintervention CAT scores lacked prior CAT scores, and only 52 percent of all students had both CAT scores. This large set of missing data created some doubt about the representativeness of the subsample with CAT scores and the generalizability of the CAT findings. Further analyses seemed necessary due to potential preintervention differences between the groups, and an ANCOVA that adjusted for pretest scores for all students was conducted.

**Table 2**

**GROUP COMPARISONS OF PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | Sig. p |
|---|---|---|---|---|---|---|
| Content Pretest | Control<br>Intervention | 35<br>33 | 37.34<br>48.91 | 13.16<br>18.09 | 3.03<br>(66) | $\leq$.01 |
| CAT Pretest | Control<br>Intervention | 17<br>19 | 8.76<br>8.96 | 1.57<br>1.36 | 0.42<br>(34) | ns |
| Content Posttest | Control<br>Intervention | 35<br>31 | 36.69<br>53.35 | 13.33<br>17.17 | 4.43<br>(64) | $\leq$.01 |
| CAT Posttest | Control<br>Intervention | 24<br>29 | 9.11<br>8.58 | 1.74<br>2.06 | -0.99<br>(51) | ns |
| GPA | Control<br>Intervention | 36<br>32 | 2.42<br>2.56 | .89<br>.68 | 0.76<br>(66) | ns |

Note. The content tests were the same pre- and postintervention, and test scores were on a percentage scale; the CAT scores were grade equivalents; and the GPA scale was a four-point scale, "A" = 4, etc. For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

*Group differences after adjusting for pretests.* A hierarchical ANCOVA adjusted for pretest scores before comparing groups on postintervention content and CAT performance measures, and the results are given in Table 3. The table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results of adding the first and each subsequent variable to the multiple regression equation, and the resulting significance test of the variable's contribution to explaining the dependent variable. The columns of the table contain the cumulative percentage of explained variance

(cum $R^2$), added contribution in explained variance of the variable ($sR^2$), F test of the contribution of the new variable, ($F(sR^2)$) and the degrees of freedom (df) for the test. Because the hypothesis was directional--improvement for the intervention group--the test statistics were compared to one-tailed probability levels; for F statistics, this involved converting from the F to t statistic ($F = t^2$) and determining the corresponding one-tailed critical value.

These first analyses adjusting for pretest scores indicated that the intervention was associated with generally higher content test scores and with generally lower CAT scores. The next analysis investigated whether the intervention was related to content performance similarly in the two concentrations.

**Table 3**

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Content Posttest | CONTENT PRETEST | .4296 | .4296 | 47.46 | 1,63 | $\leq$.01 |
| | + GROUP | .5216 | .0919 | 11.91 | 1,62 | $\leq$.01 |
| | + PRE-x-GROUP | .5236 | .0021 | 0.27 | 1,61 | ns |
| CAT Posttest | CAT PRETEST | .3921 | .3921 | 20.00 | 1,31 | $\leq$.01 |
| | + GROUP | .4804 | .0883 | 5.10 | 1,30 | $\leq$.05 |
| | + PRE-x-GROUP | .4997 | .0193 | 1.12 | 1,29 | ns |

All models were analyzed as one-tailed tests.

* Three models of independent variables were tested for each dependent variable: (1) PRETEST alone; (2) PRETEST and ('+') GROUP; (3) PRETEST and GROUP and PRETEST-by-GROUP INTERACTION ('-x-').

*Adjusted group differences, separate concentrations.* The two concentrations were separated to investigate whether the content findings held for each concentration. Table 4 shows the results. In both concentrations, the intervention group showed a significant advantage on the content test. No differences on the CAT were tested, due to the small number of students in each concentration who had both pretest and posttest CAT scores. From the analyses reported in Tables 2, 3, and 4, the intervention was related to higher scores on both content tests and to lower scores on the CAT.

Table 4

HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE SEPARATELY FOR COMPUTER SCIENCE AND NATURAL SCIENCE

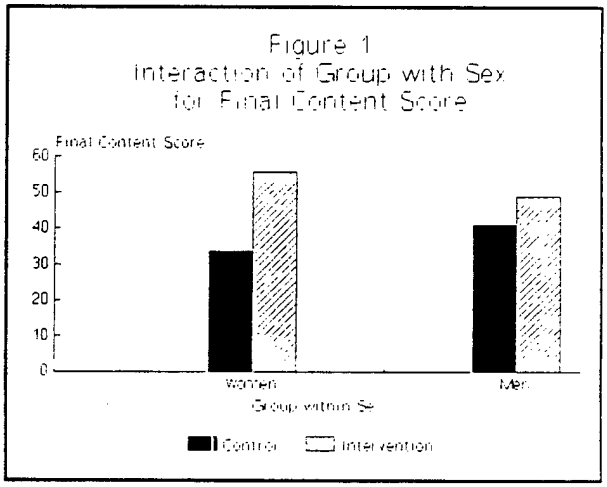
| DEPENDENT VARIABLE | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Computer Science Content | CONTENT PRETEST | .4850 | .4850 | 31.08 | 1,33 | $\leq$.01 |
| | + GROUP | .5563 | .0713 | 5.14 | 1,32 | $\leq$.05 |
| | + PRE-x-GROUP | .5715 | .0152 | 1.10 | 1,31 | ns |
| Natural Science Content | CONTENT PRETEST | .2556 | .2556 | 9.61 | 1,28 | $\leq$.01 |
| | + GROUP | .3940 | .1384 | 6.17 | 1,27 | $\leq$.01 |
| | + PRE-x-GROUP | .4028 | .0088 | 0.38 | 1,26 | ns |

All models were analyzed as one-tailed tests.

* Three models of independent variables were tested for each dependent variable: (1) PRETEST alone; (2) PRETEST and ('+') GROUP; (3) PRETEST and GROUP and PRETEST-by-GROUP INTERACTION ('-x-').

*Effects of other demographic variables on performance.* Before completing the analysis of performance measures, several demographic variables were examined for their contributions to performance. Though the statistical adjustments for pretest scores may have controlled for most of the demographic differences that had favored the intervention group, additional analyses tested whether sex, membership in a high school math/science club, or number of math/science activities were significantly related to performance after making adjustments for pretest score. Table 5 presents the hierarchical ANCOVA results for the combined concentrations.

**Figure 1**

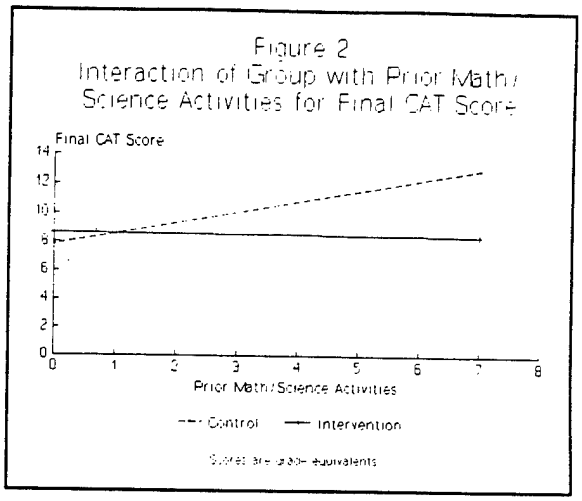



When sex, number of math/science activities, and math/science club membership were all added to the analyses of group differences on content test scores for the combined concentrations, the same general pattern of findings emerged--the intervention group outperformed the control group. Some additional findings appeared: math/science club membership was an advantage; there was a significant interaction between sex and group membership (as shown in Figure 1, the intervention helped females more than it helped males); and there was a significant interaction between sex and math/science club membership (although in general club members surpassed nonmembers, membership helped males only, as female members and nonmembers did not differ). These results indicated that the intervention was especially helpful for women's performance on the content test. Despite apparent demographic disparities, adjustments for these three demographic variables did not eliminate the significant effect of the intervention on content performance, but the demographic adjustments did reduce the explained variance from nine to six percent.

Adding the three demographic covariates changed the CAT results somewhat: the significant effect of group membership remained (favoring the control group), there was a significant effect for sex (females outperformed males), and there was a significant interaction between group membership and number of math/science activities. The significant interaction between the number of math/science activities and group membership indicated that the relationship between activities and the posttest scores was different in the two groups. The interaction was further investigated using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of values for math/science activities for which the groups differed.

**Figure 2**

As shown in Figure 2, the intervention seemed to have eliminated the advantages of having more activities prior to the intervention by equaliz-ing the intervention-group students; note that the intervention line is flat, but the control group's line rises, showing the continued advantage of prior activities.




Only for six activities (out of a possible seven) did the control group outperform the intervention group. Adjusting for the effects of sex, math/science club membership, and number of math/science activities lowered the percentage of variance explained by group membership (from nine to six percent) which favored the control group. Further, the analysis that included demographic variables indicated that the intervention ameliorated the effects of fewer math/science activities prior to the intervention.

These analyses that made extensive demographic adjustments indicated that the intervention was associated with higher content test scores in general, with especially large benefits for women's content scores. The intervention was also associated with overcoming the effects on CAT scores of having fewer math/science activities prior to the intervention. Among those students having both pre-and postintervention CAT scores (only about one half of the students), those in the control group had higher scores. Overall, the intervention had significant effects on content performance of all students but may have been associated with lower CAT performance; the small number of CAT scores makes this inconclusive. Demographic adjustments revealed that the intervention increased the content test scores of women more than it increased men's scores, and that the intervention overcame the disadvantage for CAT scores of having fewer math/science activities in high school.

Table 5

**HIERARCHICAL ANALYSIS OF COVARIANCE OF CONTENT PERFORMANCE ASSESSING THE ROLE OF MATH/SCIENCE ACTIVITIES AND CLUB MEMBERSHIP**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Content Test | PRETEST | .4128 | .4128 | 39.36 | 1,56 | ≤.01 |
| | " SEX | .4137 | .0009 | 0.09 | 1,55 | ns |
| | " MATH/SCI ACTIV | .4145 | .0008 | 0.07 | 1,54 | ns |
| | " CLUB MEMBERSHIP | .4533 | .0388 | 3.76 | 1,53 | ≤.05 |
| | " GROUP | .5118 | .0585 | 6.23 | 1,52 | ≤.01 |
| | " PRETEST-x-SEX | .5161 | .0043 | 0.45 | 1,51 | ns |
| | " PRETEST-x-GROUP | .5206 | .0046 | 0.48 | 1,50 | ns |
| | " SEX-x-GROUP | .5558 | .0352 | 3.88 | 1,49 | ≤.05 |
| | " PRETEST-x-ACTIV | .5689 | .0131 | 1.46 | 1,48 | ns |
| | " SEX-x-ACTIVITIES | .5831 | .0141 | 1.59 | 1,47 | ns |
| | " GROUP-x-ACTIV | .5889 | .0058 | 0.65 | 1,46 | ns |
| | " PRETEST-x-CLUB | .5918 | .0029 | 0.32 | 1,45 | ns |
| | " SEX-x-CLUB | .6162 | .0244 | 2.80 | 1,44 | ≤.10 |
| | " GROUP-x-CLUB | .6230 | .0069 | 0.79 | 1,43 | ns |
| | " PRE-x-SEX-x-GROUP | .6285 | .0054 | 0.61 | 1,42 | ns |
| CAT | PRETEST | .4037 | .4037 | 18.96 | 1,28 | ≤.01 |
| | " SEX | .4592 | .0551 | 2.77 | 1,27 | ≤.05 |
| | " MATH/SCI ACTIV | .4636 | .0044 | 0.21 | 1,26 | ns |
| | " CLUB MEMBERSHIP | .4647 | .0011 | 0.05 | 1,25 | ns |
| | " GROUP | .5202 | .0555 | 2.77 | 1,24 | ≤.10 |
| | " PRETEST-x-SEX | .5212 | .0010 | 0.05 | 1,23 | ns |
| | " PRETEST-x-GROUP | .5527 | .0314 | 1.55 | 1,22 | ns |
| | " SEX-x-GROUP | .5593 | .0067 | 0.32 | 1,21 | ns |
| | " PRETEST-x-ACTIV | .5594 | .0001 | 0.00 | 1,20 | ns |
| | " SEX-x-ACTIVITIES | .5864 | .0270 | 1.24 | 1,19 | ns |
| | " GROUP-x-ACTIV | .6662 | .0798 | 4.31 | 1,18 | ≤.05 |
| | " PRETEST-x-CLUB | .6746 | .0084 | 0.44 | 1,17 | ns |
| | " SEX-x-CLUB | .6746 | .0000 | 0.00 | 1,16 | ns |
| | " GROUP-x-CLUB | .6754 | .0008 | 0.04 | 1,15 | ns |
| | " PRE-x-SEX-x-GROUP | .6778 | .0023 | 0.10 | 1,14 | ns |

All models were analyzed as one-tailed tests.

* Note. $sR^2$ is the proportion of variance attributed to the last entered independent variable, and F($sR^2$) is the test of significance for that proportion of variance.

*Interrelationships among performance measures.* The somewhat inconsistent findings for the intervention among the performance measures were explored by examining their intercorrelations. Table 6 presents the correlations among all of the performance measures. The table shows that GPA was correlated with the two other performance posttests, the postintervention CAT and postintervention content tests were significantly correlated, and each posttest was correlated with its pretest, but not so for preintervention CAT with postintervention content and vice versa. The correlations among

the measures of GPA, CAT, and content were significant but not large, ranging from .18 to .35, indicating that these were measuring overlapping but different aspects of performance.

**Table 6**

**INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a]**

| | GPA<br>(n)<br>Sig.<br>p-Value | Pre CAT<br>(n)<br>Sig.<br>p-Value | Post CAT<br>(n)<br>Sig.<br>p-Value | Pre Content<br>(n)<br>Sig.<br>p-Value |
|---|---|---|---|---|
| Pre CAT | .05<br>(35)<br>ns | 1.00 | | |
| Post CAT | .35<br>(52)<br>≤.01 | .63<br>(33)<br>≤.01 | 1.00 | |
| Pre Content | .13<br>(67)<br>ns | -.02<br>(35)<br>ns | .01<br>(52)<br>ns | 1.00 |
| Post Content | .21<br>(65)<br>≤.05 | .25<br>(35)<br>≤.10 | .18<br>(52)<br>≤.10 | .66<br>(65)<br>≤.01 |

[a] All correlations were analyzed as one-tailed tests.

*Relationship between performance and participation.* If the intervention was successful, students' levels of participation in the intervention should have been related to performance. Table 7 presents these results. GPA and postintervention CAT scores were significantly correlated with participation; attending more classes was correlated with higher GPAs and higher CAT scores, and going on more field trips was correlated with higher GPAs. Because of the nature of correlations, this may indicate that better students also had better attendance. Though levels of participation were not significantly correlated with content test scores, the quasi-experimental design results and the correlation between participation and performance together argue for the conclusion that the intervention enhanced performance.

**Table 7**

**CORRELATIONS BETWEEN PERFORMANCE MEASURES AND PARTICIPATION**

| | SATURDAY CLASSES | FIELD TRIPS | SEMINAR | N |
|---|---|---|---|---|
| GPA | .58*** | .39** | .11 | 26 |
| Post CAT | .35* | .08 | -.18 | 25 |

| CORRELATIONS BETWEEN PERFORMANCE MEASURES AND PARTICIPATION | | | | |
|---|---|---|---|---|
| | **SATURDAY CLASSES** | **FIELD TRIPS** | **SEMINAR** | **N** |
| Post Content | .15 | -.03 | -.31 | 26 |

* $p \leq .10$, two-tailed
** $p \leq .05$, two-tailed
*** $p \leq .01$, two-tailed

Opinion Measures

*Group differences on pre- and postintervention measures.* The means of the intervention- and control-group students were compared for the 13 opinion variables, three constructs, and total opinion score, before and after the intervention. These results are given in Table 8. Before the intervention began, the intervention group had higher scores on 11 of the 17 measures: Total Opinion, SET Goal construct, Cultural Value, Self-Concept, Aspiration, Attitude construct, Math/Science Attitude, Persistence, Environmental Support construct, Academic Support, and Career Awareness. After the intervention ended, the intervention group had higher scores on seven of the 17 measures: Total Opinion, SET Goal construct, Self-Concept, Aspiration, Environmental Support construct, Academic Support, and Career Awareness. However, the postintervention differences may have been the persistence of preexisting differences and not due to the intervention. In order to adjust for preexisting differences, the final opinion variables were adjusted for preexisting differences via ANCOVA.

**Table 8**

| GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CONSTRUCT / Scale** | **TEST** | **CONTROL** | | **INTERVENTION** | | **t-Test** | **Sig. p** |
| | | **Mean** | **SD** | **Mean** | **SD** | | |
| OPINION, Total | Pretest | 2.83 | .23 | 3.03 | .25 | 3.45 | $\leq .01$ |
| | Posttest | 2.88 | .28 | 3.00 | .25 | 1.63 | $\leq .10$ |
| SET GOAL | Pretest | 2.91 | .31 | 3.22 | .30 | 4.09 | $\leq .01$ |
| | Posttest | 2.96 | .31 | 3.17 | .35 | 2.23 | $\leq .05$ |
| Value | Pretest | 3.30 | .35 | 3.44 | .46 | 1.46 | ns |
| | Posttest | 3.30 | .42 | 3.50 | .41 | 1.70 | $\leq .05$ |
| Cultural Value | Pretest | 3.35 | .42 | 3.58 | .32 | 2.44 | $\leq .05$ |
| | Posttest | 3.32 | .48 | 3.44 | .41 | 0.90 | ns |
| Self-Concept | Pretest | 2.56 | .45 | 2.90 | .45 | 3.14 | $\leq .01$ |
| | Posttest | 2.66 | .56 | 2.86 | .47 | 1.38 | $\leq .10$ |

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT / Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| Aspiration | Pretest | 2.65 | .46 | 3.14 | .37 | 4.76 | ≤.01 |
| | Posttest | 2.78 | .37 | 3.07 | .45 | 2.51 | ≤.01 |
| ATTITUDE | Pretest | 2.75 | .22 | 2.90 | .28 | 2.48 | ≤.05 |
| | Posttest | 2.77 | .32 | 2.83 | .27 | 0.65 | ns |
| Math/Science Attitude | Pretest | 2.85 | .32 | 2.88 | .36 | 0.43 | ns |
| | Posttest | 2.82 | .37 | 2.81 | .33 | -0.09 | ns |
| Locus of Control | Pretest | 3.03 | .38 | 3.10 | .43 | 0.76 | ns |
| | Posttest | 3.15 | .50 | 3.09 | .45 | -0.42 | ns |
| Persistence | Pretest | 2.71 | .44 | 3.03 | .45 | 2.93 | ≤.01 |
| | Posttest | 2.75 | .58 | 2.87 | .56 | 0.74 | ns |
| Study Habits | Pretest | 2.68 | .28 | 2.74 | .33 | 0.83 | ns |
| | Posttest | 2.73 | .36 | 2.74 | .36 | 0.11 | ns |
| Anxiety | Pretest | 2.51 | .39 | 2.56 | .67 | 0.37 | ns |
| | Posttest | 2.48 | .50 | 2.54 | .57 | 0.40 | ns |
| ENVIRONMENTAL SUPPORT | Pretest | 2.88 | .30 | 3.01 | .28 | 1.96 | ≤.10 |
| | Posttest | 2.95 | .36 | 3.09 | .30 | 1.42 | ≤.10 |
| Academic Support | Pretest | 2.95 | .51 | 3.29 | .47 | 2.86 | ≤.01 |
| | Posttest | 3.09 | .48 | 3.33 | .44 | 1.86 | ≤.05 |
| Career Awareness | Pretest | 2.91 | .41 | 3.16 | .48 | 2.23 | ≤.05 |
| | Posttest | 2.94 | .50 | 3.13 | .43 | 1.40 | ≤.10 |
| Role Model | Pretest | 2.66 | .50 | 2.62 | .50 | -0.26 | ns |
| | Posttest | 2.62 | .65 | 2.82 | .50 | 1.19 | ns |
| Equal Opportunity | Pretest | 2.97 | .42 | 2.98 | .58 | 0.06 | ns |
| | Posttest | 3.15 | .50 | 3.06 | .51 | -0.62 | ns |

All pretests were analyzed as two-tailed tests.
All posttests were analyzed as one-tailed tests.
Pretest n's: Control = 35; Intervention = 32
Posttest n's: Control = 24; Intervention = 26

*Group differences on opinion adjusting for prior scores.* Table 9 reports the results of the effects of group membership after adjusting for preintervention opinion scores. By this analysis, the groups did not differ overall on any opinion

measure. However, the pretest and group membership interacted for five opinion measures: Cultural Value, Aspiration, Locus of Control, Environmental Support construct, and Career Awareness.

**Table 9**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| OPINION, Total | PREINTERVENTION | .5035 | .5035 | 47.67 | 1,47 | $\leq$.01 |
| | +GROUP | .5041 | .0006 | 0.05 | 1,46 | ns |
| | +PRE-x-GROUP | .5062 | .0021 | 0.19 | 1,45 | ns |
| SET GOAL | PREINTERVENTION | .5382 | .5382 | 54.78 | 1,47 | $\leq$.01 |
| | +GROUP | .5384 | .0002 | 0.01 | 1,46 | ns |
| | +PRE-x-GROUP | .5401 | .0017 | 0.17 | 1,45 | ns |
| Value | PREINTERVENTION | .1186 | .1186 | 6.32 | 1,47 | $\leq$.01 |
| | +GROUP | .1385 | .0199 | 1.06 | 1,46 | ns |
| | +PRE-x-GROUP | .1409 | .0024 | 0.13 | 1,45 | ns |
| Cultural Value | PREINTERVENTION | .3936 | .3936 | 30.51 | 1,47 | $\leq$.01 |
| | +GROUP | .3962 | .0026 | 0.20 | 1,46 | ns |
| | +PRE-x-GROUP | .4215 | .0253 | 1.97 | 1,45 | $\leq$.10 |
| Self-Concept | PREINTERVENTION | .3866 | .3866 | 29.62 | 1,47 | $\leq$.01 |
| | +GROUP | .3866 | .0000 | 0.00 | 1,46 | ns |
| | +PRE-x-GROUP | .3989 | .0123 | 0.92 | 1,45 | ns |
| Aspiration | PREINTERVENTION | .5579 | .5579 | 59.31 | 1,47 | $\leq$.01 |
| | +GROUP | .5618 | .0039 | 0.41 | 1,46 | ns |
| | +PRE-x-GROUP | .6112 | .0493 | 5.71 | 1,45 | $\leq$.05 |
| ATTITUDE | PREINTERVENTION | .3971 | .3971 | 30.96 | 1,47 | $\leq$.01 |
| | +GROUP | .3990 | .0019 | 0.14 | 1,46 | ns |
| | +PRE-x-GROUP | .4085 | .0095 | 0.72 | 1,45 | ns |
| Math/Science Attitude | PREINTERVENTION | .2334 | .2334 | 14.31 | 1,47 | $\leq$.01 |
| | +GROUP | .2334 | .0000 | 0.00 | 1,46 | ns |
| | +PRE-x-GROUP | .2336 | .0002 | 0.01 | 1,45 | ns |
| Locus of Control | PREINTERVENTION | .0818 | .0818 | 4.19 | 1,47 | $\leq$.05 |
| | +GROUP | .0848 | .0030 | 0.15 | 1,46 | ns |
| | +PRE-x-GROUP | .1609 | .0761 | 4.08 | 1,45 | $\leq$.05 |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| | | | | | | |
|---|---|---|---|---|---|---|
| Persistence | PREINTERVENTION | .2910 | .2910 | 19.29 | 1,47 | $\leq$.01 |
| | +GROUP | .3002 | .0092 | 0.61 | 1,46 | ns |
| | +PRE-x-GROUP | .3133 | .0130 | 0.85 | 1,45 | ns |
| Study Habits | PREINTERVENTION | .0420 | .0420 | 2.06 | 1,47 | $\leq$.10 |
| | +GROUP | .0420 | .0000 | 0.00 | 1,46 | ns |
| | +PRE-x-GROUP | .0420 | .0000 | 0.00 | 1,45 | ns |
| Anxiety | PREINTERVENTION | .4529 | .4529 | 38.90 | 1,47 | $\leq$.01 |
| | +GROUP | .4582 | .0053 | 0.45 | 1,46 | ns |
| | +PRE-x-GROUP | .4692 | .0110 | 0.93 | 1,45 | ns |
| Environmental Support | PREINTERVENTION | .0979 | .0979 | 5.10 | 1,47 | $\leq$.05 |
| | +GROUP | .1141 | .0161 | 0.84 | 1,46 | ns |
| | +PRE-x-GROUP | .1531 | .0390 | 2.07 | 1,45 | $\leq$.10 |
| Academic Support | PREINTERVENTION | .1775 | .1775 | 10.14 | 1,47 | $\leq$.01 |
| | +GROUP | .1938 | .0163 | 0.93 | 1,46 | ns |
| | +PRE-x-GROUP | .1984 | .0046 | 0.26 | 1,45 | ns |
| Career Awareness | PREINTERVENTION | .0965 | .0965 | 5.02 | 1,47 | $\leq$.05 |
| | +GROUP | .1167 | .0202 | 1.05 | 1,46 | ns |
| | +PRE-x-GROUP | .1912 | .0745 | 4.14 | 1,45 | $\leq$.05 |
| Role Model | PREINTERVENTION | .0567 | .0567 | 2.82 | 1,47 | $\leq$.05 |
| | +GROUP | .0877 | .0310 | 1.56 | 1,46 | ns |
| | +PRE-x-GROUP | .0932 | .0055 | 0.27 | 1,45 | ns |
| Equal Opportunity | PREINTERVENTION | .1438 | .1438 | 7.72 | 1,46 | $\leq$.01 |
| | +GROUP | .1550 | .0113 | 0.60 | 1,45 | ns |
| | +PRE-x-GROUP | .1733 | .0183 | 0.97 | 1,44 | ns |

All models were analyzed as one-tailed tests.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure): (1) PRETEST OPINION SCORE; (2) PRETEST OPINION SCORE and GROUP ('+'); (3) PRETEST OPINION SCORE and GROUP and PRETEST OPINION SCORE-by-GROUP INTERACTION ('-x-').

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $\underline{F}(sR^2)$ is the test of significance for that proportion of variance.

As with the performance interactions, the nonparallel regression lines were graphed and the Johnson-Neyman technique used to determine the intersection point and range of values for which the groups differed.

Figure 3 shows the interaction for Cultural Value scores; for students who had lower scores (3 or less) on the prior Cultural Value scale, the intervention group produced significantly higher scores on the final Cultural Value scale.

**Figure 3**

The interactions between pretest score and group membership for the Aspiration, Locus of Control, Environmental Support, and Career Awareness opinion measures are graphed in Figures 4-7. The interactions for these four measures took a similar form such that the intervention was related to higher opinion scores for students who entered the intervention with average or slightly above average opinions (approximately 3.4 or higher for Aspiration and Locus of Control, and 3.0 or higher for Environmental Support and Career Awareness). Though the intervention had negative effects on opinion for students with below-average Aspiration, Locus of Control, Environmental Support, and Career Awareness, this group was much smaller than the group who profited from the intervention.

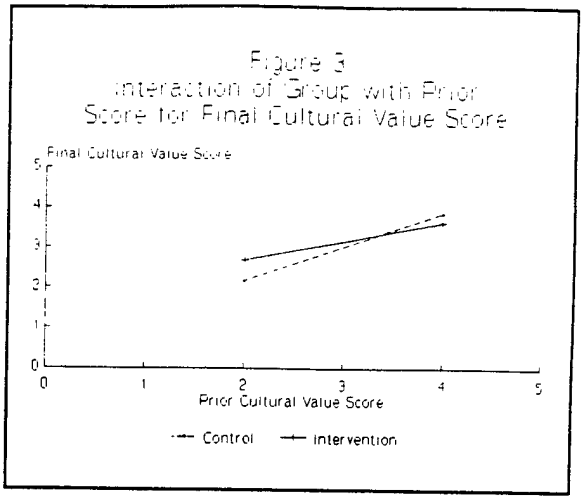



**Figure 4**

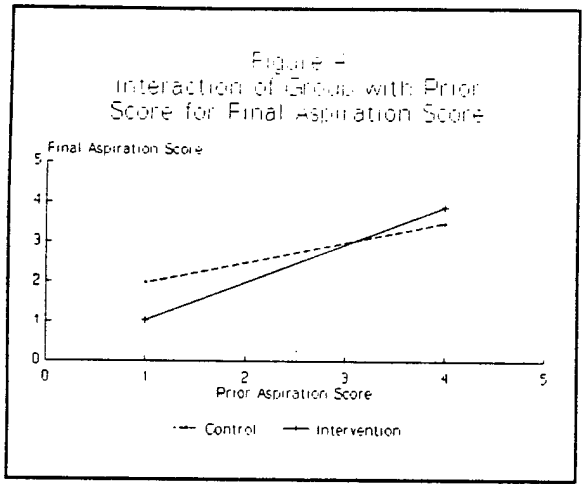



**Figure 5**

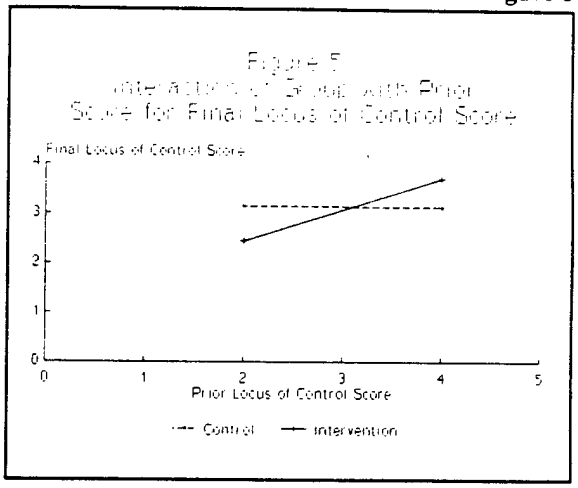



**Figure 6**

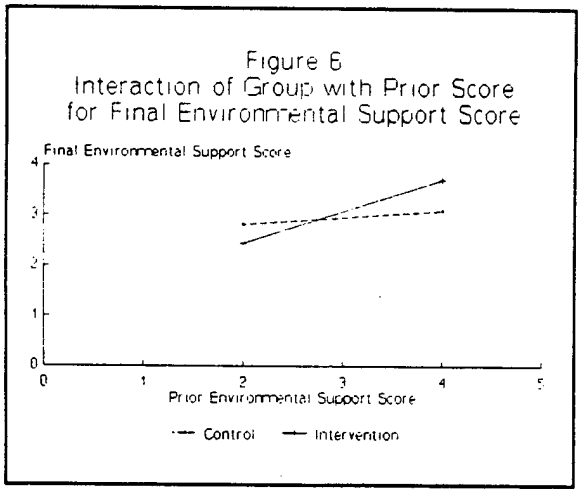
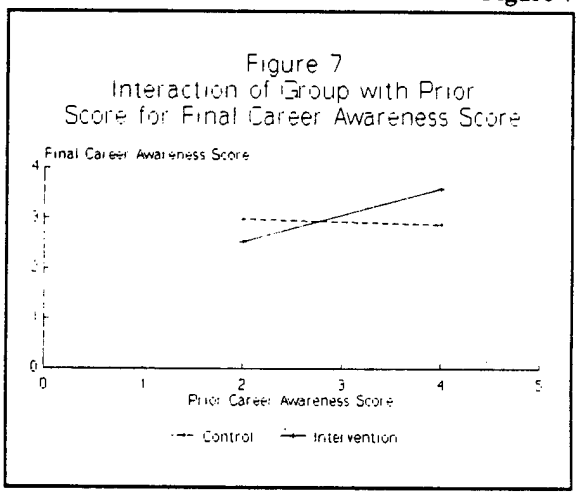



**Figure 7**



In summary, the intervention had significant positive effects on students with prior low Cultural Value scores and prior high Aspiration, Locus of Control, Environmental Support, and Career Awareness scores.

*Relationships between participation and opinion.* Correlations between participation in the components of the intervention and final opinion scores are presented in Table 10. The Saturday classes were not significantly correlated with any opinion measure. Greater field trip participation (there were two) was correlated with higher scores on the Attitude construct, Math/Science Attitude, Study Habits, and Equal Opportunity scores, and with lower scores on the Locus of Control scale. Attending the seminar was associated with higher scores on Total Opinion, Aspiration, Attitude construct, Math/Science Attitude, and Study Habits scales. From these results, it seems that participation in the two field trips and one seminar was associated generally with higher final opinion scores.

**Table 10**

**CORRELATIONS BETWEEN POSTINTERVENTION OPINION MEASURES AND PARTICIPATION**

| CONSTRUCT/ Scale | Saturday Classes | Field Trips | Seminar |
|---|---|---|---|
| OPINION | -.01 | .26 | .31* |
| SET GOAL | -.11 | .17 | .20 |
| Value | -.14 | .09 | .09 |
| Cultural Value | -.15 | .04 | .11 |
| Self-Concept | .07 | .15 | .14 |
| Aspiration | -.20 | .20 | .27* |
| ATTITUDE | .09 | .28* | .37** |
| Math/Science Attitude | -.03 | .54*** | .50*** |
| Locus of Control | .05 | -.32* | -.08 |
| Persistence | .09 | .01 | .17 |
| Study Habits | .19 | .31* | .35** |
| Anxiety | .00 | -.03 | -.04 |
| ENVIRONMENTAL SUPPORT | .01 | .22 | .18 |
| Academic Support | .03 | .14 | .13 |

| CORRELATIONS BETWEEN POSTINTERVENTION OPINION MEASURES AND PARTICIPATION | | | |
|---|---|---|---|
| **CONSTRUCT/ Scale** | **Saturday Classes** | **Field Trips** | **Seminar** |
| Career Awareness | .23 | .03 | .05 |
| Role Model | -.23 | .02 | .07 |
| Equal Opportunity | .05 | .35** | .18 |

* $p \leq .10$, one-tailed
** $p \leq .05$, one-tailed
*** $p \leq .01$, one-tailed

NOTE: Each r, the Pearson correlation coefficient, was computed on 25 cases.

## DISCUSSION

This intervention sought to facilitate entry of youths from disadvantaged backgrounds into four-year institutions and ultimately into SET careers. The more immediate objectives were to improve student performance and to enhance students' incentive to enter SET fields by exposing them to successful role models.

The hypotheses of enhanced performance and opinion scores as a result of the intervention received some support. Performance on brief subject-area content tests was enhanced for program participants, particularly for women.

Because of the unavailability of CAT scores for about half of the sample, the analysis of CAT score differences is inconclusive. For the sample for whom the scores are available, scores were lower for the intervention group after the intervention; however, demographic analysis of the same sample indicates that the intervention overcame the disadvantage for CAT scores of having fewer math/science activities in high school.

Given the goal of improved performance, particularly for women and disadvantaged students, two possible benefits of the intervention are suggested by its improving the content scores of women in particular, and by the finding that the intervention overcame the disadvantage of having participated in fewer math/science activities in high school. However, as with any finding from a quasi-experimental design with a small sample, a replication in subsequent semesters would strengthen confidence in these findings.

The major effects on opinion were select positive advantages: a higher Cultural Value (see Appendix B) of SET majors/careers for students with low prior scores, and higher scores for Aspiration, Locus of Control, Environmental Support, and Career Awareness for students with average and above-average prior scores.

Attendance at Saturday classes was related to higher GPAs and CAT scores, and greater participation in the field trips was associated with higher GPAs. Greater participation in the field trips and the seminar was associated with higher scores on about one-third of the postintervention opinion measures.

It seems that the three components of the intervention each made unique contributions: the Saturday classes were related to better performance (GPA and CAT), the field trips were related to higher scores on one performance (GPA) and four opinion measures, and the seminar was related to higher opinions on five scales. These relationships, together with the ANCOVA results, provide further support for the causal conclusions about the effects of the intervention.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# PART IV

# APPENDICES

# APPENDIX A

# COLLEGE STUDENT PROTOCOL

## College Student Protocol

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. Am. Indian (Please specify the tribe which best describes your heritage.) _____
   ___ e. Hispanic Which of the following best describes your heritage?
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

6. Class:
   ___ a. College freshman
   ___ b. College sophomore
   ___ c. College junior
   ___ d. College senior
   ___ e. Other (e.g., special or temporary student, etc.)
      Specify _____

7. Have you declared a college major?
   ___ a. No
   ___ b. Yes ..... Please specify your major. _____

8. Have you taken any advanced placement tests for college credit?
   ___ a. No
   ___ b. Yes ..... Please list tests taken. _____

9. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Two years of college
   ___ b. Four years of college
   ___ c. One or more years after college
   ___ d. Other Specify _____

10. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

11. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)

   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Work-study
   ___ d. Job other than work-study
   ___ e. Tuition or other scholarship
   ___ f. Loan
   ___ g. Previous personal earnings and savings
   ___ h. GI Bill, ROTC, or other governmental assistance (other than scholarship or loan)
   ___ i. Family trust fund, insurance plan, or other similar arrangement
   ___ j. Other Specify _____

12. You may want to receive help outside your regular college course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems
   ___ f. Increasing reading ability
   ___ g. Developing good study habits
   ___ h. Improving writing ability

13. What is or was the occupation of the person(s) with whom you lived during the years you were growing up? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

_____ _____

14. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average

15. Are you:
___ a. An only child (skip to question 17)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

16. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

17. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

18. Indicate the extent of your mother's education. (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

19. What was the language spoken most often by adults in the household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe .... What is that language? _____
___ d. Other
Specify _____

20. Which of the following did your parent(s)/guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

21. Which of the following comes closest to describing your parent(s)/guardian(s)?
___ a. Do(es) not read at all
___ b. Sometimes read(s)
___ c. Read(s) a lot

22. Which of the following comes closest to describing you?
___ a. Do not read at all
___ b. Sometimes read
___ c. Read a lot

23. How many of these do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

24. From what kind of high school or secondary school did you graduate?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

25. Were you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes.....Please list the math and/or science clubs you belonged to.

_____

_____

_____

_____

26. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL WITH DIRECTIONALITY AND SCALES OF ITEMS

Legend:

| | |
|---|---|
| **SH Study Habits** | **PS Persistence** |
| **AT Attitude toward math/science** | **CV Cultural Value** |
| **SC Self-Concept** | **AS Academic Support** |
| **AX Anxiety** | **AP Aspiration** |
| **VL Value** | **EO Equal Opportunity** |
| **LC Locus of Control** | **RM Role Model** |
| **CA Career Awareness** | |

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of any ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |

| | | | |
|---|---|---|---|
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

i. _____

ii. _____

iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE COLLEGE STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 33 | CONTROL n = 36 |
| 1. Sex: | | |
| Women | 48% | 61% |
| Men | 52% | 39% |
| 2. Age | 21.97 | 21.72 |
| 6. Class: | | |
| .Freshmen | 70% | 75% |
| .Sophomores | 15% | 17% |
| .Juniors | 0% | 6% |
| .Seniors | 0% | 0% |
| .Other | 3% | 0% |
| .Missing | 12% | 3% |
| 7. Declared SET majors | 46% | 17%[a] |
| .Missing or undeclared | 18% | 8% |
| 8. Students taken an advanced placement test | 24% | 6%[a] |
| .Missing | 12% | 3% |
| 9. Higher education expected: | | |
| .Two years of college | 3% | 11% |
| .Four years of college | 42% | 53% |
| .One or more years after college | 42% | 33% |
| .Missing | 12% | 3% |
| 10. Studies most influenced by: | | |
| .Parents | 64% | 50% |
| .Another family member | 3% | 14% |
| .Teacher | 12% | 3% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 3% |
| .Friend | 6% | 6% |
| .Science professional | 0% | 3% |
| .Nonscience professional | 0% | 3% |
| .No one at all | 24% | 19% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 33 | CONTROL n = 36 |
| 11. Sources of income:[b] | | |
| .Parents/guardians | 30% | 53%[a] |
| .Spouse | 3% | 6% |
| .Work study | 67% | 47% |
| .Job other than work study | 18% | 33% |
| .Tuition or scholarship | 36% | 22% |
| .Loan | 42% | 58% |
| .Grant | 52% | 58% |
| .Personal savings | 3% | 0% |
| .GI Bill, ROTC, etc. | 6% | 3% |
| .Family trust, etc. | 6% | 0% |
| .Other | 0% | 0% |
| Number of sources of income * | 2.64 | 2.81 |
| 12. Student needs help in:[b] | | |
| .Counseling on educational plans | 30% | 22% |
| .Counseling on career plans | 39% | 42% |
| .Improving math ability | 54% | 42% |
| .Finding part-time work | 61% | 47% |
| .Counseling on personal problems | 9% | 3% |
| .Increasing reading ability | 3% | 25%[a] |
| .Developing good study habits | 36% | 53% |
| .Improving writing ability | 27% | 36% |
| Number of areas needing help * | 2.64 | 2.69 |
| 13. Sources of outside income: | | |
| .None | 18% | 8% |
| .One | 27% | 42% |
| .Two | 33% | 28% |
| .Missing | 21% | 22% |
| 14. Family income: | | |
| .Below U.S. average | 21% | 14% |
| .About average | 39% | 56% |
| .Above average | 3% | 6% |
| .Unknown | 36% | 25% |
| 15. Birth order of student: | | |
| .Only child | 9% | 6% |
| .Oldest child | 27% | 25% |
| .Youngest child | 9% | 22% |
| .In-between child | 42% | 42% |
| .Missing | 12% | 6% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 33 | CONTROL n = 36 |
| 16. Number of siblings: | | |
| .None | 9% | 6% |
| .One | 9% | 3% |
| .Two | 18% | 17% |
| .Three or more | 52% | 67% |
| .Missing | 12% | 8% |
| 18. Mother's education: | | |
| .Grade school or less | 15% | 14% |
| .Some high school | 24% | 19% |
| .High school graduate | 24% | 47% |
| .Some college | 3% | 3% |
| .College degree or more | 21% | 11% |
| .Missing | 12% | 6% |
| 19. Language spoken most at home: | | |
| .English | 85% | 92% |
| .Spanish | 3% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| .Missing | 12% | 8% |
| 20. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 48% | 50% |
| .Attend parent-teacher conferences | 36% | 33% |
| .Visit student's class | 36% | 44% |
| .Phone/visit if there's a problem | 52% | 69% |
| .Do volunteer work | 30% | 14% |
| .Assist student in course selection | 21% | 22% |
| .Assist in student's homework | 64% | 53% |
| Number of parental involvements * | 2.88 | 2.86 |
| 21. Parent(s) read: | | |
| .Not at all | 3% | 0% |
| .Sometimes | 33% | 53% |
| .A lot | 52% | 42% |
| .Missing | 12% | 6% |
| 22. Student reads: | | |
| .Not at all | 3% | 0% |
| .Sometimes | 52% | 58% |
| .A lot | 30% | 36% |
| .Missing | 15% | 6% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 33 | CONTROL n = 36 |
| 23. Items in student's home:[b] | | |
| .Desk | 46% | 50% |
| .Daily newspaper | 64% | 69% |
| .Encyclopedia | 61% | 75% |
| .Typewriter | 61% | 56% |
| .Calculator | 73% | 75% |
| .Television | 88% | 89% |
| .Computer | 18% | 17% |
| .Video Cassette Recorder (VCR) | 52% | 69% |
| Number of support items * | 4.61 | 5.00 |
| 24. Type of high school attended: | | |
| .Public | 76% | 92% |
| .Private | 6% | 0% |
| .No formal high school | 3% | 3% |
| .Missing | 15% | 6% |
| 25. Member math/science club in high school | 48% | 19%[a] |
| .Missing | 15% | 6% |
| 26. All activities student took part in:[b] | | |
| .Math/science club | 21% | 8% |
| .Field trip | 58% | 36% |
| .Watching science programs on TV | 36% | 22% |
| .Listen to talk by scientist | 24% | 3%[a] |
| .Science/math fair | 33% | 36% |
| .Other science/math competition | 12% | 3% |
| .Play/work in computer lab | 52% | 53% |
| Number of activities * | 2.36 | 1.61[a] |
| $t(67) = 1.75$ | (2.18) | (1.34) |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# METROPOLITAN STATE COLLEGE

# INTERVENTIONS

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# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected came from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention- group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF METROPOLITAN STATE COLLEGE

Metropolitan State College, a four-year, public, coeducational institution located in Denver, Colorado, serves approximately 16,500 students and has 650 faculty members. The College, organized into the School of Business; School of Letters, Arts, and Sciences; and School of Professional Studies, offers undergraduate degrees. The student body is approximately 52 percent female and 48 percent male. Approximately 84 percent of the students are Anglo, 4 percent are Black, 7 percent are Hispanic, and 5 percent are of other ethnic origins. The president of Metropolitan State College is Dr. Thomas Brewer.

Degrees offered at Metropolitan State College in quantitative subjects are Bachelor of Arts in chemistry, mathematics, and physics, and Bachelor of Science in chemistry, computer science, mathematics, meteorology, physics, and a variety of technologies, including civil engineering, drafting engineering, electronics engineering, mechanical engineering, and industrial technology.

Denver has a population of approximately 492,000 in its metropolitan area. The state of Colorado has a population of approximately 3.4 million. According to U.S. Census Bureau estimates, the adult population of Colorado is 83 percent Anglo, 4 percent Black, 11 percent Hispanic, and 2 percent other ethnic origins. Denver has a number of other institutions of higher education, including the Community College of Denver, Denver Institute of Technology, Regis College, University of Colorado at Denver, University of Colorado Health Science Center, and the University of Denver.

# PART II

# SUMMARY OF THE METROPOLITAN STATE COLLEGE (MSC) INTERVENTIONS

This page summarizes the two interventions conducted by Metropolitan State College, a four-year public institution located in Denver, Colorado. The college is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Metropolitan State College Intervention Activities:

In Summer 1989 and Fall 1990, Metropolitan State College conducted four intervention programs for second-tier middle school students. Students came to the college campus for a program of instruction in mathematics, science and computer science, with cognitive education, learning games, and field trips. A key part of the intervention was parent education and support; middle school counselors were employed to work with parents and their children, and special parent sessions were held in conjunction with the intervention. Participants were middle-school students whose prior grades in science and mathematics were in the B+ to C- range; most of the students were Black or Hispanic.

Findings:

- The intervention had positive effects on performance in both science and mathematics.
- Mathematics performance of those students whose previous mathematics grades had been below a C- did not improve appreciably as a result of the intervention.
- Opinion scores show a gain in self-concept as a result of the intervention.

Recommendations:

- To reach middle-school students, work with their parents. The dramatic improvement in performance as a result of this intervention supports the argument that parents who see SET careers as real and positive options for their children, and who understand the requirements and benefits of those careers, can enhance the effectiveness of a program for their children.
- At the middle-school level, there would seem to be an excellent source of untapped potential in the "second-tier" students, who have not excelled up to now but who may have excellent potential.
- It seems clear that a student does not need to be an A or even a B student to gain from such an intervention as this one; however, it seems that a D or lower student may lack either the requisite skills or the motivation to succeed with this intervention.

# PART III

# CASE STUDY OF THE METROPOLITAN STATE COLLEGE

# 1989 SUMMER SEMESTER INTERVENTION

## ABSTRACT

In 1989 Metropolitan State College, Denver, Colorado, initiated and tested against a control group a summer enrichment intervention program for Denver-area middle school students. Participants were 41 seventh-grade students (28 girls and 13 boys) who were "second tier," or academically average or below in mathematics; a majority of the participants were Black or Hispanic.

The Metropolitan State College program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES*: Hypotheses were that the intervention would: (a) enhance performance in mathematics and science, and (b) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS*: Major components of the intervention were instruction in mathematics, science, computer science, and cognitive education; tutoring; counseling; field trips to educational and scientific facilities; and parent education and support.

*DATA*: All the participants furnished demographic data through the CASET Middle/Junior High School Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were pretest and posttest scores on institution-specific content tests in mathematics and science, mathematics and science scores on the Iowa Test of Basic Skills (ITBS), and school grades in mathematics and science.

The outcome measures of performance were the posttest scores on institution-specific content tests of mathematics and science. The preintervention measures of performance were the pretest scores on content tests of mathematics and science, ITBS mathematics and science national percentiles, and mathematics and science school grades from the semester before the intervention.

*RESEARCH DESIGN*: The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design; through analyses of preintervention measures it appeared that the intervention and control groups were comparable.

*FINDINGS*: In general, the intervention had a positive effect on the participants and can be considered a successful intervention. The hypotheses of enhanced performance on the content tests and enhanced opinions about SET fields and careers received substantial support. The intervention improved students' mathematics and science performance overall with one exception: The mathematics performance of students with below average mathematics grades prior to the intervention did not improve appreciably as a result of the intervention. The intervention group had significantly higher scores than the control group on the Self-Concept, Environmental Support, and Academic Support opinion scales, and selective benefits for the intervention group were shown on six additional opinion measures. These findings are seen as evidence for the untapped academic potential of "second-tier" students as well as for the importance of environmental support to academic achievement.

## DESCRIPTION OF THE INTERVENTION

Metropolitan State College developed and tested an intervention for minority and female students who had just completed the sixth grade in a Denver-area middle school and would be entering the seventh grade in the Fall. Throughout this report, this group will be referred to as seventh graders (See Appendix D). All of the students in the control group, with the exception of two, were in the same grade level as those students in the intervention group. The College chose to work with students they termed "second-tier," that is, students with prior grades in mathematics and science in the B+ to C- range. Every weekday, for six weeks, in the summer of 1989, students were picked up by bus at their middle school at 8:00 a.m. and brought to the Metropolitan State College for a program of instruction, tutoring, learning games, and other activities.

A key part of this intervention was parent education and support. Middle school counselors were employed to work with the children and their parents to increase their awareness of the importance of science and mathematics education and to inform them about the opportunities available in those fields. The counselors' work included meeting with parents, visiting intervention students and their parents at home, and providing written material to assist the parents in supporting and guiding their children through the program and beyond. The counselors were from South Middle School rather than the students' own school, Cole Middle School, in order to ensure that the counseling portion of the intervention would not inadvertently impact on the control-group students.

Parent orientation and education began before, and continued after, the six-week intervention with the students. On June 15, 1989, intervention students' parents were given an orientation with information on the changing American workforce, skills that will be needed by the year 2000, the importance of a quality education with emphases in science and mathematics, and the availablility of resources including programs. Parents were given a pamphlet published by the College Board called "Get Into the Equation" which explains why mathematics and science are important tools and how parents can help their children gain mastery of these subjects. The pamphlet tells parents what toys to provide, what courses children should take in school, and how to interact with the school. A second parent education session was held after the intervention classes, giving parents an assessment of their children's progress and providing an opportunity for parents to interact with female and minority role models. Program counselors also visited the parents of each intervention student at home to assist them in assessing the progress of students in the program. These visits also were to suggest the types of support parents should seek for their children in the upcoming academic year, such as tutoring or enrolling in the Junior Engineering and Technical Society (JETS).

The daily schedule of activities was as follows:

| | |
|---|---|
| 8:00 a.m. | Students picked up at Cole Middle School |
| 8:30 a.m. | Students arrive at Metropolitan State College campus |
| 9:00 a.m. | Mathematics class (MWF) or computer class (TTH) |
| 9:50 a.m. | Break |
| 10:00 a.m. | Science class |
| 10:50 a.m. | Break |
| 11:00 a.m. | Tutorial session (MWF) or Cognitive Education (TTH) |
| 11:50 a.m. | Lunch |
| 12:50 p.m. | Tutorial sessions, cognitive games, computer time with educational software, counseling |
| 1:50 p.m. | Departure for Cole Middle School |

The science and mathematics summer course content emphasized and reinforced the subject matter content of the sixth grade, and introduced students to seventh-grade subject matter in each area. The science modules included life science, physical science, earth sciences, and scientific inquiry. The mathematics modules included numeration, fractions, decimals, geometry, measurement, graphs, and pre-algebra.

The Cognitive Education sessions introduced three general areas of thinking skills: a) learning to learn, including attention control, goal setting, deep processing, and memory frameworks; b) content thinking skills, designed to increase a student's ability to learn academic content, including concept attainment, concept development, pattern recognition, and synthesizing skills; and c) reasoning skills, or higher-order thinking skills, including analogical reasoning, evaluation of evidence, decision making, and problem solving.

Computer skills sessions introduced students to the roles of the computer in the information age and allowed them to practice keyboard and data-processing skills. Students also had access to computer learning programs, including the following software:

- Math Machine, a mathematics skills builder from Southwest EDPSUCH Services;
- Math Blaster, a math skills builder from Davidson & Associates;
- Mind-Memory Improvement Course, a memory improvement and study skills program for junior high school students through adults from Software, Etc.;
- The Human Body, a set of eight programs to help learn the way main body systems work from Brainbank, Inc.

Three science- and technology-related field trips were scheduled on Friday afternoons:
June 30: University of Colorado
July 14: NASA-contractor Martin Marietta, Inc.
July 21: Lowry Air Force Technical Training Center

Students toured the facilities and interacted with minority and female professionals.

The Project Director for this CASET project at Metropolitan State College was Dr. Gwendolyn Thomas, Assistant Vice President, Student Affairs, Metropolitan State College. The Project Coordinator was Sharon R. Bailey. The middle school counselors were from South Middle School. The six-week course for the students was conducted from June 19 through July 28, 1989. Orientation for parents was held on June 15, 1989; the follow-up parent education meeting was held on July 24, 1989.

The intervention's two major hypotheses were that the intervention activities would: (a) enhance performance in SET-related content areas, and (b) enhance opinions about SET fields and careers.

## METHOD

Subjects

Subjects were minority and female seventh-grade students, recruited from Cole Middle School in the Denver area. Table 1 shows the ethnic and sex breakdown for the intervention and control groups.

**Table 1**

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | 0 | 0 | 1 | 0 | 1 | 0 |
| Anglo | 0 | - | 2 | - | 2 | - |
| Black | 9 | 6 | 10 | 2 | 19 | 8 |
| Hispanic | 2 | 0 | 2 | 1 | 4 | 1 |
| Unknown | 1 | 2 | 1 | 2 | 2 | 4 |
| TOTAL | 12 | 8 | 16 | 5 | 28 | 13 |

Students with prior school grades in mathematics and science ranging from B+ to C-, and in some cases lower, were selected. A control group was identified, consisting of students demographically similar to the intervention group. The control group did not participate in any intervention activities. All demographic, opinion, and performance data were collected from the control group as well as the intervention group. Forty-two sets of data were received from intervention- and control-group students. One control-group student, an Anglo male, was removed from the sample; Anglo males are not underrepresented in SET fields and are not a focus of CASET research. Forty-one sets of data were analyzed: 21 from the intervention group and 20 from the control group.

CASET Protocols and Other Instruments

Demographic and descriptive data about the subjects were developed through the CASET Middle/Junior High School Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This Protocol is shown in Appendix A.

Hypotheses tested were that the intervention would enhance performance in the content areas taught in the intervention classes and would change opinions of participants in ways thought to be favorable to continuing in SET studies and careers. To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were

developed, varying in directionality. Combining the question items for each variable gave a scalar measurement for that variable. Thus the completed Opinion Protocol provided a scale measuring each of the thirteen variables.

CASET adapted the CASET Opinion Protocol items for middle school and junior high school students by changing questions to make them more appropriate for the younger age group, while addressing the same thirteen attitudinal variables as the older-level Opinion Protocol. An additional change is that, for the younger students, there were only two possible answers: "yes" and "no" rather than the four-point scale of the older students' Opinion Protocol.

The Opinion Protocol items, together with the scales (attitudinal variables) they represented, are shown in Appendix B. The protocol was administered to intervention- and control-group students before and after the intervention project.

To assess student performance before and after the intervention, a number of measures were used. Pre- and posttests of content in mathematics and science were developed, administered, and scored by project faculty, and the scores were submitted to CASET. For both mathematics and science, the same test was administered before and after the intervention. The mathematics test consisted of 30 questions: 25 calculations and 5 word problems. The science test had 25 questions: seven were true-or-false questions, and the other 18 were multiple-choice and short-answer questions. In addition, the institution supplied school transcripts for intervention-and control-group students, as well as scores on the Iowa Test of Basic Skills (ITBS), a nationally standardized achievement test, administered prior to the intervention. CASET used the school grades that were taken from the students' transcripts in mathematics and science for the semester before the intervention, and the national percentiles for mathematics and science from the ITBS.

These performance scores, together with the completed CASET Student Protocols and preintervention and postintervention Opinion Protocols, were all submitted to, and analyzed by CASET.

## Procedure

At the beginning of the intervention, parents of the intervention- and control-group members signed consent forms and transcript release forms. The CASET Middle/Junior High School Student Protocol and the Opinion Protocol were administered to intervention- and control-group students, along with the faculty-developed tests of content described above.

Intervention students then took part in the project activities. After the intervention, the postintervention Opinion Protocol was administered to intervention- and control-group students, along with the faculty-developed postintervention tests of content mastery. The attendance records and content test scores were forwarded to CASET, along with the completed CASET instruments. The institution also supplied school transcripts for intervention- and control-group students and standardized test scores.

The items of the Opinion Protocol were coded by CASET according to the thirteen scales they represent. Scoring of the positively worded items on the Opinion Protocol was reversed so that scores could be totaled meaningfully (see Appendix B). The scales were organized into three constructs--SET Goal, Environmental Support, and Attitude--as shown in Appendix C.

# RESULTS

## Methodological Issues

The intervention's two major hypotheses were that the intervention activities would: (a) enhance performance on SET-content measures, and (b) enhance opinions about SET fields and careers. The preintervention and postintervention measures of performance and opinion were analyzed in terms of a nonequivalent control group design. This type of quasi-experimental design has one major weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty may be addressed by analyzing the influence of preexisting characteristics on students' performance and opinion; the analysis of covariance (ANCOVA), adjusting for preintervention performance or opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that may have existed prior to the intervention.

## Demographic Results

The comparability of the intervention- and control-groups prior to the intervention was examined by testing for differences on the items of the Student Protocol. The complete results are given in Appendix D. Of the 48 comparisons, the groups differed on only three: (a) the intervention-group students were younger ($\underline{M}$ = 12.19 years) than the control-group students ($\underline{M}$ = 12.58 years); (b) a greater percentage of intervention-group students reported that their parents had attended a parent-teacher conference (intervention = 86%, control = 42%); and (c) intervention-group students reported that their parents had more involvements in their education ($\underline{M}$ = 3.76) than had the control-group students' parents ($\underline{M}$ = 2.63). Based on finding only three differences, the groups were judged to be relatively comparable on demographic characteristics prior to the intervention. However, two of the demographic differences--age and number of parental involvements--were used to adjust performance measures in a set of exploratory analyses reported below.

## Performance Measures

*Group differences in performance.* The six preintervention measures and the two postintervention measures of performance were used to test the first hypothesis, group differences in performance. The results are given in Table 2. Note that the control-group and the intervention-group did not differ significantly on any pretest measure, but the intervention-group outperformed the control-group on the postintervention mathematics and science tests. The intervention-group students scored 19 points higher on the math posttest and 41 points higher on the science posttest. Since the intervention-group students began with a nonsignificant 5-point advantage on the science test, further analyses were conducted that adjusted for preintervention scores.

Table 2

GROUP COMPARISONS OF PERFORMANCE MEASURES

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | Sig.p |
|---|---|---|---|---|---|---|
| ITBS Math | Control<br>Intervention | 18<br>20 | 22.72<br>28.05 | 19.23<br>22.75 | 0.78<br>(36) | ns |
| ITBS Science | Control<br>Intervention | 18<br>20 | 34.89<br>45.25 | 20.76<br>23.36 | 1.44<br>(36) | ns |
| Math Grade | Control<br>Intervention | 17<br>21 | 1.82<br>2.29 | 1.09<br>1.04 | 1.33<br>(36) | ns |
| Science Grade | Control<br>Intervention | 17<br>21 | 2.26<br>1.87 | 0.84<br>0.80 | -1.44<br>(36) | ns |
| Math Pretest | Control<br>Intervention | 20<br>21 | 15.38<br>15.65 | 13.37<br>11.14 | 0.07<br>(39) | ns |
| Science Pretest | Control<br>Intervention | 20<br>20 | 43.35<br>48.75 | 17.08<br>13.13 | 1.12<br>(38) | ≤.01 |
| Math Posttest | Control<br>Intervention | 18<br>17 | 22.22<br>40.88 | 12.39<br>17.61 | 3.64<br>(33) | ≤.01 |
| Science Posttest | Control<br>Intervention | 18<br>17 | 28.83<br>69.35 | 15.40<br>23.36 | 6.09<br>(33) | |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

*Group differences after adjusting for pretests.* As a further test of the first hypothesis of group differences in performance, a hierarchical ANCOVA procedure adjusted for pretest scores before comparing groups on postintervention performance measures; the results are given in Table 3. This table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding the first and each subsequent variable to the multiple regression equation (one variable per row), and the significance test of each variable's contribution toward explaining the dependent variable. The columns of the table include the cumulative percentage of explained variance (cum $R^2$), the variable's contribution to explained variance ($Sr^2$), the test of the variable's contribution ($F(Sr^2)$), and the test's degrees of freedom (df).

Table 3

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES* | Cumul. $R^2$ | $Sr^2$ | F ($Sr^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Mathematics | PRETEST | .1176 | .1176 | 4.40 | 1,33 | ≤.05 |
| | + GROUP | .3864 | .2688 | 14.02 | 1,32 | ≤.01 |
| | + PRE-x-GROUP | .5456 | .1582 | 10.77 | 1,31 | ≤.01 |
| Mathematics | ITBS MATH | .5269 | .5269 | 34.52 | 1,31 | ≤.01 |
| | + GROUP | .6710 | .1441 | 13.14 | 1,30 | ≤.01 |
| | + ITBS-x-GROUP | .6879 | .0169 | 1.57 | 1,29 | ns |
| Mathematics | PRIOR GRADE | .3568 | .3568 | 17.19 | 1,31 | ≤.01 |
| | + GROUP | .5066 | .1498 | 9.11 | 1,30 | ≤.01 |
| | + GRADE-x-GROUP | .5459 | .0394 | 2.51 | 1,29 | ≤.10 |
| Science | PRETEST | .1945 | .1945 | 7.73 | 1,32 | ≤.01 |
| | + GROUP | .6378 | .4434 | 37.95 | 1,31 | ≤.01 |
| | + PRE-x-GROUP | .6546 | .0168 | 1.46 | 1,30 | ns |
| Science | ITBS SCIENCE | .3605 | .3605 | 17.47 | 1,31 | ≤.01 |
| | + GROUP | .7248 | .3643 | 39.71 | 1,30 | ≤.01 |
| | + ITBS-x-GROUP | .7261 | .0014 | 0.14 | 1,29 | ns |
| Science | PRIOR GRADE | .0060 | .0060 | 0.19 | 1,31 | ns |
| | + GROUP | .6196 | .6136 | 48.40 | 1,30 | ≤.01 |
| | + GRADE-x-GROUP | .6227 | .0030 | 0.23 | 1,29 | ns |

All models were analyzed as one-tailed tests.

* Three models of independent variables were tested for each dependent variable: (1) The PREMEASURE alone; (2) PREMEASURE and ('+') GROUP; (3) PREMEASURE and GROUP and PREMEASURE-by-GROUP INTERACTION ('-x-').

Because the hypothesis was directional--improvement for the intervention-group--the test statistics were compared to one-tailed probability levels; for F statistics, this involved converting from F to t statistics ($F = t^2$), and comparison to the corresponding one-tailed critical values.

The results in Table 3 were based on analyses that used three different pretest scores as covariates for the posttest measures of mathematics and science. It was expected that the findings from the analysis that used the "best" covariate would test the hypothesis of improved performance in the intervention-group, and that the findings from this "best" covariate would be supported by the findings from the other two covariates. The analyses of postintervention mathematics performance found significantly higher scores by the intervention-group than by the control- group. The

best covariate (based on its explaining the most variance of the mathematics posttest) was the ITBS mathematics percentile; the finding from this ANCOVA was superior performance by the intervention-group, which supported the hypothesis. The analyses that adjusted for mathematics pretest or for prior math grade also found superior performance by the intervention-group, but these two analyses also demonstrated significant interactions between prior score and group membership: Except for the students with the lowest pretest scores or prior grades, the intervention-group students outperformed the control-group students. These significant interactions were explored further.

The ANCOVAs for science posttest scores also demonstrated superior performance by the intervention-group. Again, the ITBS science percentile was the best covariate, but the other analyses produced similar findings.

The significant interactions indicated that the relationship between prior scores and the postintervention mathematics scores was different between the intervention- and control-groups. The interactions were analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of pretest scores for which the groups differed. Figures 1 and 2 show the nonparallel regression lines that indicated that, except for students with lower-than-average prior mathematics performance, the intervention-group students outperformed the control-group students.

In Figure 1, for students with preintervention mathematics test scores at or above 15 (overall $\underline{M}$ = 16), the intervention group outperformed the control group on the mathematics posttest.

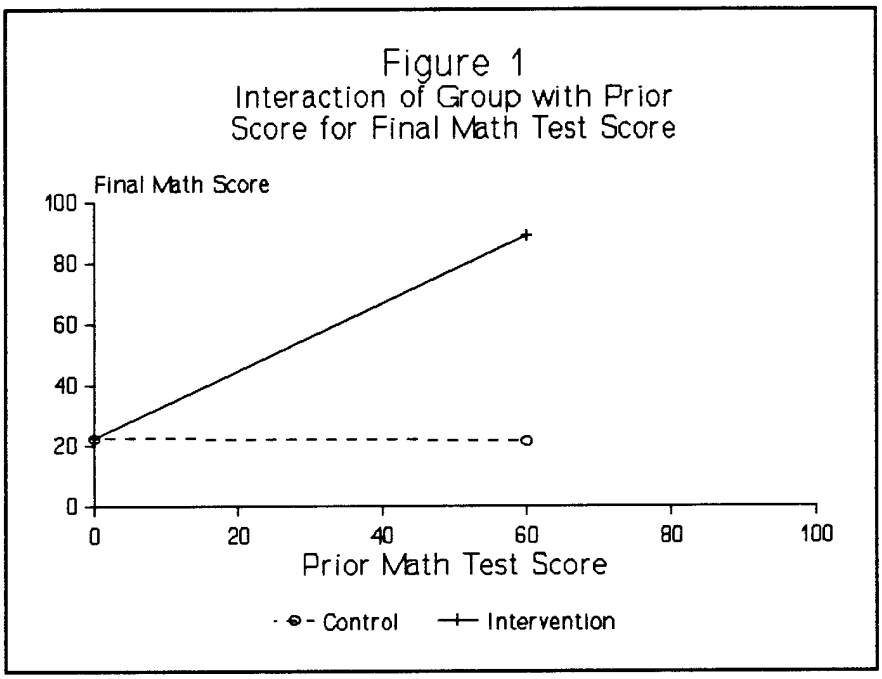
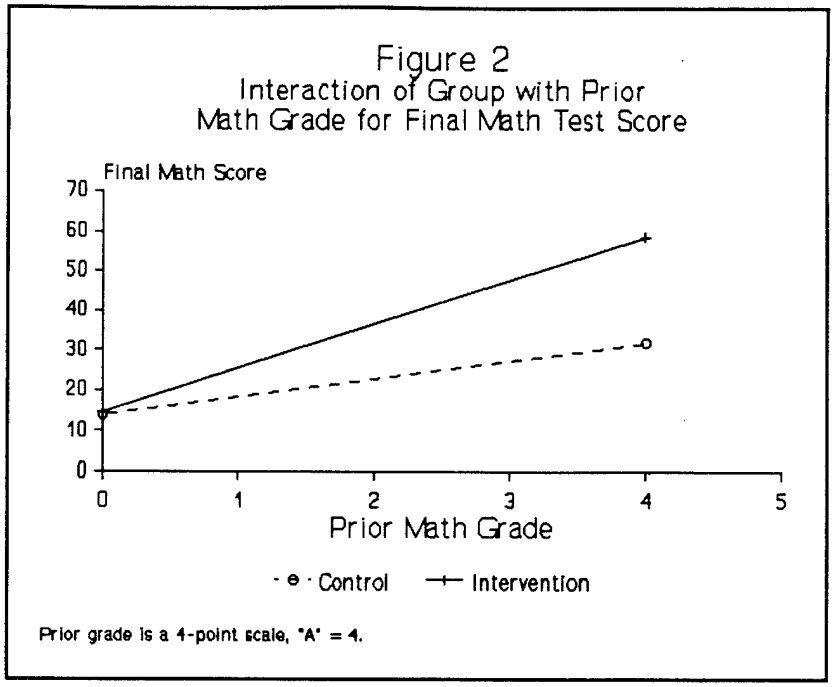


Figure 2 indicates that for those students with prior mathematics GPAs of 1.7 (C-) or greater overall M = 2.1 C, the intervention-group had higher postintervention mathematics test scores than did the control- group students.




For both mathematics and science posttests, the intervention enhanced the performance of students; for the mathematics test, the enhancement was restricted to students who began as average or above average students. These findings paralleled and strengthened the findings from the t-tests of Table 2. The next section describes exploratory analyses that evaluated the performance hypothesis after making further adjustments for demographic differences between the intervention- and control- groups.

*Group differences after adjusting for pretests.* Two demographic variables--age and number of parental involvements--that had differed between the control- and intervention-groups were tested for their relationship to the math and science posttests; as reported above, the intervention-group students were slightly younger and had parents who were more involved in their children's education than were the parents of the control-group students. These two demographic variables were correlated significantly with postintervention performance: (a) age was negatively correlated with math and science posttests, $r(32) = -.31$ and $-.42$, $p \leq .10$ and .05 two-tailed, respectively; and (b) the number of parental involvements was positively correlated with math and science posttests, $r(32) = .60$ and .43, $p \leq .05$ and .01 two-tailed, respectively. A set of ANCOVAs tested whether additional adjustments for age and number of parental involvements would alter the results of the ANCOVAs of Table 3.

The additional adjustments for age and parental involvement produced the same pattern of findings for five of the six analyses. The one exception was for the analysis with prior math grade; adding age and parental involvement as covariates reduced the group difference for math posttest and the significant interaction between prior grade and group membership for math posttest, below the level of significance. Though the findings in five of the six analyses were the same, the extra demographic adjustments reduced the size of the intervention-group's advantage by several points. The difference between the unadjusted, postintervention math tests was 19 points (see Table 2); after adjusting for ITBS math percentile, the groups' difference was reduced to 13 points (Table 3); and after adjusting for ITBS math percentile, age, and parental involvement, the groups' difference was reduced to 8 points. The difference between the unadjusted, postintervention science tests was 40 points (see Table 2); after adjusting for ITBS science percentile, the groups' difference was reduced to 34 points (Table 3); and after adjusting for ITBS science percentile, age, and parental involvement, the groups' difference was reduced to 28 points. In summary, whether or not adjustments are made for possible differences, the intervention-group performed at a significantly higher level on mathematics and science posttests, findings which supported the first hypothesis.

*Interrelationships among performance.* The interrelatedness of the performance measures was examined in Table 4, to establish the construct validity of the mathematics and science content tests.

**Table 4**

**INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a]**

| | Pre-Math Sig p (n) | Prior MathG Sig p (n) | ITBS Math Sig p (n) | Pre-Sci. Sig p (n) | Prior Sci.G Sig p (n) | ITBS Sci. Sig p (n) | Post Math Sig p | Post Sci. Sig p |
|---|---|---|---|---|---|---|---|---|
| Prior Math Grade | .36 ≤.05 (38) | 1.00 | | | | | | |
| ITBS Math | .29 ≤.05 (38) | .73 ≤.01 (37) | 1.00 | | | | | |
| Pre-Sci. | .28 ≤.05 (40) | .36 ≤.05 (37) | .29 ≤.05 (37) | 1.00 | | | | |
| Prior Sci. Grade | .12 ns (38) | .53 ≤.01 (38) | .42 ≤.01 (37) | .10 ns (37) | 1.00 | | | |
| ITBS Sci. | .25 ≤.10 (38) | .47 ≤.01 (37) | .62 ≤.01 (38) | .46 ≤.01 (37) | .23 ≤.10 (37) | 1.00 | | |
| Post Math | .34 ≤.05 (35) | .60 ≤.01 (33) | .73 ≤.01 (33) | .04 ns (34) | .19 na (33) | .51 ≤.01 (33) | 1.00 | |
| Post Sci. | .15 ns (35) | .57 ≤.01 (33) | .54 ≤.01 (33) | .44 ≤.01 (34) | .08 ns (33) | .60 ≤.01 (33) | .67 ≤.01 (35) | 1.00 |

[a] All correlations were analyzed as two-tailed tests.

Prior MathG = Prior Math Grade
Prior Sci.G = Prior Science Grade
Sci. = Science

Evidence for the validity of the tests could be obtained through intercorrelations that demonstrated convergence among different measures of the same construct, e.g., significant correlations between mathematics pretest scores and prior mathematics grades, and divergence among measures of different constructs, e.g., nonsignificant correlations between mathematics pretest scores and prior science grades (Cook & Campbell, 1979).

The patterns of correlations indicated that the mathematics and science tests had convergent and divergent validity. One notable exception was a lack of convergence for science grades with the science pretest and posttest, though prior science grades were correlated with the ITBS science percentile. Another validity finding was that the ITBS scores had significant correlations across content areas: The correlations between ITBS math and science posttest and between ITBS science and math posttest were greater than .5. However, the correlations showed some divergence, because the within-content correlations (ITBS mathematics with mathematics posttest, and ITBS science with science posttest) were greater than the cross-content correlations. The conclusions from the intercorrelations shown in Table 4 were that the mathematics and science posttest measures did measure what they were designed to measure.

## Opinion Measures

*Group differences on pre- and postintervention measures.* The second hypothesis was that the intervention would produce enhanced opinions of SET fields, and this hypothesis was tested by evaluating the students' responses to the Opinion Protocol. The means of the intervention group and control group students were compared for the 13 opinion variables, three constructs, and the total opinion score, measured before and after the intervention. These results are given in Table 5. Before the intervention began, the control and intervention groups did not differ on any of the 17 opinion measures. After the intervention ended, the intervention group had higher scores on the Self-Concept scale, Environmental Support construct, and Academic Support scale. The control group had higher scores on the Cultural Value, Attitude, and Math/Science Attitude scales. This combination of positive and negative effects of the intervention on opinion did not take students' opinions prior to the intervention into consideration. The postintervention differences may have been the further development of preexisting differences and not the result of the intervention. In order to adjust for preexisting differences, the final opinion variables were adjusted for preexisting differences via ANCOVA.

Table 5

GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES

| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| OPINION, Total | Pretest | 1.64 | .08 | 1.66 | .08 | 0.69 | ns |
| | Posttest | 1.59 | .06 | 1.59 | .05 | 0.06 | ns |
| SET GOAL | Pretest | 1.63 | .12 | 1.64 | .06 | 0.28 | ns |
| | Posttest | 1.60 | .10 | 1.62 | .10 | 0.59 | ns |
| Value | Pretest | 1.76 | .19 | 1.74 | .10 | -0.52 | ns |
| | Posttest | 1.75 | .23 | 1.71 | .22 | -0.58 | ns |
| Cultural Value | Pretest | 1.64 | .20 | 1.68 | .14 | 0.76 | ns |
| | Posttest | 1.75 | | 1.68 | | -1.31 | ≤.10 |
| Self-Concept | Pretest | 1.57 | .21 | 1.57 | .21 | 0.00 | ns |
| | Posttest | 1.54 | .16 | 1.64 | .26 | 1.39 | ≤.10 |
| Aspiration | Pretest | 1.60 | .22 | 1.61 | .22 | 0.21 | ns |
| | Posttest | 1.43 | .14 | 1.47 | .22 | 0.67 | ns |
| ATTITUDE | Pretest | 1.60 | .11 | 1.63 | .13 | 0.72 | ns |
| | Posttest | 1.52 | .09 | 1.48 | .06 | -1.55 | ≤.10 |
| Math/Science Attitude | Pretest | 1.59 | .19 | 1.54 | .14 | -1.05 | ns |
| | Posttest | 1.55 | .12 | 1.48 | .13 | -1.58 | ≤.10 |
| Locus of Control | Pretest | 1.54 | .27 | 1.57 | .19 | 0.41 | ns |
| | Posttest | 1.38 | .23 | 1.31 | .14 | -1.02 | ns |
| Persistence | Pretest | 1.69 | .25 | 1.73 | .30 | 0.40 | ns |
| | Posttest | 1.51 | .29 | 1.50 | .18 | -0.17 | ns |
| Study Habits | Pretest | 1.57 | .24 | 1.62 | .23 | 0.71 | ns |
| | Posttest | 1.53 | .31 | 1.44 | .27 | -0.93 | ns |
| Anxiety | Pretest | 1.58 | .24 | 1.71 | .28 | 1.52 | ns |
| | Posttest | 1.53 | .21 | 1.55 | .14 | 0.24 | ns |
| ENVIRONMENTAL SUPPORT | Pretest | 1.74 | .12 | 1.75 | .10 | 0.49 | ns |
| | Posttest | 1.70 | .13 | 1.76 | .12 | 1.42 | ≤.10 |
| Academic Support | Pretest | 1.83 | .20 | 1.84 | .23 | 0.12 | ns |
| | Posttest | 1.74 | .24 | 1.92 | .15 | 2.64 | ≤.01 |

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| Career Awareness | Pretest | 1.82 | .20 | 1.84 | .23 | 0.37 | ns |
| | Posttest | 1.74 | .22 | 1.71 | .20 | -0.50 | ns |
| Role Model | Pretest | 1.51 | .25 | 1.40 | .27 | -1.36 | ns |
| | Posttest | 1.47 | .23 | 1.50 | .20 | 0.38 | ns |
| Equal Opportunity | Pretest | 1.78 | .27 | 1.89 | .16 | 1.53 | ns |
| | Posttest | 1.86 | .22 | 1.90 | .20 | 0.59 | ns |

All pretests were analyzed as two-tailed tests.
All posttests were analyzed as one tailed tests.
Pretests n's: Control = 20; Intervention = 21
Posttest n's: Control = 18; Intervention = 17

*Group differences on opinion adjusting for prior scores.* Table 6 reports further tests of the second hypothesis that measured the effects of the intervention on opinions about SET fields after adjusting for preintervention opinion scores in ANCOVAs. The three scales that had shown a control group advantage in Table 5 were not significantly different when adjustments for preintervention opinion scores were made. By these analyses, the intervention and control groups differed overall on three opinion measures: The intervention group had significantly higher Self-Concept, Environmental Support, and Academic Support scores. These results paralleled the t-test results.

In addition to the three overall advantages for the intervention group, there were significant interactions between preintervention opinion score and group membership for six postintervention opinion measures: Aspiration, Attitude, Math/Science Attitude, Locus of Control, Anxiety, and Role Model.

Table 6

| HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION | | | | | | |
|---|---|---|---|---|---|---|
| **FINAL OPINION CONSTRUCT/ Scale** | **INDEPENDENT VARIABLES MODELS** | **Cumul. $R^2$** | **$sR^2$** | **$F(sR^2)$** | **df** | **Sig. p** |
| OPINION, Overall | PREINTERVENTION | .2644 | .2641 | 11.84 | 1,33 | ≤.01 |
| | +GROUP | .2756 | .0116 | 0.51 | 1,32 | ns |
| | +PRE-x-GROUP | .2794 | .0038 | 0.16 | 1,31 | ns |
| SET GOAL | PREINTERVENTION | .2953 | .2953 | 13.83 | 1,33 | ≤.01 |
| | +GROUP | .2953 | .0000 | 0.00 | 1,32 | ns |
| | +PRE-x-GROUP | .2964 | .0011 | 0.05 | 1,31 | ns |
| Value | PREINTERVENTION | .0734 | .0734 | 2.61 | 1,33 | ≤.10 |
| | +GROUP | .0788 | .0055 | 0.19 | 1,32 | ns |
| | +PRE-x-GROUP | .0789 | .0001 | 0.00 | 1,31 | ns |
| Cultural Value | PREINTERVENTION | .0036 | .0036 | 0.12 | 1,33 | ns |
| | +GROUP | .0496 | .0460 | 1.55 | 1,32 | ns |
| | +PRE-x-GROUP | .0517 | .0021 | 0.07 | 1,31 | ns |
| Self-Concept | PREINTERVENTION | .0921 | .0921 | 3.35 | 1,33 | ≤.05 |
| | +GROUP | .1443 | .0522 | 1.95 | 1,32 | ≤.10 |
| | +PRE-x-GROUP | .1681 | .0238 | 0.89 | 1,31 | ns |
| Aspiration | PREINTERVENTION | .4899 | .4899 | 31.69 | 1,33 | ≤.01 |
| | +GROUP | .4903 | .0004 | 0.03 | 1,32 | ns |
| | +PRE-x-GROUP | .5286 | .0383 | 2.52 | 1,31 | ≤.10 |
| ATTITUDE | PREINTERVENTION | .2014 | .2014 | 8.32 | 1,33 | ≤.01 |
| | +GROUP | .3303 | .1289 | 6.16 | 1,32 | ≤.01 |
| | +PRE-x-GROUP | .4189 | .0886 | 4.73 | 1.31 | ≤.01 |
| Math/ Science Attitude | PREINTERVENTION | .0746 | .0746 | 2.66 | 1,33 | ≤.10 |
| | +GROUP | .1285 | .0539 | 1.98 | 1,32 | ≤.10 |
| | +PRE-x-GROUP | 2120 | .0835 | 3.29 | 1,31 | ≤.05 |
| Locus of Control | PREINTERVENTION | .0528 | .0528 | 1.84 | 1,33 | ≤.10 |
| | +GROUP | .0956 | .0428 | 1.51 | 1,32 | ns |
| | +PRE-x-GROUP | .1530 | .0574 | 2.10 | 1,31 | ≤.10 |
| Persistence | PREINTERVENTION | .3358 | .3358 | 16.68 | 1,33 | ≤.01 |
| | +GROUP | .3403 | .0046 | 0.22 | 1,32 | ns |
| | +PRE-x-GROUP | .3728 | .0325 | 1.61 | 1,31 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Study Habits | PREINTERVENTION | .1552 | .1552 | 6.06 | 1,33 | ≤.01 |
| | +GROUP | .1978 | .0427 | 1.70 | 1,32 | ns |
| | +PRE-x-GROUP | .2261 | .0282 | 1.13 | 1,31 | ns |
| Anxiety | PREINTERVENTION | .1270 | .1270 | 4.80 | 1,33 | ≤.05 |
| | +GROUP | .1344 | .0075 | 0.28 | 1,32 | ns |
| | +PRE-x-GROUP | .2501 | .1157 | 4.78 | 1,31 | ≤.05 |
| ENVIRONMENTAL SUPPORT | PREINTERVENTION | .2672 | .2672 | 12.03 | 1,33 | ≤.01 |
| | +GROUP | .3055 | .0383 | 1.77 | 1,32 | ≤.10 |
| | +PRE-x-GROUP | .3204 | .0149 | 0.68 | 1,31 | ns |
| Academic Support | PREINTERVENTION | .0655 | .0665 | 2.35 | 1,33 | ≤.10 |
| | +GROUP | .2467 | .1802 | 7.66 | 1,32 | ≤.01 |
| | +PRE-x-GROUP | .2501 | .0034 | 0.14 | 1,31 | ns |
| Career Awareness | PREINTERVENTION | .0228 | .0228 | 0.77 | 1,33 | ns |
| | +GROUP | .0320 | .0092 | 0.30 | 1,32 | ns |
| | +PRE-x-GROUP | .0665 | .0345 | 1.15 | 1,31 | ns |
| Role Model | PREINTERVENTION | .0476 | .0476 | 1.65 | 1,33 | ns |
| | +GROUP | .0639 | .0163 | 0.56 | 1,32 | ns |
| | +PRE-x-GROUP | .1571 | .0932 | 3.43 | 1,31 | ≤.05 |
| Equal Opportunity | PREINTERVENTION | .0401 | .0401 | 1.38 | 1,33 | ns |
| | +GROUP | .0412 | .0011 | 0.04 | 1,32 | ns |
| | +PRE-x-GROUP | .0445 | .0033 | 0.11 | 1,31 | ns |

All models were analyzed as one-tailed tests.

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

As with the performance interactions, the nonparallel regression lines were graphed, and the Johnson-Neyman technique was used to determine the intersection point and range of values for which the groups differed.

Figures 4, 5, and 7 showed a similar pattern of differences: The intervention was most successful in enhancing the opinions of students who entered with low opinions of the value of SET fields, and in lowering the anxiety of students who had begun with high levels of anxiety.

Figure 4
Interaction of Group with Prior Attitude for Final Attitude Score

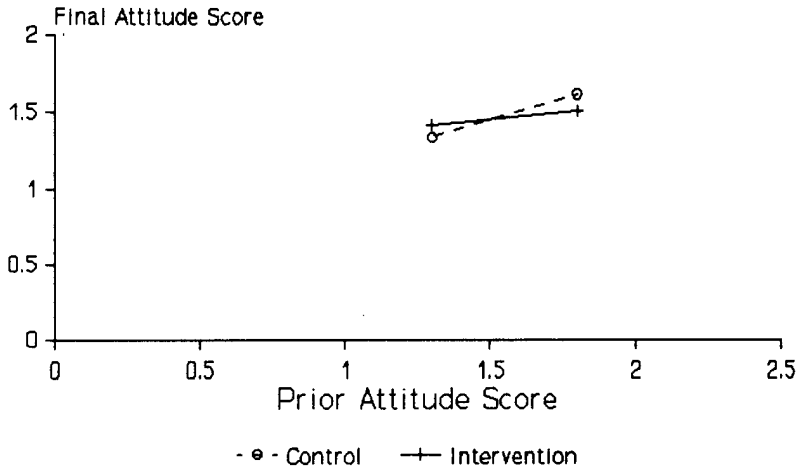
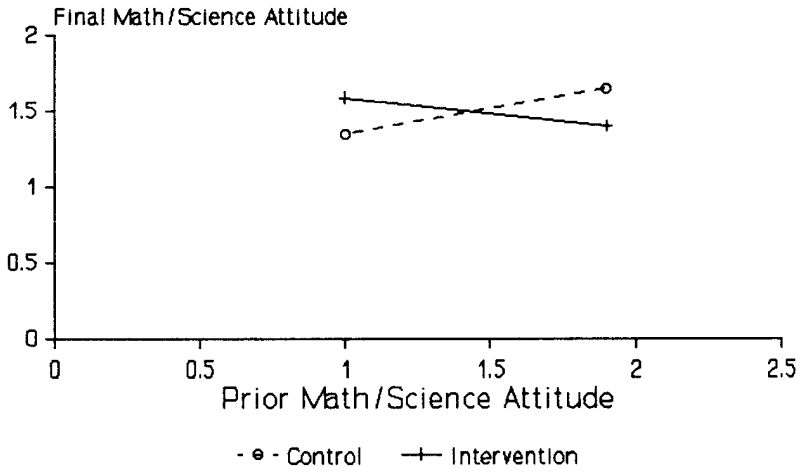
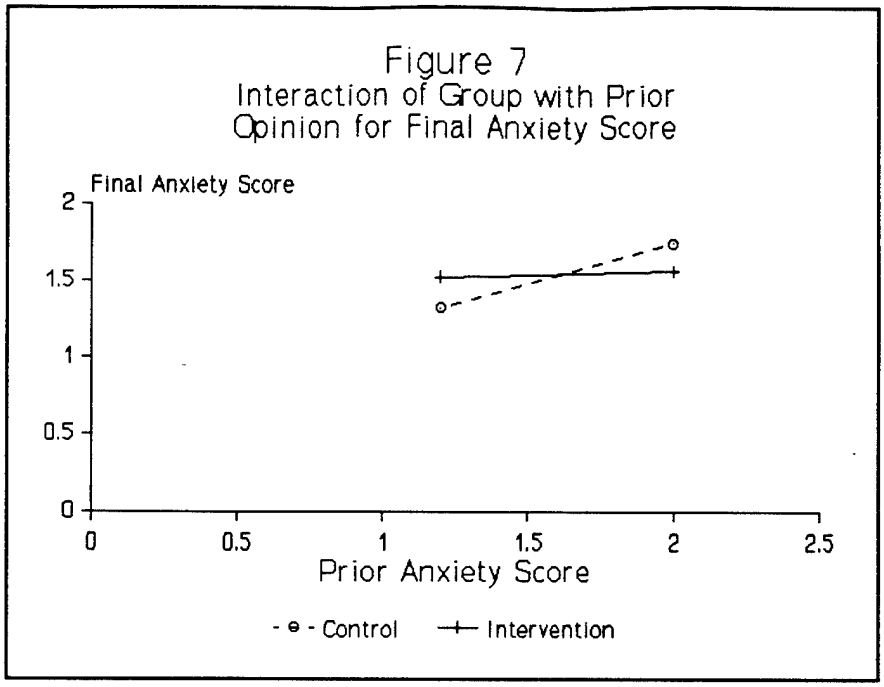
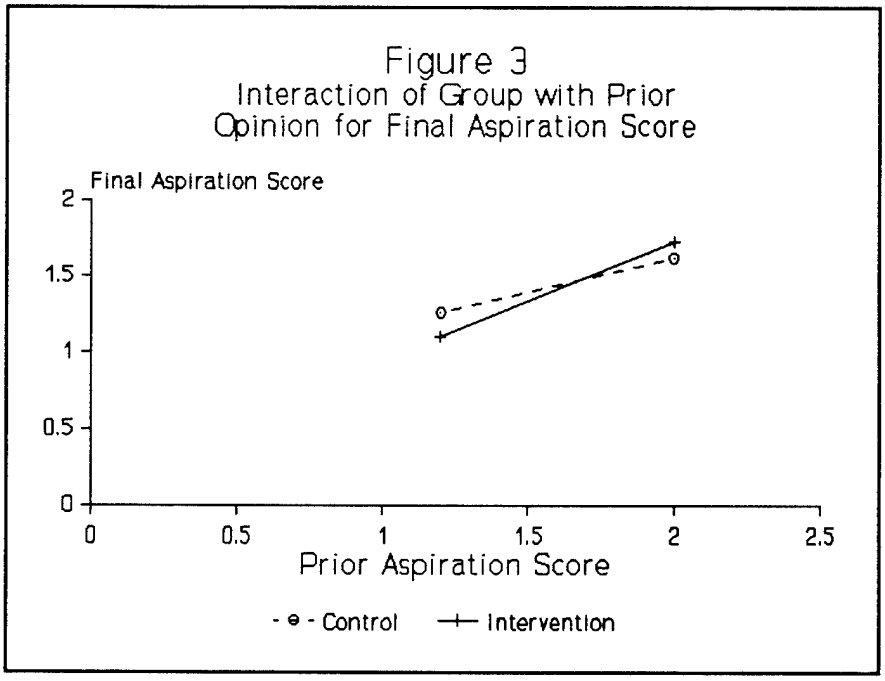


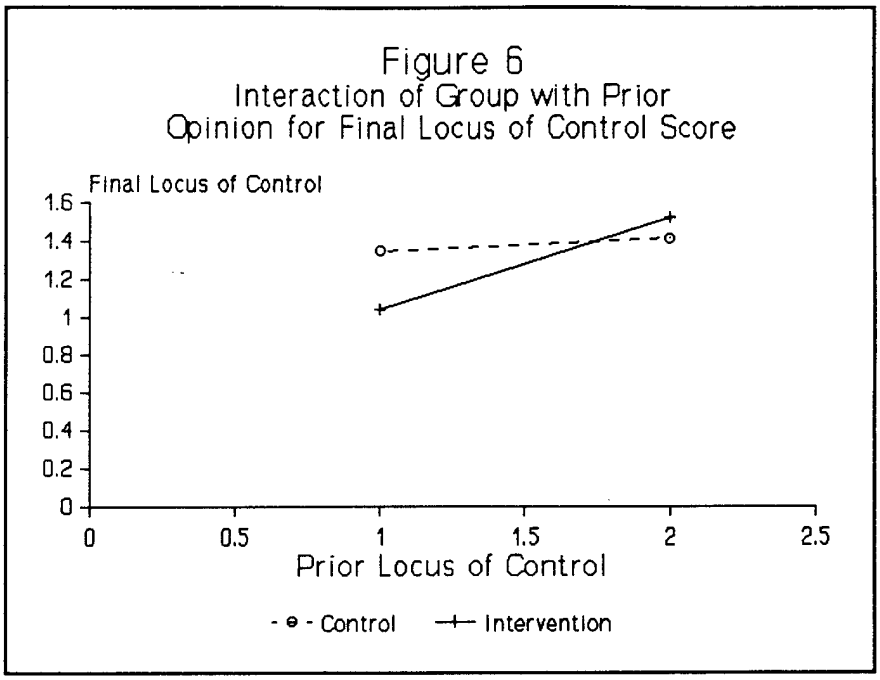

Figure 5
Interaction of Group with Prior Opinion for Final Math/Science Attitude

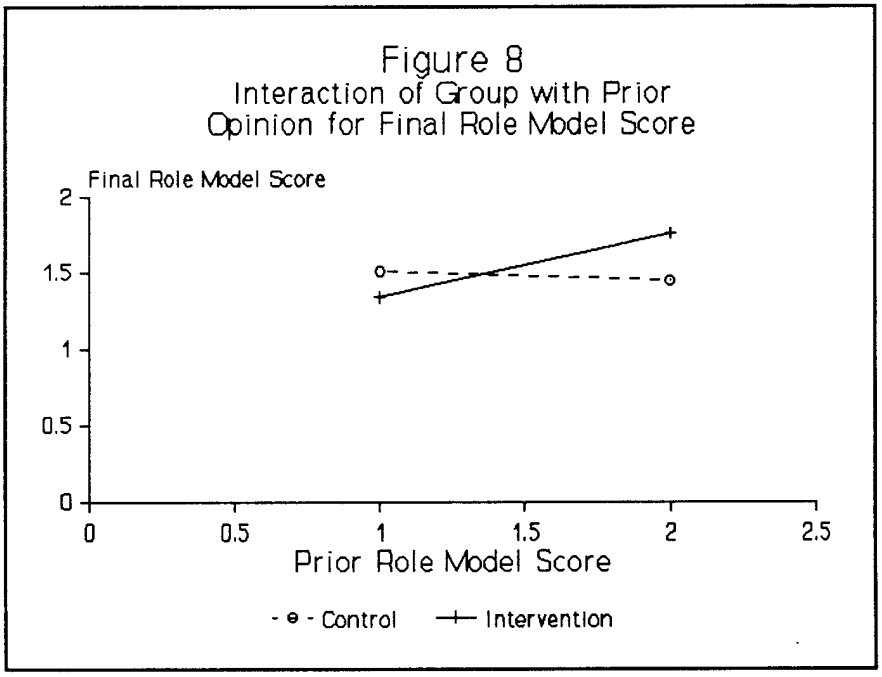





Figures 3, 6, and 8 all show another pattern of the intervention's effects: The intervention was most helpful at raising the scores of students who had entered with higher levels of aspiration, a more internal locus of control, or more positive role model scores.




Figure 6
Interaction of Group with Prior
Opinion for Final Locus of Control Score
Final Locus of Control
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
Prior Locus of Control
- o - Control
Intervention


Figure 8
Interaction of Group with Prior
Opinion for Final Role Model Score
Final Role Model Score
2
1.5
1
0.5
0
0
0.5
1
1.5
2
2.5
Prior Role Model Score
- o - Control
Intervention

Of the six selective benefits of the intervention on opinion scores, the intervention aided about one-half of the students on four opinion measures (Aspiration, Attitude, Math/Science Attitude, and Anxiety); the intervention benefitted more than one-half of the students on one measure (Role Model); and the intervention enhanced the scores of fewer than one-half of the students on one measure (Locus of Control).

In summary, the test of the second hypothesis found support for the intervention's success; the intervention-group students had more positive opinions than did the control-group students on three measures, and some of the intervention-group students had more positive scores that did the control-group students on six more opinion measures.

## DISCUSSION

Two points are particularly interesting about this intervention: the fact that it was directed to "second-tier" students, and the involvement of middle school counselors to work with students' parents, including home visits. The "second-tier" students, who have not excelled in school but who in many cases have excellent untapped potential, may represent an important source of new talent for the technological fields in the next century, so an intervention specifically geared to them which succeeds as well as this one did, has great potential. This intervention may also support the argument that parents who see SET careers as real and positive options for their children and understand the requirements and benefits of those careers, can enhance the effectiveness of a program for their children.

The performance of these students in the mathematics and science areas was rather dramatically enhanced. The intervention-group considerably outperformed the control-group in both the mathematics and the science posttests of content. Keeping in mind that these are "second-tier" students, this enhanced performance is particularly exciting. There was one exception to this almost universal improvement in performance: students whose prior grade in mathematics was below a C- did not improve appreciably in their mathematics performance as a consequence of the intervention. This suggests that, although the present intervention was effective with "second-tier" students, it would seem that a foundation in mathematics is necessary for success. If these findings are replicated in later research, they will suggest that while a student does not need to be an A or even a B student in mathematics to benefit from such a program, a D or lower student may lack either the requisite skills or the motivation to succeed with this intervention.

For these young students, the gains in opinion scores are exciting. Students completed this intervention with heightened self-concept as well as enhanced performance; with a greater sense of their own abilities and a greater sense of being supported by their environment. These are findings that would seem to relate directly to the components of the intervention with its focus on counselors and the home.

The success of this project is important, not only for the students involved, but for what the findings suggest about the importance of counselor and parental support for success. Further research should address questions about the relative importance of the intervention's components: To what extent are these findings due to the counselor and/or parent involvement in the intervention, and to what extent other aspects, such as being on the college campus, the classes, or study skills seminar.

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Documents supplied by CASET Consortium institutions: baseline reports, research proposals, college catalogs and bulletins

# APPENDICES

# APPENDIX A

# MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

Participant Number: _____

## MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

Thank you for agreeing to participate in this important project. It is geared to help us develop new programs for students and improve existing programs.

Your opinions and experience are important to us. Please read each question carefully and answer completely and accurately to the best of your ability. All of your answers will be kept in confidence. Your answers will be grouped with those of other students in other places, and together they will help us better understand students' needs and preferences today.

Please ask your administrator if any of these questions are unclear to you.

Thanks for your help!

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. American Indian (Please specify the tribe which best describes your heritage.)

   _____
   ___ e. Hispanic (Which of the following best describes your heritage?)
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

   City: _____ State: _____

6. Class:
   ___ a. 4th grade
   ___ b. 5th grade
   ___ c. 6th grade
   ___ d. 7th grade
   ___ e. 8th grade

7. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Less than high school graduation
   ___ b. High school graduation
   ___ c. Two-year college degree (community college or junior college)
   ___ d. Four-year college degree
   ___ e. Education beyond four years of college
   ___ f. Other Specify _____

8. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

9. What is or are the occupation(s) of the person(s) with whom you live? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

   _____ _____

10. Would you say that your family's income is:
   ___ a. Below the U.S. average
   ___ b. About average
   ___ c. Above average
   ___ d. Don't know

11. Are you:
   ___ a. An only child (skip to question 13)
   ___ b. The oldest child
   ___ c. The youngest child
   ___ d. An in-between child

12. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

13. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

14. What was the highest level of school your mother completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

15. What is the language spoken most often by adults in your household? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe (What is that language?) _____
___ d. Another language - Specify _____

16. Which of the following did your parent(s) or guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Help you with your homework

17. Which of the following comes closest to describing how much your parent(s) or guardian(s) read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

18. Which of the following comes closest to describing how much you read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

19. Which of these items do you have in your family home? (Check all that apply)
    ___ a. A desk
    ___ b. Daily newspaper
    ___ c. Encyclopedia
    ___ d. Typewriter
    ___ e. Pocket calculator
    ___ f. Television
    ___ g. Computer
    ___ h. Video cassette recorder (VCR)

20. Have you ever taken part in any of these activities? (Check all that apply)
    ___ a. Math and science clubs
    ___ b. Field trip to science museum, laboratory, or other place where scientists work
    ___ c. Watching science programs on TV
    ___ d. A talk by a scientist
    ___ e. Science/math fair
    ___ f. Other science/math competition
    ___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL ITEMS WITH DIRECTIONALITY AND SCALES

## Opinion Protocol Items with Directionality and Scales

Legend:

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | Do you study each day rather than just before exams? |
| 2. | + | AT | Are scientists smarter than most people? |
| 3. | + | SC | Can you imagine yourself as a scientist? |
| 4. | - | AX | Do word problems in mathematics make you nervous? |
| 5. | + | VL | Do you think mathematics is needed in most jobs? |
| 6. | + | VL | Is science important to our country? |
| 7. | + | LC | When you make plans, can you usually make them work? |
| 8. | + | CA | Do girls have a good chance of becoming scientists when they grow up? |
| 9. | + | PS | Do you usually finish the things you start? |
| 10. | + | CV | Is it important to you that your people be proud of you? |
| 11. | - | SH | Do you prefer to study alone? |
| 12. | - | AT | Do scientists do boring work? |
| 13. | + | AS | If you have problems at school, is there someone who will help you? |

| | | | |
|---|---|---|---|
| 14. | - | AX | Do tests make you nervous? |
| 15. | + | SH | Do you get your homework done on time? |
| 16. | - | SC | Are science experiments hard for you to understand? |
| 17. | + | AP | Do you want to take any more mathematics courses? |
| 18. | + | CV | Are your friends good at mathematics? |
| 19. | - | EO | Does a person's color make a difference in whether or not they get to be a scientist? |
| 20. | - | PS | Do you get bored with your school work by the middle of the school year? |
| 21. | - | PS | Do you have trouble keeping your mind on your homework? |
| 22. | + | EO | Do people care if a good scientist is a man or a woman? |
| 23. | + | AP | Are you thinking of becoming a scientist? |
| 24. | - | AT | Is mathematics boring? |
| 25. | + | RM | Are many people of your ethnic/racial group successful scientists? |
| 26. | + | AP | Do you try to get good grades in science? |
| 27. | - | LC | Is success mostly a matter of luck? |
| 28. | + | AT | Do most scientists enjoy their work? |
| 29. | + | AT | Do you enjoy solving mathematics problems? |
| 30. | + | VL | Does mathematics come in handy outside of class? |
| 31. | - | AX | Do you feel scared when you have to work a mathematics problem? |

| | | | |
|---|---|---|---|
| 32. | + | CA | Can you really become a scientist if you want to? |
| 33. | + | CA | Do you think there are a lot of jobs for scientists? |
| 34. | - | AX | Do tests scare you even when you have studied for them? |
| 35. | + | SC | Do you think you are a good science student? |
| 36. | + | SH | Do you like to read about science? |
| 37. | + | RM | Have you ever met a scientist? |
| 38. | + | VL | Is science an important subject? |
| 39. | + | SC | Are you good at figuring out mathematics problems? |
| 40. | + | AP | Do you want to improve your mathematics skills? |
| 41. | + | AS | Do the teachers in your school care how well you do in school? |
| 42. | + | CV | Do your people think highly of scientists? |
| 43. | - | AP | Would you like to spend less time on science in school? |
| 44. | - | AS | Do your teachers think you don't do very well? |
| 45. | + | CV | Does your family care a lot about education? |
| 46. | - | AT | Are scientists unfriendly? |
| 47. | - | AX | Do you worry about being able to understand your science assignments? |
| 48. | + | RM | Is there a scientist you look up to? |
| 49. | - | EO | Are boys better in science than girls? |

| | | | |
|---|---|---|---|
| 50. | + | LC | Can you control whether or not you have a good day? |
| 51. | - | SC | Is science too hard for you? |
| 52. | - | PS | Do you often quit when things get tough? |
| 53. | - | AX | Do you get scared when you are called on to answer a question in mathematics? |
| 54. | + | AT | Is science interesting? |
| 55. | + | SC | Are you very good at mathematics? |

56. What do you want to be when you grow up?

a. _____

b. _____

c. _____

57. Please describe the work you feel scientists do in a typical work day. If you don't know, just use your imagination.

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE MIDDLE/JUNIOR HIGH STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 21 | CONTROL n = 19 |
| 1. Sex | | |
| Women | 76% | 60% |
| Men | 24% | 40% |
| 2. Age t(38)-2.52 | 12.19 | 12.58[a] |
| 6. Class | | |
| .Fifth grade | 0% | 5% |
| .Sixth grade | 5% | 0% |
| .Seventh grade | 95% | 79% |
| .Eighth grade | 0% | 10% |
| .Missing | 0% | 5% |
| 7. Higher education expected: | | |
| .Less than high school | 0% | 0% |
| .High school graduation | 14% | 16% |
| .Two-year college | 19% | 16% |
| .Four-year college | 38% | 10% |
| .One or more years after college | 29% | 42% |
| .Other | 0% | 5% |
| .Missing | 0% | 11% |
| 8. Studies most influenced by | | |
| .Parents | 62% | 58% |
| .Another family member | 19% | 5% |
| .Teacher | 5% | 16% |
| .Counselor | 5% | 0% |
| .Minister | 0% | 0% |
| .Friend | 0% | 5% |
| .Science professional | 0% | 0% |
| .Nonscience professional | 5% | 0% |
| .No one at all | 5% | 5% |
| .Missing | 0% | 10% |
| 9. Sources of outside income | | |
| .None | 10% | 10% |
| .One | 38% | 26% |
| .Two | 48% | 21% |
| .Missing | 5% | 42% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 21 | CONTROL n = 19 |
| 10. Family income: | | |
| .Below U.S. average | 0% | 0% |
| .About average | 19% | 26% |
| .Above average | 24% | 32% |
| .Unknown | 57% | 42% |
| 11. Birth order of student: | | |
| .Only child | 14% | 10% |
| .Oldest child | 33% | 32% |
| .Youngest child | 19% | 32% |
| .In-between child | 33% | 16% |
| .Missing | 0% | 10% |
| 12. Number of siblings: | | |
| .None | 14% | 10% |
| .One | 19% | 26% |
| .Two | 33% | 10% |
| .Three or more | 33% | 42% |
| .Missing | 0% | 10% |
| 13. Father's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 0% | 0% |
| .High school graduate | 19% | 26% |
| .Some college | 5% | 5% |
| .College degree or more | 19% | 32% |
| .Missing | 57% | 37% |
| 14. Mother's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 5% | 5% |
| .High school graduate | 52% | 26% |
| .Some college | 5% | 5% |
| .College degree or more | 19% | 42% |
| .Missing | 19% | 21% |
| 15. Language spoken most at home: | | |
| .English | 95% | 100% |
| .Spanish | 5% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 21 | CONTROL n = 19 |
| 16. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 38% | 16% |
| .Attend parent-teacher conferences | 86% | 42%[a] |
| .Visit student's class | 57% | 53% |
| .Phone/visit if there's a problem | 81% | 53% |
| .Do volunteer work | 24% | 26% |
| .Assist in student's homework | 90% | 74% |
| Number of parental involvements * t(38) = 2.66 | 3.76 | 2.63 |
| 17. Parent(s) read: | | |
| .Not at all | 0% | 5% |
| .Sometimes | 43% | 26% |
| .A lot | 57% | 68% |
| 18. Student reads: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 62% | 74% |
| .A lot | 38% | 26% |
| 19. Items in student's home:[b] | | |
| .Desk | 62% | 58% |
| .Daily newspaper | 95% | 90% |
| .Encyclopedia | 81% | 58% |
| .Typewriter | 57% | 74% |
| .Calculator | 86% | 84% |
| .Television | 95% | 95% |
| .Computer | 33% | 47% |
| .Video Cassette Recorder (VCR) | 76% | 74% |
| Number of support items * | 5.86 | 5.79 |
| 20. All activities student took part in:[b] | | |
| .Math/science club | 43% | 32% |
| .Field trip | 81% | 84% |
| .Watching science programs on TV | 67% | 68% |
| .Listen to talk by scientist | 33% | 37% |
| .Science/math fair | 29% | 53% |
| .Other science/math competition | 33% | 26% |
| .Play/work in computer lab | 90% | 84% |
| Number of activities * | 3.76 | 3.84 |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# NAVAJO COMMUNITY COLLEGE

# INTERVENTIONS

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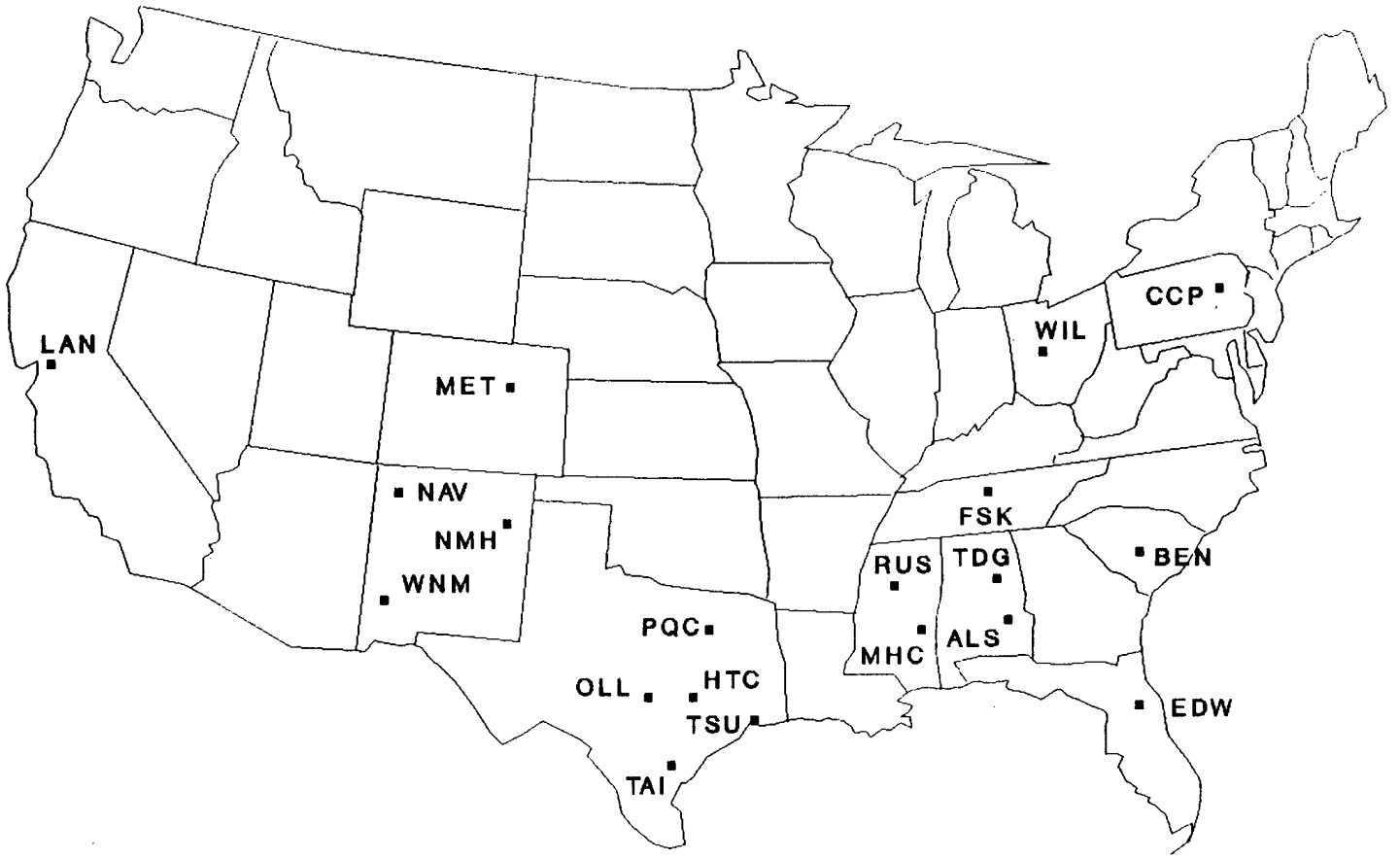
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# CASET Consortium Intervention Sites




LEGEND

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enables CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of the set of project reports produced by CASET to present the findings of the individual colleges' research.

Each college developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, with students; each collected data to measure the effects of those interventions. Data collected included the CASET protocols described in this report, outcome measures developed by the colleges according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All measures were taken on the intervention group students, as well as on a control group of students identified by each college for comparison purposes.

Intervention strategies tested by individual colleges included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The colleges explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each college. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Colleges were encouraged to develop and improve their interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research will be described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF NAVAJO COMMUNITY COLLEGE

Navajo Community College (NCC) is a tribally-controlled educational institution on the Navajo Reservation. It is a multi-campus, two-year, public, coeducational institution with its main campus in Tsaile, Arizona and a branch campus in Shiprock, New Mexico. The College, founded in 1968, is the first Indian-owned college to be fully accredited and the first to be established on an Indian reservation. In addition to its two campuses, there are five Community Campus centers that provide academic services; these centers are located in Chinle, Ganado, Tuba City, and Window Rock in Arizona and in Crownpoint, New Mexico. The College serves approximately 1800 students and has approximately 45 faculty members. NCC offers associate degrees in business, computer science, elementary education, fine arts, human services, liberal arts, Navajo studies, social science, social work, office management, physical/earth science, pre-law, pre-engineering, and pre-professional programs. Nearly the entire student population is American Indian. The president of NCC is Mr. Lawrence Gishey.

Degrees offered at NCC in quantitative subjects are Associate of Arts in computer science, and Associate of Science in computer science, mathematics, physical/earth science, and pre-engineering. The College also offers a variety of pre-professional programs including pre-engineering, resource science, chemistry, and mathematics.

Shiprock is located 90 miles east of the Tsaile, Arizona campus, in the Four Corners area and has a population of 15,000. The state of New Mexico has a population of approximately 1.5 million. According to 1980 Census figures, the population of New Mexico is 75 percent Anglo, 8 percent Hispanic, 2 percent Black, and 15 percent other ethnic origins including American Indian.

# PART II

# SUMMARY OF THE NAVAJO COMMUNITY COLLEGE (NCC) INTERVENTIONS

This report summarizes the two interventions conducted by Navajo Community College (NCC), a tribally-controlled, two-year institution located in Shiprock, New Mexico. NCC is a member of a consortium formed by The Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Navajo Community College Intervention Activities:

During the summer of 1989 and 1990, NCC conducted a hands-on summer science program for American Indian middle school students. This six-week program consisted of hands-on science laboratory instruction as developed by Lawrence Livermore National Laboratory in Livermore, California, and instruction in mathematics, science, computer science, and communications skills. An important feature of the program was the students' association with Navajo science majors attending NCC who served as program assistants and role models for the younger students. Participants were recruited primarily from among American Indian families who have traditionally brought their children to NCC to register for summer programs.

Findings:

- The science and mathematics performance of students who participated in the intervention improved in both summers.
- The intervention was particularly effective in improving science performance.
- The intervention improved students' grades in school and improved their scores on the nationally standardized California Test of Basic Skills (CTBS).
- In addition to improvements in science and mathematics, a number of students also improved in English achievement.
- Students previously making "C" or lower in science continued to have higher science grades in school and higher CTBS science scores two semesters after the intervention.
- Students in the intervention showed gains in the following opinion areas: self-concept, locus of control, persistence, SET value, and science attitude.

Recommendations:

- Providing students with a combination of substantial science and mathematics content along with environmental support will help to strengthen their academic performance, self- concept, and locus of control.
- It is important to give young students the opportunity to observe and work with role models they respect and to whom they can relate.
- It is recommended that a structured, instructional package that includes instructor training and staff preparation be used, such as the one developed by the Lawrence Livermore National Laboratory.

- The positive outcomes of this intervention underscore the potential of young students and supports the idea of reaching students at an early age.

- For students of this age, if a program is conveniently scheduled for the students' families (in terms of meeting day care needs, for example), access to students will be increased, and students will be more likely to persist.

# PART III

# CASE STUDY OF THE NAVAJO COMMUNITY COLLEGE

# 1989 SUMMER SEMESTER INTERVENTION

## ABSTRACT

In 1989 Navajo Community College (NCC), Shiprock, New Mexico, initiated and tested against a control group a hands-on summer science program for young American Indian students. Participants were 105 Navajo middle school students (53 girls and 52 boys). The intervention was repeated in the summer of 1990.

The NCC program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance in mathematics and science, and (b) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* The major components of the intervention were hands-on science laboratory instruction as developed by Lawrence Livermore National Laboratory in Livermore, California, along with instruction in mathematics, communications skills, and computer science. Instructors were four college faculty, five high school faculty, and five college-student program assistants, all of whom had been specially trained through instructor workshops conducted at the College by Lawrence Livermore personnel. A key feature of the program was the students' association with the NCC students (all science majors) who served as program assistants and as Navajo role models for the younger students.

*DATA:* All the participants furnished demographic data through the CASET Middle/Junior High School Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were scores on institution-specific content tests in computer science, English, mathematics, and science; scores in mathematics and science on the California Test of Basic Skills (CTBS); and school grades in mathematics and science.

The outcome measures of performance were, in the short term, four content test scores and a composite score, and in the long term, scores in mathematics and science on the CTBS, and postintervention two-semester averages in mathematics and in science. The preintervention measures of performance were four content test scores and a composite score, scores in mathematics and science on the CTBS, and preintervention two-semester averages in mathematics and in science.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design; through analyses of preintervention measures it appeared that the intervention and control groups were comparable.

*FINDINGS:* In general, the intervention had a positive effect on the participants and can be considered a successful intervention. Performance in science was enhanced in both the short term and the long term for intervention participants, while attitudinal data showed enhancement of self-concept and locus of control. All these outcomes, both performance and attitudinal, are thought to be favorable for increased participation by Navajo young people in SET studies and fields.

## DESCRIPTION OF THE INTERVENTION

For Navajo middle-school children, this 1989 summer intervention offered hands-on science instruction, together with work in mathematics, computer science, and communication skills. A significant aspect of this intervention was the involvement of presently-enrolled, science-major Navajo college students, as highly visible participants in the teaching and lab activities.

The primary objective of the intervention was to motivate Navajo junior high school students to choose the college preparatory mathematics and science sequences in high school by interesting them in science early and by showing them older Navajo students who are succeeding in science. Further objectives were the improvement of performance in mathematics and science, as measured by teacher-made tests, by nationally standardized achievement tests, and by grades in school in science and mathematics.

Four consultants from Lawrence Livermore National Laboratory in Livermore, California visited the reservation prior to the intervention to lead workshops in instructor training for the hands-on science instruction. Four college faculty, five student laboratory assistants (NCC students majoring in science) and several area science teachers attended the Livermore workshop and then participated in the intervention as instructors and assistants.

The sequence of activities was as follows:

[1] Two-week workshop at the Shiprock campus for instructors, led by Lawrence Livermore National Laboratory personnel

[2] One-week faculty and staff preparation for intervention with students

[3] Six-week intervention with students

Students participated in hands-on science laboratory work in physics for three of the six weeks, and in chemistry for three of the six weeks. They wrote computer programs using the LOGO program for low resolution graphics. Sessions were conducted four times a week for six weeks, from June 26 through August 4, 1989. Project Director for this intervention was Dr. Mark C. Bauer, Chair, Mathematics/Science Department, NCC.

## METHOD

### Subjects

This intervention took place on the NCC Shiprock campus during the summer of 1989. Subjects for this study were Navajo students going into the fifth, sixth, and seventh grades. Subjects were recruited primarily from among American Indian families who have traditionally brought their children to register for summer programs and meals at the College.

Table 1 shows the sex distribution of the intervention- and control-group members. Males and females were equally represented in the intervention group; the control group had slightly more females than males.

Table 1

| SEX DISTRIBUTION OF THE SAMPLE | | |
|---|---|---|
| SEX | INTERVENTION (n = 74) | CONTROL (n = 31) |
| Males | 50% | 45% |
| Females | 50% | 55% |

The intervention-group students participated in the intervention classes and activities; the control-group students took part in other programs on the reservation which were not science-related.

CASET Protocols and Other Instruments

Demographic and descriptive data about the subjects were developed through the Middle/Junior High School Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This Protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gives a scalar measurement for that variable. Thus the completed Opinion Protocol provides a scale measuring each of the thirteen variables.

For middle school and junior high school students, CASET adapted the CASET Opinion Protocol items, simplifying wording and concepts and/or changing questions to make them more appropriate to the younger age group while addressing the same thirteen attitudinal variables as the older-level Opinion Protocol. An additional change is that for the younger students, the possible answers are only two: "yes" and "no" rather than the four-point scale of the older students' Opinion Protocol. The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B. The Opinion Protocol was administered to intervention- and control-group students before and after intervention activity.

Three types of performance measures were collected: (a) California Tests of Basic Skills (CTBS) mathematics and science scores for the Spring administrations before and (when available) after the intervention; (b) semester grades for two preceding and two following semesters in math and science courses in school; and (c) pre- and postintervention achievement scores in computer science, English, mathematics, science, and a composite score, based on content tests developed by the intervention faculty.

Procedure

At the beginning of the intervention, the faculty-developed pretests of content, together with the CASET Middle/Junior High School Student Protocol and the CASET Opinion Protocol: Middle/Junior High School version, were administered to intervention- and control-group students. In the last week of the intervention, the CASET Opinion Protocol and the posttests of content were administered to all students.

The content tests were scored by the intervention faculty, who forwarded to CASET achievement scores, CASET instruments, CTBS scores and school grades in mathematics and science for two semesters before and two semesters after the intervention.

The items of the Opinion Protocol were coded according to the thirteen scales they represent. Scoring of the negatively worded items on the Opinion Protocol was reversed so that scores could be totaled meaningfully (see Appendix B). The scales were organized into three constructs--SET Goal, Environmental Support, and Attitude--as shown in Appendix C.

## RESULTS

Methodological Issues

The intervention conducted at NCC in the summer of 1989 was evaluated in a quasi-experimental design: the "nonequivalent control group design" (untreated control group design with pretest and posttest). This type of design has a greater burden in demonstrating a causal relationship than does an experimental design; alternatives to the conclusion that the intervention caused significant differences in posttest performance scores and opinion measures must be considered and ruled out (Campbell & Stanley, 1966; Cook & Campbell, 1979). The research design of the performance and opinion data may have some internal validity questions, of which selection-maturation was most likely to be operating. The selection-maturation question appears as the possibility that the treatment and control groups were maturing at different rates in the same direction. This question is common when subjects self-select into treatment groups.

Performance Measures

The hypothesis that the intervention group would outperform the control group was tested by comparing the pretest and posttest scores of the two groups in two sets of analyses: (a) $t$-tests on pretests and posttests, and (b) analysis of covariance (ANCOVA), using pretest score as the covariate. For a non-equivalent control group design, several methods of analysis are available (Reichardt, 1979). These two methods were determined to provide the most useful information. Using a non-equivalent control group design, an interpretable pattern of $t$-tests results follow nonsignificant pretest differences; if the groups show pre-existing differences or if the treatment's effect depends upon pretest performance, ANCOVA better assesses the effects of the treatment. These analyses use one-directional statistical tests at the 10 percent ($p$ = .10) probability level in order to be most sensitive to detecting the predicted effects of the intervention. For the preliminary analyses of pretest differences, the tests were compared to two-tailed critical values because the direction of any pre-existing differences could not be anticipated.

Three types of performance measures were available: (a) California Tests of Basic Skills (CTBS) for mathematics and science; (b) semester grades for two preceding and two following semesters in math and science courses; and (c) achievement test scores in computer science, English, mathematics, science, and a composite score.

Table 2 includes the group differences on CTBS scores prior to and following the intervention; because students in this school system take the CTBS in the third, fifth, and eighth grades, only fifth- and eighth-grade students had both preintervention and postintervention scores. Note that the control- and intervention-group students differed only on science posttests.

However, there were nonsignificant differences on pretests that may have persisted or matured into posttest differences; ANCOVA allows one to statistically control for some of these pre-existing differences in this quasi-experimental design. Table 3 reports the
ANCOVA on CTBS scores after the intervention, covarying CTBS scores before the intervention. This analysis confirms that the intervention significantly increased CTBS science scores after adjusting for pretest differences.

**Table 2**

**GROUP DIFFERENCES ON CALIFORNIA TEST OF BASIC SKILLS (CTBS) MATH AND SCIENCE SCORES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST | d | Sig. p |
|---|---|---|---|---|---|---|---|
| CTBS Math Pretest | Control<br>Intervention | 6<br>19 | 40.33<br>45.32 | 22.83<br>16.71 | 0.58 | .22 | ns |
| CTBS Math Posttest | Control<br>Intervention | 6<br>19 | 30.33<br>42.47 | 22.45<br>22.13 | 1.17 | .54 | ns |
| CTBS Science Pretest | Control<br>Intervention | 6<br>19 | 30.67<br>42.11 | 21.18<br>19.53 | 1.22 | .54 | ns |
| CTBS Science Posttest | Control<br>Intervention | 6<br>19 | 24.67<br>48.89 | 14.01<br>26.98 | 2.09 | 1.73 | $\leq$.05 |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

Effect size d is computed by dividing the difference between the two groups' means by the control group's standard deviation s.

**Table 3**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTTEST CTBS SCORES COVARYING PRETEST CTBS SCORES**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| CTBS Math Posttest | CTBS, Math Pre | .3578 | .3578 | 12.81 | 1,23 | $\leq$.01 |
| | + GROUP | .3851 | .0273 | 0.98 | 1,22 | ns |
| | + CTBSM-x-GROUP | .3946 | .0095 | 0.33 | 1,21 | ns |

| HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTTEST CTBS SCORES COVARYING PRETEST CTBS SCORES | | | | | | |
|---|---|---|---|---|---|---|
| **DEPENDENT VARIABLE** | **INDEPENDENT VARIABLES*** | **Cumul. $R^2$** | **$sR^2$** | **F ($sR^2$)** | **df** | **Sig. p** |
| CTBS Science Posttest | CTBS, Sci Pre | .0934 | .0934 | 2.27 | 1,22 | $\leq$.10 |
| | + GROUP | .2092 | .1158 | 3.08 | 1,21 | $\leq$.05 |
| | + CTBSS-x-GROUP | .2092 | .0000 | 0.00 | 1,20 | ns |

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable: $F(sR^2)$ is the test of significance for that proportion of variance. All of the cumulative $R^2$ F-tests were significant at the $p \leq .10$ level, one-tailed.

* Three models of independent variables were tested for each dependent variable: (1) CTBS alone; (2) CTBS and ('+') GROUP; (3) CTBS and GROUP and CTBS-by-GROUP INTERACTION ('-x-').

Semester grades for the two semesters (Fall 1988 and Spring 1989) before the intervention and for the two semesters (Fall 1989 and Spring 1990) after the intervention in math and science were averaged, and the significant effect of the intervention was tested via t-tests (Table 4) and ANCOVA (Table 5). The unadjusted means of the control and intervention groups did not differ for math or science grades, prior to or following the intervention.

**Table 4**

| GROUP DIFFERENCES ON SEMESTER MATH AND SCIENCE GRADES | | | | | | | |
|---|---|---|---|---|---|---|---|
| **MEASURE** | **GROUP** | **N** | **MEAN** | **SD** | **t-TEST** | **d** | **Sig. p** |
| Math Grade Pretest | Control | 28 | 2.53 | 1.03 | -0.65 | -.15 | ns |
| | Intervention | 49 | 2.38 | 0.93 | | | |
| Math Grade Posttest | Control | 28 | 2.47 | 1.11 | -0.21 | -.04 | ns |
| | Intervention | 49 | 2.42 | 0.91 | | | |
| Science Grade Pretest | Control | 27 | 2.47 | 0.91 | -1.29 | -.32 | ns |
| | Intervention | 44 | 2.18 | 0.93 | | | |
| Science Grade Posttest | Control | 27 | 2.36 | 1.17 | -0.43 | -.09 | ns |
| | Intervention | 44 | 2.25 | 0.98 | | | |

Note. The statistic d is a measure of effect size.

Table 5

HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTTEST GRADES COVARYING PRETEST GRADES

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Mathematics Posttest | Math Pretest | .3268 | .3268 | 36.41 | 1,75 | $\leq$.01 |
| | + GROUP | .3273 | .0005 | 0.06 | 1,74 | ns |
| | + Pre-x-GROUP | .3307 | .0034 | 0.37 | 1,73 | ns |
| Science Posttest | Science Pretest | .3500 | .3500 | 37.16 | 1,69 | $\leq$.01 |
| | + GROUP | .3518 | .0018 | 0.19 | 1,68 | ns |
| | + Pre-x-GROUP | .3689 | .0171 | 1.82 | 1,67 | $\leq$.10 |

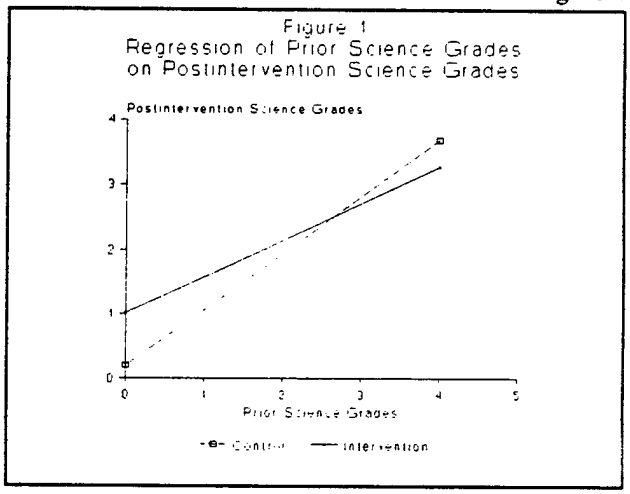
**Note:** $sR^2$ is the proportion of variance attributed to the last entered independent variable; $F(sR^2)$ is the test of significance for that proportion of variance. All of the cumulative $R^2$ F-tests were significant at the $p \leq .10$ level, one-tailed.

* Three models of independent variables were tested for each dependent variable: (1) Pretest alone: (2) Pretest and ('+') GROUP: (3) Pretest and GROUP and Pretest-by-GROUP INTERACTION ('-x-').

Table 5 presents the results of the ANCOVA analyses of the semester grades, adjusting postintervention grades for preintervention grades. As with the t-test results from Table 4, there was no simple relationship between group membership and grades, but there was a significant interaction between pretest grade and group membership for science grades in the postintervention semesters.

This significant interaction in the ANCOVA can be described as a difference in the regression lines between pretest science grades and posttest grades for the intervention and control groups (Cohen & Cohen, 1975). Figure 1 depicts this difference, indicating that the lines cross at 2.66 (approximately B-); an analysis of this interaction via the Johnson-Neyman technique (Rogosa, 1980) indicates that the 95 percent confidence interval around the intersection point ranges from 2.13 to 3.18. For students who had preintervention grades at or below 2.13 (approximately C), the intervention enabled them to outperform similarly-scoring control-group students for the two semesters after the intervention.

**Figure 1**




Group differences on the achievement tests are summarized in Table 6 (t-tests) and Table 7 (ANCOVA). The results in Table 6 indicated that the control and intervention groups did not differ on any achievement pretest, and that the intervention group outperformed the control group on the science posttest and on the composite achievement posttest score.

Table 6

GROUP DIFFERENCES ON ACHIEVEMENT TEST SCORES

| MEASURE | GROUP | N | MEAN | SD | t-TEST | d | Sig. p |
|---|---|---|---|---|---|---|---|
| Comp Science Pretest | Control<br>Intervention | 22<br>49 | 34.91<br>37.14 | 16.57<br>15.64 | 0.55 | .13 | ns |
| Comp Science Posttest | Control<br>Intervention | 22<br>49 | 47.36<br>51.14 | 14.57<br>23.27 | 0.83 | .26 | ns |
| English Pretest | Control<br>Intervention | 22<br>49 | 45.45<br>44.08 | 23.40<br>16.06 | -0.25 | -.06 | ns |
| English Posttest | Control<br>Intervention | 22<br>49 | 45.82<br>45.53 | 17.79<br>16.57 | -0.07 | -.02 | ns |
| Mathematics Pretest | Control<br>Intervention | 22<br>50 | 36.73<br>34.32 | 17.70<br>11.86 | -0.58 | -.14 | ns |
| Mathematics Posttest | Control<br>Intervention | 22<br>50 | 34.91<br>33.20 | 14.77<br>16.70 | -0.41 | -.12 | ns |
| Science Pretest | Control<br>Intervention | 22<br>50 | 31.59<br>31.36 | 15.14<br>12.73 | -0.07 | -.02 | ns |
| Science Posttest | Control<br>Intervention | 22<br>50 | 34.27<br>46.92 | 11.55<br>19.38 | 3.43 | 1.10 | $\leq$.01 |
| Composite Pretest | Control<br>Intervention | 22<br>49 | 37.50<br>36.73 | 12.95<br>9.21 | -0.25 | -.06 | ns |
| Composite Posttest | Control<br>Intervention | 224<br>9 | 40.55<br>44.73 | 9.33<br>13.66 | 1.50 | .45 | $\leq$.10 |

**Note:** The statistic d is a measure of effect size.

Table 7 gives the results of ANCOVAs that adjusted the posttest achievement scores by the pretest scores before testing for group differences or interactions between the intervention and the pretest scores. As in the t-test results of Table 6, the intervention group scored higher on the science test and on the composite measure. In addition, the ANCOVA results indicated that the intervention interacted with the pretest for English and mathematics.

Table 7

**HIERARCHICAL ANALYSIS OF COVARIANCE OF POSTTEST ACHIEVEMENT COVARYING PRETEST ACHIEVEMENT**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Comp Science Posttest | C Sci Pretest | .0490 | .0490 | 3.55 | 1,69 | $\leq$.10 |
| | + GROUP | .0538 | .0048 | 0.34 | 1,68 | ns |
| | + Pre-x-GROUP | .0561 | .0023 | 0.16 | 1,67 | ns |
| English Posttest | English Pretest | .2072 | .2072 | 18.03 | 1,69 | $\leq$.01 |
| | + GROUP | .2073 | .0008 | 0.01 | 1,68 | ns |
| | + Pre-x-GROUP | .2287 | .0214 | 1.86 | 1,67 | $\leq$.10 |
| Mathematics Posttest | Math Pretest | .2427 | .2427 | 22.43 | 1,70 | $\leq$.01 |
| | + GROUP | .2428 | .0001 | 0.01 | 1,69 | ns |
| | + Pre-x-GROUP | .3004 | .0576 | 5.60 | 1,68 | $\leq$.05 |
| Science Posttest | Science Pretest | .0371 | .0371 | 2.70 | 1.70 | $\leq$.10 |
| | + GROUP | .1415 | .1044 | 8.39 | 1,69 | $\leq$.01 |
| | + Pre-x-GROUP | .1415 | .0000 | 0.00 | 1,68 | ns |
| Composite Posttest | Comp Pretest | .2486 | .2486 | 22.83 | 1,69 | $\leq$.01 |
| | + GROUP | .2783 | .0297 | 2.80 | 1,68 | $\leq$.05 |
| | + Pre-x-GROUP | .2908 | .0125 | 1.18 | 1,67 | ns |

**Note:** $sR^2$ is the proportion of variance attributed to the last entered independent variable; $F(sR^2)$ is the test of significance for that proportion of variance. All of the cumulative $R^2$ F-tests were significant at the $p \leq .10$ level, one-tailed.

* Three models of independent variables were tested for each dependent variable: (1) Pretest alone; (2) Pretest and ('+') GROUP; (3) Pretest and GROUP and Pretest-by-GROUP INTERACTION ('-x-').

The significant interactions were examined by plotting the intervention and control groups' regression lines for pretest on posttest, and by computing 95 percent confidence intervals around the intersection point. The results for the English achievement test scores are plotted in Figure 2.

The regression lines intersect at 43.75, and the 95 percent confi- dence interval extends from 35 to 52. For students who scored at or above 52 on the English pretest, inter- vention-group students outperformed control-group students; for students scoring below average on the English pretest, the control-group students seemed to do better than did the intervention-group students.

The significant interaction of mathematics pretest scores and the intervention is depicted in Figure 3.

Figure 2

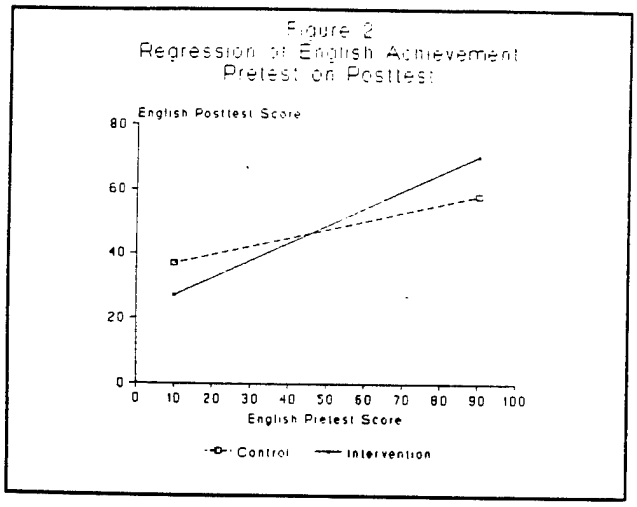
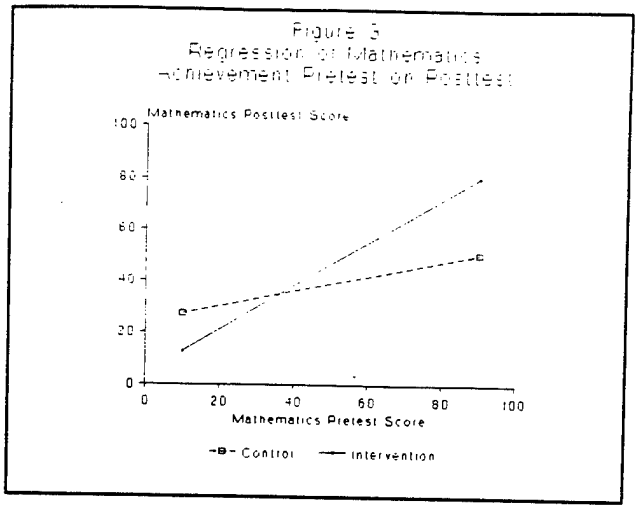



Figure 3




The regression lines intersect at 36.2, and the 95 percent confi- dence interval ranges from 28.2 to 44.2. For students with above-average pretest mathe- matics scores (44 or higher), the inter-vention produced significantly greater achievement on the posttest mathematics test.

In summary, the effects of the intervention on performance were as follows: (a) the intervention produced higher scores on CTBS science tests; (b) the intervention produced higher science grades in the two semesters following the intervention for students previously making "C" or lower; (c) the intervention produced higher scores on science and composite achievement tests; and (d) the intervention was associated with higher English and mathematics achievement scores for above-average students.

## Opinion Measures

The hypothesis of more positive scores on postintervention opinion measures was tested through a combination of t-tests and ANCOVA. Table 8 contains comparisons of pretest and posttest scores for the 55 items of the Opinion Protocol, grouped into 13 opinion measures organized under three constructs: SET (Science, Engineering, and Technology) Goal, Attitude, and Environmental Support.

For two preintervention opinion measures--Value and Career Awareness--the control group had higher scores than did the intervention group. These differences did not appear on the posttest. The intervention group had more desirable scores on two postintervention measures: the Self-Concept and Anxiety scales. However, the Self-Concept and Anxiety pretest differences were near statistical significance. The near-significant preexisting differences on opinion measures complicates the interpretation of the t-test results, but the ANCOVA analyses were made to clarify the pretest-to-posttest group differences.

Table 8

| GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | d | Sig. p |
| | | Mean | SD | Mean | SD | | | |
| **SET GOAL** | | | | | | | | |
| Value | Pretest | 3.64 | .50 | 3.17 | .83 | -2.42 | -.94 | ≤.05 |
| | Posttest | 3.50 | .67 | 3.15 | .97 | -1.17 | -.52 | ns |
| Cultural Value | Pretest | 3.00 | .74 | 2.65 | .91 | -1.25 | -.47 | ns |
| | Posttest | 2.85 | .80 | 2.85 | 1.04 | 0.02 | .00 | ns |
| Self-Concept | Pretest | 3.91 | 1.51 | 3.19 | 1.55 | -1.40 | -.48 | ns |
| | Posttest | 2.77 | 1.69 | 3.50 | 1.47 | 1.54 | .43 | ≤.10 |
| Aspiration | Pretest | 3.08 | 1.16 | 3.48 | .97 | 1.22 | .34 | ns |
| | Posttest | 3.15 | 1.34 | 3.40 | 1.06 | 0.71 | .19 | ns |
| **ATTITUDE** | | | | | | | | |
| Math/Science Attitude | Pretest | 5.57 | 1.40 | 5.56 | 1.37 | -0.04 | -.01 | ns |
| | Posttest | 5.08 | 1.32 | 5.11 | 1.73 | 0.07 | .02 | ns |
| Locus of Control | Pretest | 1.86 | .86 | 1.57 | .74 | -1.20 | -.34 | ns |
| | Posttest | 1.54 | .97 | 1.75 | .81 | 0.80 | .22 | ns |
| Persistence | Pretest | 1.86 | 1.35 | 2.21 | 1.16 | 0.97 | .26 | ns |
| | Posttest | 1.85 | 0.90 | 2.31 | 1.26 | 1.25 | .51 | ns |
| Study Habits | Pretest | 2.58 | 1.16 | 2.45 | 1.10 | -0.37 | -.11 | ns |
| | Posttest | 2.38 | 0.96 | 2.38 | 1.05 | -0.01 | .00 | ns |
| Anxiety | Pretest | 2.42 | 2.15 | 3.32 | 1.71 | 1.55 | .42 | ns |
| | Posttest | 2.38 | 2.43 | 3.25 | 2.06 | 1.30 | .36 | ≤.10 |
| **ENVIRONMENTAL SUPPORT** | | | | | | | | |
| Academic Support | Pretest | 2.58 | 0.51 | 2.48 | 0.68 | -0.49 | -.20 | ns |
| | Posttest | 2.38 | 0.96 | 2.27 | 0.71 | -0.48 | -.11 | ns |
| Career Awareness | Pretest | 2.83 | 0.39 | 2.35 | 0.64 | -3.30 | -1.23 | ≤.01 |
| | Posttest | 2.54 | 0.66 | 2.52 | 0.77 | -0.08 | -.03 | ns |
| Role Model | Pretest | 1.08 | 1.00 | 1.02 | 0.99 | -0.19 | -.06 | ns |
| | Posttest | 1.15 | 0.99 | 1.26 | 0.97 | 0.33 | .11 | ns |

| GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | d | Sig. p |
| | | Mean | SD | Mean | SD | | | |
| Equal Opportunity | Pretest | 2.15 | 0.80 | 2.13 | 0.80 | -0.10 | -.02 | ns |
| | Posttest | 2.23 | 1.01 | 1.92 | 1.06 | -0.90 | -.31 | ns |
| All pretests were analyzed as two-tailed tests. Pretest n's: Control = 14; Intervention = 49 | | | | All posttests were analyzed as one-tailed tests. Posttest n's: Control = 13; Intervention = 49 | | | | |

Table 9 presents the ANCOVA analyses (via a hierarchical regression procedure) for the 13 opinion measures. Of the four SET Goal opinion measures, only Self-Concept showed a group difference, with the intervention producing a more positive self-concept. Of the four Attitude opinion measures, Locus of Control was more internal for the intervention group, and the Persistence measure showed a significant interaction between pretest measure and the intervention; this interaction was interpreted by graphing the regression lines (Figure 4) and determining the 95 percent confidence interval around the intersection point, .84 on a scale ranging from 0 to 4. The confidence interval ranges from 0 to 2, and as the graph shows, for a pretest score of 2 or greater, the intervention-group students showed significant gains in Persistence relative to the control group. Note that the groups did not differ on Anxiety after the intervention if preintervention Anxiety was covaried.

**Table 9**

| HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION | | | | | | |
|---|---|---|---|---|---|---|
| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
| **SET GOAL** | | | | | | |
| Value | PREINTERVENTION | .5205 | .5205 | 57.53 | 1,53 | ≤.01 |
| | +GROUP | .5221 | .0016 | 0.17 | 1,52 | ns |
| | +PRE-x-GROUP | .5253 | .0032 | 0.34 | 1,51 | ns |
| Cultural Value | PREINTERVENTION | .1874 | .1874 | 12.91 | 1,56 | ≤.01 |
| | +GROUP | .1887 | .0013 | 0.09 | 1,55 | ns |
| | +PRE-x-GROUP | .1918 | .0031 | 0.21 | 1,54 | ns |
| Self-Concept | PREINTERVENTION | .1330 | .1330 | 8.59 | 1,56 | ≤.01 |
| | +GROUP | .2177 | .0847 | 5.95 | 1,55 | ≤.01 |
| | +PRE-x-GROUP | .2226 | .0049 | 0.34 | 1,54 | ns |
| Aspiration | PREINTERVENTION | .1001 | .1010 | 6.29 | 1,56 | ≤.01 |
| | +GROUP | .1112 | .0102 | 0.63 | 1,55 | ns |
| | +PRE-x-GROUP | .1159 | .0047 | 0.30 | 1,54 | ns |

## HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| **ATTITUDE** | | | | | | |
| Math/Science Attitude | PREINTERVENTION | .2760 | .2760 | 20.20 | 1,53 | $\leq$.01 |
| | +GROUP | .2763 | .0003 | 0.02 | 1,52 | ns |
| | +PRE-x-GROUP | .2790 | .0027 | 0.19 | 1,51 | ns |
| Locus of Control | PREINTERVENTION | .0955 | .0955 | 6.02 | 1,57 | $\leq$.01 |
| | +GROUP | .1248 | .0293 | 1.87 | 1,56 | $\leq$.10 |
| | +PRE-x-GROUP | .1301 | .0053 | 0.34 | 1,55 | ns |
| Persistence | PREINTERVENTION | .4928 | .4928 | 55.37 | 1,57 | $\leq$.01 |
| | +GROUP | .5054 | .0126 | 1.43 | 1,56 | ns |
| | +PRE-x-GROUP | .5211 | .0157 | 1.80 | 1,55 | $\leq$.10 |
| Study Habits | PREINTERVENTION | .1985 | .1985 | 14.11 | 1,57 | $\leq$.01 |
| | +GROUP | .1985 | .0000 | 0.00 | 1,56 | ns |
| | +PRE-x-GROUP | .1986 | .0001 | 0.01 | 1,55 | ns |
| Anxiety | PREINTERVENTION | .4679 | .4679 | 48.36 | 1,55 | $\leq$.01 |
| | +GROUP | .4726 | .0047 | 0.48 | 1,54 | ns |
| | +PRE-x-GROUP | .4751 | .0025 | 0.25 | 1,53 | ns |
| **ENVIRONMENTAL SUPPORT** | | | | | | |
| Academic Support | PREINTERVENTION | .0523 | .0523 | 3.15 | 1,57 | $\leq$.05 |
| | +GROUP | .0525 | .0002 | 0.01 | 1,56 | ns |
| | +PRE-x-GROUP | .1034 | .0509 | 3.12 | 1,55 | $\leq$.05 |
| Career Awareness | PREINTERVENTION | .0730 | .0730 | 4.49 | 1,57 | $\leq$.05 |
| | +GROUP | .0756 | .0026 | 0.16 | 1,56 | ns |
| | +PRE-x-GROUP | .0789 | .0033 | 0.20 | 1,56 | ns |
| Role Model | PREINTERVENTION | .1108 | .1108 | 6.85 | 1,55 | $\leq$.05 |
| | +GROUP | .1139 | .0031 | 0.19 | 1,54 | ns |
| | +PRE-x-GROUP | .1274 | .0135 | 0.82 | 1,53 | ns |
| Equal Opportunity | PREINTERVENTION | .0360 | .0360 | 2.13 | 1,57 | $\leq$.10 |
| | +GROUP | .0399 | .0039 | 0.23 | 1,56 | ns |
| | +PRE-x-GROUP | .0529 | .0230 | 1.34 | 1,55 | ns |

All models were analyzed as one-tailed tests.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure): (1) PRETEST OPINION SCORE; (2) PRETEST OPINION SCORE and GROUP ('+'); (3) PRETEST OPINION SCORE and GROUP and PRETEST OPINION SCORE-by-GROUP INTERACTION ('-x-').

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance. All of the cumulative $R^2$ F-tests were significant at the $p \leq .10$ level, one-tailed.

Figure 4

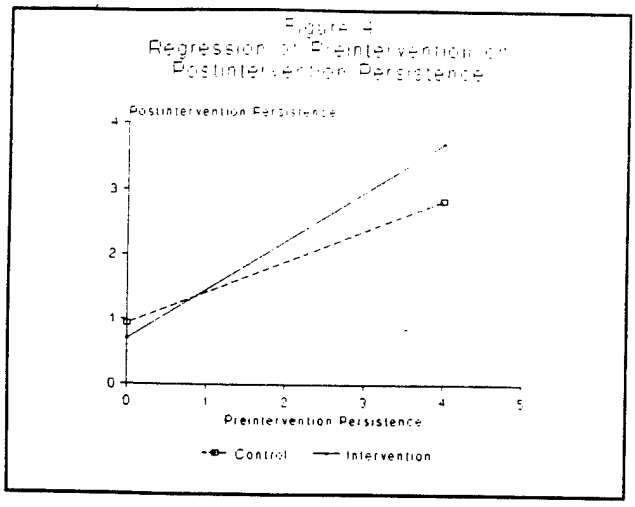
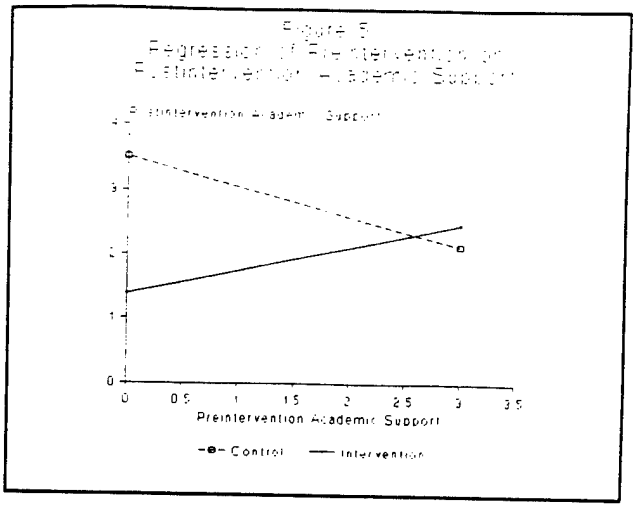



Figure 5




Of the four Environmental Support measures, only Academic Support showed a significant effect of the intervention through a significant interaction between pretest and intervention; in this case the interpretation of the interaction is unclear. The intersection point of the two regression lines is at 2.6, and the confidence interval extends from 2.1 to 3, the maximum score.

The graph in Figure 5 seems to indicate that control-group students scoring two or lower in Academic Support on the pretest showed higher support scores on the posttest than did intervention-group students who scored two or lower on the pretest. However, in fact no students in the control group made lower than 2 on the pretest; Therefore this should be understood to be merely an extrapolation, which may not hold true in practice.

In summary, the opinion findings were clearest based on the ANCOVA results: the intervention was associated with significant enhancements in the students' Self-Concept and Locus of Control scores. In addition, those intervention-group students whose pretest scores in Persistence were average or above showed increased Persistence scores on the posttest relative to the control group.

## Demographic Results

An analysis of the Middle/Junior High School Student Protocol revealed demographic characteristics of the participants; the percentages of responses to selected items are presented in Appendix D. The groups differed significantly (tested via chi-square) on only six items of the 64 compared in Appendix D, which is approximately equal to the number of chance differences at the 10 percent probability level. The differences were distributed fairly evenly into two that likely favored the intervention group (parents more often influenced studies, someone influenced studies) and two that likely favored the control group (more parental attendance at PTA meetings and at parent-teacher conferences), as well as two (more intervention-group students were youngest children in their families; control-group students' families had more sources of income) that are more ambiguous in possible effects on performance and opinion. The important finding is that the groups were not different in many respects. The failure to find demographic differences argues for the comparability of groups; this comparability strengthens the study's causal conclusions.

## DISCUSSION

Interventions with middle-school children pose an exciting challenge, both to program directors and to the researchers who set out to evaluate the programs. Program directors are challenged to provide content and experience that will be effective with this age group; identifying components that will have an impact on the child is not the least of the problems. In addition, researchers are faced with the problems of measuring the outcomes of interventions targeted at youngsters who have few or no elective choices in their studies.

The intervention at NCC was developed on the premise that hands-on science experience, coupled with exposure to positive Navajo role models, would have positive impact on both the performance and the attitudes of these young American Indian students. In proposing the project to CASET, the project director identified as a key component the participation of NCC students majoring in science, who would function as program assistants in regular contact with the participants. He expressed the hope that exposure to these Navajo role models in science would demonstrate to young Navajos that they too could succeed in pursuing science studies at the college level. In addition, he pointed out that for many of the college students, this would be their first experience of earning money as scientists.

Given this orientation, it is particularly exciting that the Navajo children participating in the intervention show a significantly enhanced self-concept and a stronger internal locus of control, compared with their own preintervention measures and compared with a control group who did not receive the intervention. In addition to the significant enhancements in the students' self-concept and locus of control scores, posttests showed increased persistence scores for students whose pretest persistence scores had been average or above.

These positive attitudinal changes are accompanied by significant improvements in performance, both in school and on standardized tests. A rise in scores in science and composite achievement tests was the intervention's short-term performance effect. For above-average students there was another short-term performance effect: a rise in scores in mathematics and English achievement. The relatively long-term effects were a rise in scores on CTBS science tests, and in science grades for the following two semesters for students previously making "C" or lower. The long-term effects are particularly impressive because these measures are, respectively, a nationally standardized test (the CTBS) and school performance, both assessed by independent personnel who were not a part of the intervention.

The success of the program in boosting long-term science performance is a significant accomplishment. Both higher self-concept and a more internal locus of control have been linked with achievement (Eccles, 1983), but the question about whether self-concept or locus of control influences achievement or is influenced by achievement is still unanswered. (See Midkiff, Burke, and Helmstadter (1989), as well as Scheirer and Kraut (1979), for discussion on this point.)

Some other questions remain unanswered after this first term of intervention activity: It is not yet known whether these opinion changes would be maintained in the long-term or whether they were transient. Finally, there are two concerns about possible improvements in the program: (a) what aspects of the intervention could be changed to improve mathematics achievement, grades, or CTBS scores; and (b) why did the control group's computer science achievement scores increase as much as the intervention group's scores?

Further experience and research with this intervention model may answer some of these questions. A second wave of intervention-group students will participate in the summer of 1990. If the results of the second intervention replicate these findings, the success of "Hands-on Science" will be even more firmly established.

In the opinion of the CASET researchers, this intervention has demonstrated significant effectiveness in terms of the CASET objectives. Particularly impressive are: the demonstration of enhanced self-concept in conjunction with the use of Navajo college students as role models; the maintenance of enhanced performance over a relatively long time span (two semesters following intervention); and the documentation of improved performance on a nationally standardized test as well as school performance assessed by non-project personnel.

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# APPENDICES

# APPENDIX A

# MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

Participant Number: _____

## MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

Thank you for agreeing to participate in this important project. It is geared to help us develop new programs for students and improve existing programs.

Your opinions and experience are important to us. Please read each question carefully and answer completely and accurately to the best of your ability. All of your answers will be kept in confidence. Your answers will be grouped with those of other students in other places, and together they will help us better understand students' needs and preferences today.

Please ask your administrator if any of these questions are unclear to you.

Thanks for your help!

1. Sex:
   - ___ a. Male
   - ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   - ___ a. Anglo
   - ___ b. Black
   - ___ c. Asian American
   - ___ d. American Indian (Please specify the tribe which best describes your heritage.)

     _____
   - ___ e. Hispanic (Which of the following best describes your heritage?)
     - ___ a. Cuban-American
     - ___ b. Mexican-American
     - ___ c. Puerto Rican
     - ___ d. Other Specify _____
   - ___ f. Other Specify _____

4. Are you a United States citizen?
   - ___ a. Yes
   - ___ b. No

5. Name of your school: _____

   City: _____ State: _____

6. Class:
   ___ a. 4th grade
   ___ b. 5th grade
   ___ c. 6th grade
   ___ d. 7th grade
   ___ e. 8th grade

7. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Less than high school graduation
   ___ b. High school graduation
   ___ c. Two-year college degree (community college or junior college)
   ___ d. Four-year college degree
   ___ e. Education beyond four years of college
   ___ f. Other Specify _____

8. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

9. What is or are the occupation(s) of the person(s) with whom you live? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")
   _____ _____

10. Would you say that your family's income is:
   ___ a. Below the U.S. average
   ___ b. About average
   ___ c. Above average
   ___ d. Don't know

11. Are you:
   ___ a. An only child (skip to question 13)
   ___ b. The oldest child
   ___ c. The youngest child
   ___ d. An in-between child

12. How many brothers and sisters do you have?
   ___ a. One
   ___ b. Two
   ___ c. Three or more

13. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

14. What was the highest level of school your mother completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

15. What is the language spoken most often by adults in your household? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe (What is that language?) _____
___ d. Another language - Specify _____

16. Which of the following did your parent(s) or guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Help you with your homework

17. Which of the following comes closest to describing how much your parent(s) or guardian(s) read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

18. Which of the following comes closest to describing how much you read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

19. Which of these items do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia
___ d. Typewriter
___ e. Pocket calculator
___ f. Television

___ g. Computer
___ h. Video cassette recorder (VCR)

20. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL ITEMS WITH DIRECTIONALITY AND SCALES

## Opinion Protocol Items with Directionality and Scales

**Legend**:

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | Do you study each day rather than just before exams? |
| 2. | + | AT | Are scientists smarter than most people? |
| 3. | + | SC | Can you imagine yourself as a scientist? |
| 4. | - | AX | Do word problems in mathematics make you nervous? |
| 5. | + | VL | Do you think mathematics is needed in most jobs? |
| 6. | + | VL | Is science important to our country? |
| 7. | + | LC | When you make plans, can you usually make them work? |
| 8. | + | CA | Do girls have a good chance of becoming scientists when they grow up? |
| 9. | + | PS | Do you usually finish the things you start? |
| 10. | + | CV | Is it important to you that your people be proud of you? |
| 11. | - | SH | Do you prefer to study alone? |
| 12. | - | AT | Do scientists do boring work? |
| 13. | + | AS | If you have problems at school, is there someone who will help you? |

| | | | |
|---|---|---|---|
| 14. | - | AX | Do tests make you nervous? |
| 15. | + | SH | Do you get your homework done on time? |
| 16. | - | SC | Are science experiments hard for you to understand? |
| 17. | + | AP | Do you want to take any more mathematics courses? |
| 18. | + | CV | Are your friends good at mathematics? |
| 19. | - | EO | Does a person's color make a difference in whether or not they get to be a scientist? |
| 20. | - | PS | Do you get bored with your school work by the middle of the school year? |
| 21. | - | PS | Do you have trouble keeping your mind on your homework? |
| 22. | + | EO | Do people care if a good scientist is a man or a woman? |
| 23. | + | AP | Are you thinking of becoming a scientist? |
| 24. | - | AT | Is mathematics boring? |
| 25. | + | RM | Are many people of your ethnic/racial group successful scientists? |
| 26. | + | AP | Do you try to get good grades in science? |
| 27. | - | LC | Is success mostly a matter of luck? |
| 28. | + | AT | Do most scientists enjoy their work? |
| 29. | + | AT | Do you enjoy solving mathematics problems? |
| 30. | + | VL | Does mathematics come in handy outside of class? |
| 31. | - | AX | Do you feel scared when you have to work a mathematics problem? |

| | | | |
|---|---|---|---|
| 32. | + | CA | Can you really become a scientist if you want to? |
| 33. | + | CA | Do you think there are a lot of jobs for scientists? |
| 34. | - | AX | Do tests scare you even when you have studied for them? |
| 35. | + | SC | Do you think you are a good science student? |
| 36. | + | SH | Do you like to read about science? |
| 37. | + | RM | Have you ever met a scientist? |
| 38. | + | VL | Is science an important subject? |
| 39. | + | SC | Are you good at figuring out mathematics problems? |
| 40. | + | AP | Do you want to improve your mathematics skills? |
| 41. | + | AS | Do the teachers in your school care how well you do in school? |
| 42. | + | CV | Do your people think highly of scientists? |
| 43. | - | AP | Would you like to spend less time on science in school? |
| 44. | - | AS | Do your teachers think you don't do very well? |
| 45. | + | CV | Does your family care a lot about education? |
| 46. | - | AT | Are scientists unfriendly? |
| 47. | - | AX | Do you worry about being able to understand your science assignments? |
| 48. | + | RM | Is there a scientist you look up to? |
| 49. | - | EO | Are boys better in science than girls? |

| | | | |
|---|---|---|---|
| 50. | + | LC | Can you control whether or not you have a good day? |
| 51. | - | SC | Is science too hard for you? |
| 52. | - | PS | Do you often quit when things get tough? |
| 53. | - | AX | Do you get scared when you are called on to answer a question in mathematics? |
| 54. | + | AT | Is science interesting? |
| 55. | + | SC | Are you very good at mathematics? |

56. What do you want to be when you grow up?

a. _____

b. _____

c. _____

57. Please describe the work you feel scientists do in a typical work day. If you don't know, just use your imagination.

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF

# THE MIDDLE/JUNIOR HIGH STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION | CONTROL |
| 1. Sex: | | |
| Females | 50% | 55% |
| Males | 50% | 45% |
| | (n=74) | (n=31) |
| 7. Higher education expected: | | |
| .Less than high school | 18% | 27% |
| .High school graduation | 23% | 13% |
| .Two-year college degree | 17% | 20% |
| .Four-year college degree | 22% | 23% |
| .One or more years after college | 20% | 17% |
| | (n=65) | (n=30) |
| 8. Studies most influenced by: | | |
| .Parents | 54% | 35%[a] |
| .Another family member | 5% | 3% |
| .Teacher | 23% | 29% |
| .Counselor | 0% | 6% |
| .Minister | 0% | 0% |
| .Friend | 9% | 3% |
| .Science professional | 0% | 3% |
| .No one at all | 8% | 19%[a] |
| | (n=74) | (n=31) |
| 9. Sources of income: | | |
| .None | 42% | 26% |
| .One | 37% | 26% |
| .Two | 20% | 48%[a] |
| | (n=64) | (n=31) |
| 10. Family income: | | |
| .Below U.S. average | 14% | 0% |
| .About average | 57% | 75% |
| .Above average | 29% | 25% |
| | (n=28) | (n=8) |
| 11. Birth order of student: | | |
| .Only child | 6% | 6% |
| .Oldest child | 21% | 23% |
| .Youngest child | 32% | 16%[a] |
| .In-between child | 42% | 55% |
| | (n=72) | (n=31) |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION | CONTROL |
| 12. Number of siblings: | | |
| .One | 17% | 14% |
| .Two | 24% | 17% |
| .Three or more | 59% | 69% |
| | (n=66) | (n=29) |
| 13. Father's education: | | |
| .Grade school or less | 9% | 11% |
| .Some high school | 14% | 0% |
| .High school graduate | 27% | 22% |
| .Some college | 27% | 22% |
| .College degree or more | 23% | 44% |
| | (n=22) | (n=9) |
| 14. Mother's education: | | |
| .Grade school or less | 6% | 0% |
| .Some high school | 6% | 8% |
| .High school graduate | 28% | 31% |
| .Some college | 25% | 23% |
| .College degree or more | 36% | 38% |
| | (n=36) | (n=13) |
| 15. Language spoken most at home: | | |
| .English | 62% | 72% |
| .Spanish | 2% | 0% |
| .Language of tribe | 37% | 24% |
| .Other | 0% | 3% |
| | (n=60) | (n=28) |
| 16. Parents' involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 8% | 19%[a] |
| .Attend parent-teacher conferences | 23% | 42%[a] |
| .Visit student's class | 26% | 35% |
| .Phone/visit if there's a problem | 19% | 19% |
| .Do volunteer work | 9% | 13% |
| .Assist in student's homework | 69% | 65% |
| | (n=74) | (n=31) |
| 17. Parent(s) read: | | |
| .Not at all | 11% | 7% |
| .Sometimes | 58% | 45% |
| . A lot | 31% | 48% |
| | (n=74) | (n=29) |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION | CONTROL |
| 18. Student reads: | | |
| .Not at all | 5% | 3% |
| .Sometimes | 70% | 62% |
| .A lot | 24% | 34% |
| | (n=74) | (n=29) |
| 19. Items in student's home:[b] | | |
| .Desk | 45% | 32% |
| .Daily newspaper | 76% | 65% |
| .Encyclopedia | 45% | 55% |
| .Typewriter | 31% | 45% |
| .Calculator | 49% | 55% |
| .Television | 78% | 84% |
| .Computer | 16% | 26% |
| .Video Cassette Recorder (VCR) | 68% | 71% |
| | (n=74) | (n=31) |
| 20. All activities student took part in:[b] | | |
| .Math/science club | 28% | 32% |
| .Field trip | 35% | 26% |
| .Watching science programs on TV | 38% | 29% |
| .Listen to talk by scientist | 9% | 16% |
| .Science/math fair | 14% | 19% |
| .Other science/math competition | 11% | 19% |
| .Play/work in computer lab | 62% | 68% |
| | (n=74) | (n=31) |

[a] Significant at $p \leq .10$

[b] Students selected all applicable responses.

# CASET RESEARCH REPORT:

# NEW MEXICO HIGHLANDS UNIVERSITY

# INTERVENTIONS

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# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected came from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention- group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF NEW MEXICO HIGHLANDS UNIVERSITY

New Mexico Highlands University (NMHU) is a four-year, public, coeducational institution located in Las Vegas, New Mexico. The campus community consists of approximately 2100 students and 123 faculty members. The University, organized into the School of Liberal and Fine Arts, School of Professional Studies, and School of Science and Technology, offers undergraduate and graduate degrees. Approximately 70 percent of the students are Hispanic, 4 percent are American Indian, 3 percent are Black, and most of the remaining 23 percent are Anglos (non-Hispanic Whites). The president of NMHU is Dr. Gilbert Sanchez.

Degrees offered at NMHU in quantitative subjects are: Bachelor of Science in computer science, mathematics, computer engineering technology, electronic engineering technology, environmental science, and chemistry; Bachelor of Arts in computer information systems and mathematics; Associate of Science in computer science, computer engineering technology, and electronic engineering technology; and Associate of Arts in computer information systems. The graduate degree offered is Master of Science in applied chemistry.

Las Vegas, New Mexico, located in the foothills of the Sangre de Cristo Mountains in the Southern Rockies, has a population of 15,000. The state of New Mexico has a population of approximately 1.6 million. According to 1989 Census Bureau estimates, the population of New Mexico is 53.6 percent Anglo, 8.8 percent American Indian and other ethnic origins, 1.6 percent Black, and 36 percent Hispanic.

# PART II

# SUMMARY OF THE NEW MEXICO HIGHLANDS UNIVERSITY (NMHU) INTERVENTIONS

This report summarizes the two summer interventions conducted by New Mexico Highlands University, a four-year, public institution located in Las Vegas, New Mexico. New Mexico Highlands University is a member of a consortium formed by The Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

New Mexico Highlands University Intervention Activities:

During the summer of 1989 and 1990, New Mexico Highlands University conducted a residential science program for high school students called the Pre-College Science & Engineering Technology (PSET) Project. This four-week program consisted of instruction in mathematical logic, computer science, science, research methods, technical writing, the philosophy of engineering, talks by guest speakers from high-tech industries, tutoring by advanced students, and field trips. Participants were recruited from several nearby high schools and qualified for the program on the basis of strong academic performance in high school and recommendations by high school teachers.

Findings:

- The intervention was very effective in improving students' mathematical logic and computer science performance.
- The intervention was more effective in teaching mathematical logic than computer science.
- Although there were opinion gains in some areas, these gains were not consistent from one summer to the next.

Recommendations:

- Closer attention should be paid to the affective experience and the "quality of experience" of the students.
- The project director, based on his experience, recommended that more time be allowed for the research aspect of this intervention; specifically, he called for lengthening the program from four weeks to six weeks and suggested that students work with graduate students who have active research projects underway.

# PART III

# CASE STUDY OF THE NEW MEXICO HIGHLANDS UNIVERSITY

# 1989 SUMMER SEMESTER INTERVENTION

## ABSTRACT

In 1989, New Mexico Highlands University, Las Vegas, New Mexico, initiated and tested against a control group a summer residential intervention program for high-ability high school students. Participants were 58 high school students (41 women and 17 men) who were going into the eleventh and twelfth grades; a majority of the participants were Hispanic or American Indian. The intervention was repeated in the summer of 1990.

The New Mexico Highlands University program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance in mathematics and science, and (b) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* Major components of the four-week intervention were: instruction in mathematical logic, philosophy of engineering, computer science, science, research methods and technical writing, talks by guest speakers from high-tech industries, field trips, and career counseling.

*DATA:* All the participants furnished demographic data through the CASET High School Student Protocol. Other data collected were grade point average (GPA) prior to the intervention, scores on national standardized tests, e.g., ACT and California Test of Basic Skills (CTBS) scores, the CASET Opinion Protocol given near the end of the intervention, and the grades that the intervention students made in their summer classes.

The outcome measure of performance was the overall grade in summer classes, available for intervention-group students only. The preintervention measures of performance were preintervention high school GPA and preintervention ACT and CTBS scores.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Data were analyzed in the context of a nonequivalent control group design made possible by the construction of a proxy pretest of opinion, adjusting for preexisting differences in the two groups.

*FINDINGS:* The intervention had a positive effect on the participants and can be considered a successful intervention based on enhanced opinions on certain scales. The focus of the analysis was on changes in opinion. Of the thirteen opinion scales, the intervention group scored higher on three environmental support scales, but lower on three attitude scales.

## DESCRIPTION OF THE INTERVENTION

This summer residential intervention was designed to recruit students going into the eleventh and twelfth grades with grade-point averages (GPAs) of 3.0 or better, for SET careers. Students were in residence at NMHU for this program from June 5 through June 30, 1989. They attended classes Monday through Thursday in the following subject areas: Mathematical Logic, Introduction to Engineering and Engineering Technology, Computer as a Tool, Philosophy of Science, Research and Study, and Technical Writing. Students were scheduled to be bussed onto the NMHU campus two Saturdays per month during the following academic year for seminars and lectures in science, engineering, and mathematics. This follow-up was outside the time frame of this research which covered only the summer program. Fridays were reserved for guest speakers from local and state high-technology industries, field trips to Department of Energy laboratories, and career counseling on such topics as resume preparation, college preparatory expectations, college financial aid, and preparing for the SAT and ACT examinations. The project was funded by CASET and by the National Science Foundation (NSF). The Project Director was Dr. Gilbert D. Rivera, Vice President for Academic Affairs, New Mexico Highlands University.

## METHOD

### Subjects

Participants were recruited as tenth and eleventh grade students from high schools in and around Las Vegas, New Mexico. Fifty students participated in the project: twenty-five funded by CASET and twenty-five funded by the National Science Foundation. The majority of the students were Hispanic. Blacks and American Indians were also represented. Students qualified on the basis of strong performance in high school and recommendations by high school teachers.

A control group was constructed from applicants for the program who were not selected. Data was submitted for fifty intervention-group students and seventeen control-group students. Of these 67 sets of data, eight sets were eliminated because the students did not represent the populations that were the focus of this study: seven were Anglo males and one was an Asian female. Data from 43 intervention-group students and 15 control-group students were analyzed.

### CASET Protocols and Other Instruments

Demographic and descriptive data about the subjects were developed through the High School Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspirations, career expectations, and academic support. This protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. CASET used thirteen attitudinal variables as the framework for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gives a scalar measurement for that variable. The completed Opinion Protocol thus provides a scale measuring each of the thirteen variables.

The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B, which also shows which items were coded positively and which negatively.

In addition to the CASET Protocols, several performance measures were obtained: (a) the intervention-group students had an overall grade from their summer courses, (b) all students had a grade-point average prior to the intervention, and (c) some students had standardized test scores, e.g., ACT.

### Procedure

Intervention faculty scored the content tests and forwarded them to CASET along with CASET protocols, standardized test scores and high school transcripts.

Near the end of the intervention, students completed two CASET instruments, the High School Student Protocol and the High School Opinion Protocol. In addition, several performance measures were obtained: (a) for intervention-group students, an overall grade from their summer courses, (b) for all students, a grade-point average prior to the intervention, and (c) standardized test scores, e.g., SAT, ACT, for those students who had taken these tests.

The items of the Opinion Protocol were coded according to the thirteen scales they represent. Scoring of the negatively worded items on the Opinion Protocol was reversed so that scores could be totaled meaningfully (see Appendix B). The scales were organized into three constructs--SET Goal, Environmental Support, and Attitude--as shown in Appendix C.

## RESULTS

### Methodological Issues

The intervention was designed to recruit high-ability high school students for SET careers; this was a long-term goal that could not be fully evaluated within the time-frame of this study. Shorter-term goals, such as favorable attitudes toward SET careers, were used to evaluate the intervention's success. The evaluation of the intervention was in a preexperimental design (static group comparison or posttest only design with nonequivalent groups; Campbell & Stanley, 1966; Cook & Campbell, 1979) because students were not randomly assigned to intervention and control groups and preexperimental measures were not taken. Preexperimental designs are difficult to interpret because of the large number of rival hypotheses. For example, if the intervention group surpassed the control group in this design, the higher scores might be due to the intervention, to preexisting differences between groups, to differential loss of subjects, or to differences in maturation. CASET utilized one solution to this problem: the construction of a proxy pretest from the set of measures available, thus creating a more interpretable quasi-experimental design, i.e., a nonequivalent control group design.

A proxy pretest should possess two qualities: (a) it should measure a characteristic that existed prior to the intervention, and (b) it should correlate with the postintervention measure within each group. Once a proxy is constructed, it serves two functions: (a) a proxy pretest increases the statistical power of the test of postintervention differences by reducing the error variance in an analysis of covariance (ANCOVA), and (b) a proxy pretest provides an indication of how the formation of the groups may have created important preexisting differences. A proxy pretest is usually inferior to a same-scale pretest because the proxy-posttest correlation will be smaller than the pretest-posttest correlation, and therefore, the proxy pretest will under-adjust for preexisting differences and provide a smaller increase in statistical power.

The nonequivalent control group design with proxy pretest has one type of rival hypothesis to the conclusion that the intervention caused any observed differences between the groups: preexisting group differences in maturation or aspects of the intervention's situation may have interacted with the intervention to produce the differences. The ANCOVA procedure adjusts by the pretest to provide some evaluation of this rival hypothesis.

Candidates for the proxy pretest measure were considered from among the demographic variables, students' GPAs, and a group of nine opinion items that assessed enduring, preexisting characteristics; the opinion items and their numbers are: (a) I study each day rather than just before exams (#1); (b) I make it a point to get my assignments in on time (#15); (c) None of my friends have ever been good at math (#18); (d) I find myself losing interest in my studies by the middle of the semester (#20); (e) I have trouble keeping my mind from wandering as I study (#21); (f) I try to be one of the best students in my science classes (#26); (g) I only do as much as I have to in my science classes (#36); (h) My family cares a lot about education (#45); and (i) I often feel like quitting school (#52).

The proxy pretest of opinion drew six items from the attitude construct, including three items about study habits (1, 15, & 36) and three about persistence (20, 21, & 52). In addition, three items were taken from the SET goal construct: two items were about cultural value (18 & 45), and one was about aspiration (26). In general, these items referred either to enduring characteristics or to experiences in the semester(s) prior to the intervention that related to the student's level of involvement in their education.

Because some of the same items occurred in two measures that were to be correlated, for example, in study habits and the proxy pretest, and because this would have violated the independence assumption on which statistical probability rests, specific proxy pretests were created for study habits, persistence, cultural value, aspiration, attitude construct, and SET goal construct by removing from the set of nine proxy items those that were also a part of that particular postintervention measure. And finally, though none of the proxy pretest items were from the Environmental Support construct's items, the proxy pretest was expected to correlate significantly with at least some of the Environmental Support variables.

The presentation of the results begins by testing the preintervention equivalence of the two groups for demographic characteristics and for academic performance. Following this are the tests of the intervention's hypothesis of enhanced opinions about SET careers and recruitment.

## Demographic Results

The ethnic and sex distribution of students in the intervention and control groups is given in Table 1. The two groups did not differ significantly in ethnic or sex composition.

Table 1

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | 2 | 1 | 7 | 1 | 9 | 2 |
| Anglo | | | 5 | | 5 | |
| Black | 1 | | 1 | | 2 | |
| Hispanic | 8 | 3 | 17 | 12 | 25 | 15 |
| Unknown | | | | | | |
| TOTAL | 11 | 4 | 30 | 13 | 41 | 17 |

The percent responses of each group's students to all of the High School Student Protocol are given in Appendix D; the questions on which the groups differed are discussed in this section. Of the 88 comparisons made, the intervention and control groups differed significantly on only seven, or less than eight percent of the comparisons. Of the seven, two seem to have favored the intervention group, two seem to have favored the control group, and three seem to have been ambiguously influential.

More intervention-group students than control-group students (98% vs. 80%) had been on a science field trip, and more intervention-group students had participated in a math and/or science fair (79% vs. 53%). More control-group students' families than intervention-group students' families spoke English at home (87% vs. 61%), and more control-group students' parents read a lot (87% vs. 63%). The ambiguous differences were that more control-group students than intervention-group students had a dual wage earner situation (100% vs. 81%), more control-group students' parents had phoned or visited about problems in school (93% vs. 70%), and more control-group students' parents had volunteered at the school (87% vs. 58%).

The conclusion that the groups were comparable before the intervention was supported by the small number of differences between the groups on the demographic variables.

## Performance Measures

The students in the intervention and control groups were compared on three measures--high school grade point average (GPA), ACT score, and California Test of Basic Skills (CTBS) percentile--to assess further the comparability of the groups before the intervention. The results, given in Table 2, indicated that the groups did not differ significantly on any measure of performance before the beginning of the intervention. Because both performance and demographic analyses found few or no differences between the groups, one can argue more persuasively that the control and intervention groups were equivalent before the intervention.

Table 2

GROUP COMPARISONS OF PERFORMANCE MEASURES

| MEASURE | GROUP | N | MEAN | SD | t-TEST | d | Sig.p |
|---|---|---|---|---|---|---|---|
| Preintervention GPA | Control<br>Intervention | 14<br>40 | 3.17<br>3.40 | 0.59<br>0.47 | 1.51 | .39 | ns |
| Preintervention ACT | Control<br>Intervention | 2<br>9 | 16.50<br>15.89 | 2.12<br>4.34 | -0.19 | -.29 | ns |
| Preintervention CTBS | Control<br>Intervention | 3<br>8 | 53.33<br>68.50 | 25.77<br>20.91 | 1.01 | .59 | ns |

Note:The statistic d is a measure of effect size, and SD is the standard deviation.
(t-statistics were significant at $p \leq .10$, two-tailed.)

Opinion Measures

The opinion measures were used to test the hypothesis that participation in the intervention group was related to more positive opinions about SET education and SET careers. Two sets of analyses were made: (a) comparisons of postintervention opinions via t-tests, and (b) comparisons of postintervention opinions after adjusting for preintervention opinions via analysis of covariance (ANCOVA) with proxy pretests.

Ideally, the preintervention equality of groups would be tested by comparing the groups' means for the opinion measures. Because there were no preintervention opinion measures, proxy pretests were constructed. Table 3 presents the comparisons of groups for these proxy preintervention measures. The groups did not differ on any proxy pretest at the $p = .10$, two-tailed level; however, the groups would have differed on four of the seven measures at the one-tailed probability level. Because all four near-significant differences favored the control group, the ANCOVA adjustments become more important for tests of the hypothesis.

Table 3

| GROUP DIFFERENCES ON PROXY PRETEST OPINION CONSTRUCTS AND SCALES | | | | | | |
|---|---|---|---|---|---|---|
| CONSTRUCT / Scale | CONTROL | | INTERVENTION | | t-Test (df) | Sig. p |
| | Mean | SD | Mean | SD | | |
| OPINION, Total-PROXY | 3.1806 | .359 | 2.9773 | .478 | 1.37 (54) | ns |
| SET GOAL-PROXY | 3.3056 | .308 | 3.1490 | .377 | 1.32 (54) | ns |
| Cultural Value-PROXY | 3.2262 | .336 | 3.0455 | .453 | 1.29 (54) | ns |
| Aspiration-PROXY | 3.2813 | .316 | 3.1108 | .387 | 1.40 (54) | ns |
| ATTITUDE-PROXY | 3.5556 | .385 | 3.4924 | .384 | .50 (54) | ns |
| Persistence-PROXY | 3.3333 | .275 | 3.2652 | .364 | .60 (54) | ns |
| Study Habits-PROXY | 3.4028 | .366 | 3.2045 | .387 | 1.59 (54) | ns |
| All statistical comparisons were made at p < .10, two-tailed.<br>Proxy Pretest n's: Control = 12; Intervention = 44 | | | | | | |

Table 4 presents the comparisons of the groups for the postintervention opinion measures. For the SET Goal construct and variables, the control group surpassed the intervention group on Self-Concept. For the Attitude construct and variables, the control group surpassed the intervention group on the Attitude construct, Persistence, and Anxiety (control group had lower anxiety). And for the Environmental Support construct and variables, the intervention group reported higher levels of Academic Support. Though these findings suggest that the control group surpassed the intervention group in four out of five differences, the near-significant differences on the proxy pretests suggest that some of these postintervention differences may have been due to preexisting differences. Other analyses adjusted the postintervention measures with proxy preintervention measures.

Table 4

| GROUP DIFFERENCES ON POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | |
|---|---|---|---|---|---|---|
| CONSTRUCT / Scale | CONTROL | | INTERVENTION | | t-Test (df) | Sig. p |
| | Mean | SD | Mean | SD | | |
| SET GOAL | 3.4956 | .272 | 3.3893 | .349 | 0.98 (54) | ns |
| Value | 3.6667 | .359 | 3.4886 | .464 | 1.23 (54) | ns |
| Cultural Value | 3.4792 | .617 | 3.4943 | .347 | -.08 (12.96) | ns |
| Self-Concept | 3.3472 | .219 | 3.1970 | .550 | 1.44 (46.43) | $\leq$.10 |
| Aspiration | 3.5500 | .427 | 3.4545 | .447 | .66 (54) | ns |
| ATTITUDE | 2.8715 | .262 | 2.6918 | .290 | 1.94 (54) | $\leq$.05 |
| Attitude toward Math/Science | 3.0119 | .223 | 2.9719 | .274 | .46 (54) | ns |
| Locus of Control | 3.3333 | .402 | 3.1856 | .436 | 1.06 (54) | ns |
| Persistence | 3.2500 | .489 | 2.9886 | .525 | 1.55 (54) | $\leq$.10 |
| Study Habits | 2.8958 | .225 | 2.8352 | .424 | .66 (34.39) | ns |
| Anxiety | 2.9722 | .521 | 2.5189 | .606 | 2.36 (54) | $\leq$.05 |
| ENVIRONMENTAL SUPPORT | 2.9931 | .571 | 3.1288 | .333 | -.79 (13.11) | ns |
| Academic Support | 2.9722 | .771 | 3.3409 | .526 | -1.56 (13.91) | $\leq$.10 |
| Career Awareness | 3.1944 | .577 | 3.1818 | .479 | .08 (54) | ns |

| GROUP DIFFERENCES ON POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | |
|---|---|---|---|---|---|---|
| Role Model | 2.7500 | .622 | 2.9318 | .587 | -.94 (54) | ns |
| Equal Opportunity | 3.0556 | .814 | 3.0606 | .585 | -.02 (54) | ns |
| Recruitment Index | 8.3639 | 1.567 | 8.0597 | 1.609 | .56 (51) | ns |

Posttest n's: Control = 12; Intervention = 44

Note. When the variances of the two groups were significantly different ($p \leq .05$, two-tailed), a separate-various t-test was calculated which resulted in a smaller, fractional number of degrees of freedom.

Analysis of covariance (ANCOVA) was applied to the postintervention measures in a hierarchical fashion, adjusting for a proxy pretest before examining the effect of group membership. In the event that the pretest interacted significantly with group membership, the interaction was interpreted as a conditional advantage for one group (Cohen & Cohen, 1975) for a range of pretest scores. The region of pretest scores for which the groups differ is determined via the Johnson-Neyman technique to begin beyond the 95-percent confidence interval around the intersection of the two groups' regression lines (Rogosa, 1980).

Table 5 presents the ANCOVA results. With proxy pretest adjustments, the one difference on a SET Goal variable--Self-Concept--disappeared. For Attitude variables, the control group surpassed the intervention group on the Attitude construct, on the Persistence variable, and on the Anxiety variable (control group had lower anxiety); these results are parallel to the t-tests' results.

**Table 5**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PROXY PRETEST OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig.p |
|---|---|---|---|---|---|---|
| SET GOAL | PRETEST | .3622 | .3622 | 30.66 | 1,54 | ≤.01 |
| | +GROUP | .3626 | .0005 | 0.04 | 1,53 | ns |
| | +PRETEST-x-GROUP | .3651 | .0025 | 0.20 | 1,52 | ns |
| Value | PRETEST | .2629 | .2629 | 19.05 | 1,54 | ≤.01 |
| | +GROUP | .2686 | .0057 | 0.41 | 1,53 | ns |
| | +PRETEST-x-GROUP | .2692 | .0006 | 0.04 | 1,52 | ns |
| Cultural Value | PRETEST | .0508 | .0508 | 2.85 | 1,54 | ≤.05 |
| | +GROUP | .0538 | .0030 | 0.17 | 1,53 | ns |
| | +PRETEST-x-GROUP | .0539 | .0001 | 0.01 | 1,52 | ns |
| Self-Concept | PRETEST | .2873 | .2873 | 21.76 | 1,54 | ≤.01 |
| | +GROUP | .2882 | .0009 | 0.07 | 1,53 | ns |
| | +PRETEST-x-GROUP | .2967 | .0085 | 0.63 | 1,52 | ns |
| Aspiration | PRETEST | .2195 | .2195 | 15.18 | 1,54 | ≤.01 |
| | +GROUP | .2195 | .0000 | 0.00 | 1,53 | ns |
| | +PRETEST-x-GROUP | .2209 | .0014 | 0.09 | 1,52 | ns |
| ATTITUDE | PRETEST | .1639 | .1639 | 10.59 | 1,54 | ≤.01 |
| | +GROUP | .2160 | .0521 | 3.52 | 1,53 | ≤.05 |
| | +PRETEST-x-GROUP | .2239 | .0079 | 0.53 | 1,52 | ns |
| Math/ Science Attitude | PRETEST | .0980 | .0980 | 5.87 | 1,54 | ≤.01 |
| | +GROUP | .0981 | .0001 | 0.00 | 1,53 | ns |
| | +PRETEST-x-GROUP | .1064 | .0084 | 0.49 | 1,52 | ns |
| Locus of Control | PRETEST | .1496 | .1496 | 9.50 | 1,54 | ≤.01 |
| | +GROUP | .1553 | .0056 | 0.35 | 1,53 | ns |
| | +PRETEST-x-GROUP | .1798 | .0245 | 1.55 | 1,52 | ns |
| Persistence | PRETEST | .2964 | .2964 | 23.74 | 1,54 | ≤.01 |
| | +GROUP | .3227 | .0264 | 2.06 | 1,53 | ≤.10 |
| | +PRETEST-x-GROUP | .3325 | .0098 | 0.76 | 1,52 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PROXY PRETEST OPINION**

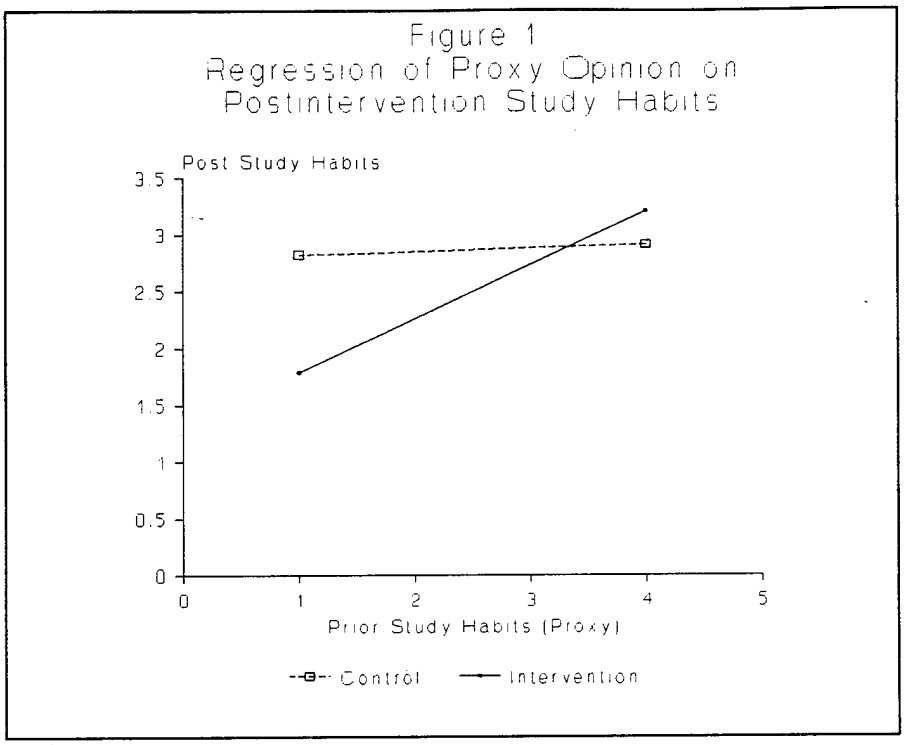
| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig.p |
|---|---|---|---|---|---|---|
| Study Habits | PRETEST | .1507 | .1507 | 9.58 | 1,54 | ≤.01 |
| | +GROUP | .1511 | .0003 | 0.02 | 1,53 | ns |
| | +PRETEST-x-GROUP | .1796 | .0285 | 1.81 | 1,52 | ≤.10 |
| Anxiety | PRETEST | .2001 | .2001 | 13.51 | 1,54 | ≤.01 |
| | +GROUP | .2531 | .0530 | 3.76 | 1,53 | ≤.05 |
| | +PRETEST-x-GROUP | .2551 | .0020 | 0.14 | 1,52 | ns |
| ENVIRONMENTAL SUPPORT | PRETEST | .0947 | .0947 | 5.65 | 1,54 | ≤.05 |
| | +GROUP | .1348 | .0411 | 2.46 | 1,53 | ≤.10 |
| | +PRETEST-x-GROUP | .1758 | .0410 | 2.59 | 1,52 | ≤.10 |
| Academic Support | PRETEST | .0242 | .0242 | 1.34 | 1,54 | ns |
| | +GROUP | .1066 | .0824 | 4.89 | 1,53 | ≤.05 |
| | +PRETEST-x-GROUP | .1165 | .0099 | 0.58 | 1,52 | ns |
| Career Awareness | PRETEST | .1721 | .1721 | 11.23 | 1,54 | ≤.01 |
| | +GROUP | .1762 | .0041 | 0.26 | 1,53 | ns |
| | +PRETEST-x-GROUP | .2074 | .0312 | 2.05 | 1,52 | ≤.10 |
| Role Model | PRETEST | .1393 | .1393 | 8.74 | 1,54 | ≤.01 |
| | +GROUP | .1778 | .0384 | 2.48 | 1,53 | ≤.10 |
| | +PRETEST-x-GROUP | .2244 | .0466 | 3.13 | 1,52 | ≤.05 |
| Equal Opportunity | PRETEST | .0032 | .0032 | 0.17 | 1,54 | ns |
| | +GROUP | .0032 | .0001 | 0.00 | 1,53 | ns |
| | +PRETEST-x-GROUP | .0080 | .0048 | 0.25 | 1,52 | ns |
| Recruitment Index | PRETEST | .1161 | .1161 | 6.70 | 1,51 | ≤.01 |
| | +GROUP | .1164 | .0003 | 0.02 | 1,50 | ns |
| | +PRETEST-x-GROUP | .1346 | .0182 | 1.03 | 1,49 | ns |

All models were analyzed as one-tailed tests.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure): (1) PRETEST OPINION SCORE; (2) PRETEST OPINION SCORE and GROUP ('+'); (3) PRETEST OPINION SCORE and GROUP and PRETEST OPINION SCORE-by-GROUP INTERACTION ('-x-').

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance. All of the cumulative $R^2$ tests were significant at $p \leq .10$, one-tailed.

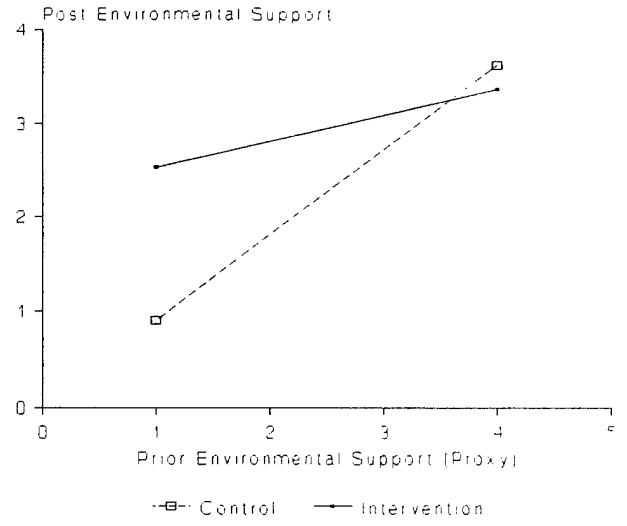
In addition, preintervention scores interacted with group membership for Study Habits; as shown in Figure 1, the control-group students who had average or below-average scores on the pretest (below 2.9) also had higher scores on the postintervention measure of Study Habits.




For the Environmental Support variables, the intervention group surpassed the control group on the Environmental Support construct, on Academic Support, and on the Role Model measure. In addition, preintervention scores interacted with group membership for Environmental Support, Career Awareness, and Role Model variables; in each of these interactions (shown in Figures 2, 3, and 4, respectively), the intervention-group students who scored at or below-average on the pretest did better than did students in the control group with similar pretest scores.

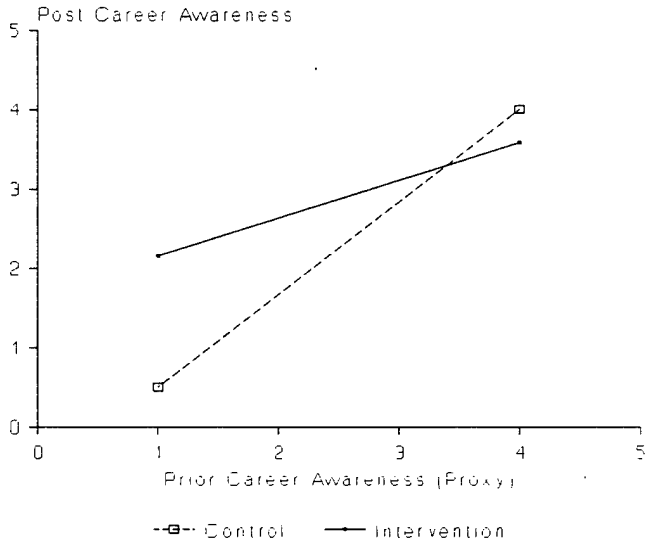
Intervention-group students with pretest scores below 3.3 reported higher scores on the Environmental Support construct than did comparable control-group students.

Figure 2
Regression of Proxy Opinion on Postintervention Environmental Support



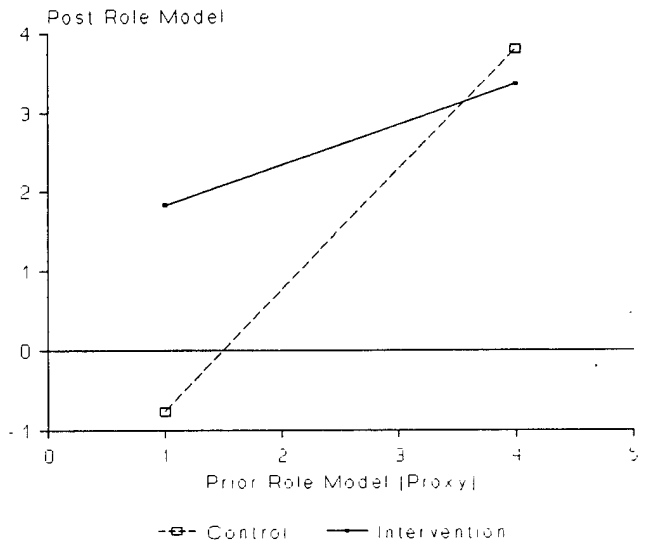

Similarly, intervention-group students with pretest scores below 3.1 had higher levels of career awareness than did comparable control-group students.

Figure 3
Regression of Proxy Opinion on Postintervention Career Awareness



And of students who scored below 3.0 on the pretest, intervention-group students had higher scores on the Role Model variable.

Figure 4
Regression of Prior Opinion on Postintervention Role Model




A comparison of the t-test and ANCOVA results indicated that the adjustment for generally higher control group pretest scores eliminated one control group advantage (Self-Concept) and uncovered one conditional control group advantage (Study Habits for students scoring average or below). It also uncovered two general intervention group advantages (Environmental Support construct and Role Model) and a conditional advantage (Career Awareness for intervention-group students scoring average or below) in addition to the already known Academic Support advantage. The proxy pretests were successful in that they were significantly related to the posttest in 15 of the 17 ANCOVAs (all except for Academic Support and Equal Opportunity), and detected group differences that the t-tests missed.

In summary, the intervention was associated with higher scores on three Environmental Support measures--Academic Support, Role Model, and Career Awareness (conditionally)--and lower scores on three attitude measures--Persistence, Anxiety, and Study Habits (conditionally). The intervention and control groups did not differ on any SET goal variables. In the absence of random assignment or parallel pretest measures, the opinion results should be considered tentative.

## DISCUSSION

One of this intervention's goal was to make students more aware of SET careers, and the results of the opinion analyses indicate that the intervention was moderately successful. First, the analyses of the demographic and performance variables demonstrate that the intervention and control groups were not very different even though random assignment had not been used to create the two groups. Second, the analyses of group differences for the opinion variables indicate that after adjusting for preexisting differences (via proxy pre-measures), the intervention group had higher scores for Academic Support, Role Model, and Career Awareness (for students who tested average and below-average on the pretest in that area); these three differences indicate partial accomplishment of the intervention's goals. However, three differences indicate that the intervention was associated with lower scores on three attitude measures: lower Persistence, higher Anxiety, and lower Study Habits (for average and below-average students). An evaluation of the three negative differences argues against the conclusion that the intervention was harmful.

For two of these negative outcomes--Persistence and Study Habits--three of the four items that comprised each variable were such enduring characteristics that one would not expect any change as a result of a summer-long program. Three of the four items that made up the Persistence and Study Habits scales were judged to be so enduring that they were a part of the general proxy pretest. In other words, the Persistence and Study Habits variables measure enduring qualities, and postintervention differences are likely due to preintervention differences.

The greater level of anxiety in the intervention group may have been due to the higher level of challenge that these students encountered during their summer courses. This explanation is suggested by the fact that the intervention-group students had significantly lower grades in their summer courses than in their previous high school courses, $t$ (38) = 3.57, $p$ = .001, two-tailed (summer GPA = 3.05, prior GPA = 3.40). In addition, intervention-group students' prior GPAs were not significant predictors of their summer GPAs; in other words, some "A" students were making "C" grades during the summer. These two pieces of evidence suggest that the difficulty of the summer courses may have increased anxiety in the intervention group relative to a control group who did not experience a set of challenging courses.

The tentative conclusion is that the intervention produced some gains in several measures related to environmental support for SET careers; intervention-group students showed higher scores on measures of Academic Support, Role Model, and Career Awareness (if they had been average or below on a pretest). Limitations of the research design make this conclusion tentative. Three desirable improvements to the research design would be to randomly assign students to intervention and control groups, obtain postintervention measures of performance for the control group, and measure preintervention opinions on the same scales used for the posttest measures. With or without these changes, if these or similar results are replicated in a subsequent intervention, confidence in these findings will be strengthened.

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Documents supplied by CASET Consortium institutions: baseline reports, research proposals, college catalogs and bulletins

# APPENDICES

# APPENDIX A

# HIGH SCHOOL STUDENT PROTOCOL

Participant Number: _____

## HIGH SCHOOL STUDENT PROTOCOL

Thank you for agreeing to participate in this important project. It is geared to help us develop new programs for students and improve existing programs.

Your opinions and experience are important to us. Please read each question carefully and answer completely and accurately to the best of your ability. All of your answers will be kept in confidence. Your answers will be grouped with those of other students in other places, and together they will help us better understand students' needs and preferences today.

Please ask your administrator if any of these questions are unclear to you.

Thanks for your help!

1. Sex:
   - ___ a. Male
   - ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   - ___ a. Anglo
   - ___ b. Black
   - ___ c. Asian American
   - ___ d. American Indian (Please specify the tribe which best describes your heritage.)

     _____
   - ___ e. Hispanic (Which of the following best describes your heritage?)
     - ___ a. Cuban-American
     - ___ b. Mexican-American
     - ___ c. Puerto Rican
     - ___ d. Other Specify _____
   - ___ f. Other Specify _____

4. Are you a United States citizen?
   - ___ a. Yes
   - ___ b. No

5. Name of your school: _____

   City: _____ State: _____

6. Class:
   ___ a. High School Freshman
   ___ b. High School Sophomore
   ___ c. High School Junior
   ___ d. High School Senior
   ___ e. Other Specify _____

7. Which of the following college entrance exams have you taken?
   ___ a. I haven't taken any
   ___ b. ACT
   ___ c. PSAT or SAT
   ___ d. Other Specify _____
   ___ f. Other Specify _____

8. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Less than high school graduation
   ___ b. High school graduation
   ___ c. Two-year college degree (community college or junior college)
   ___ d. Four-year college degree
   ___ e. Education beyond four years of college
   ___ f. Other Specify _____

9. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

10. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)
   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Job
   ___ d. Previous personal earnings and savings
   ___ e. Family trust fund, insurance plan, or other similar arrangement
   ___ f. Other Specify _____

11. You may want to receive help outside your regular high school course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems

___ f. Increasing reading ability
___ g. Developing good study habits
___ h. Improving writing ability

12. What is or are the occupation(s) of the person(s) with whom you live? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

_____ _____

13. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average
___ d. Don't know

14. Are you:
___ a. An only child (skip to question 16)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

15. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

16. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

17. What was the highest level of school your mother completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

18. What is the language spoken most often by adults in your household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe (What is that language?) _____
___ d. Another language - Specify _____

19. Which of the following did your parent(s) or guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

20. Which of the following comes closest to describing how much your parent(s) or guardian(s) read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

21. Which of the following comes closest to describing how much you read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

22. Which of these items do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

23. What kind of high school or secondary school do you attend?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

24. Are you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes (Please list them.)

_____

_____

_____

_____

_____

25. Have you ever taken part in any of these activities? (Check all that apply)
    ___ a. Math and science clubs
    ___ b. Field trip to science museum, laboratory, or other place where scientists work
    ___ c. Watching science programs on TV
    ___ d. A talk by a scientist
    ___ e. Science/math fair
    ___ f. Other science/math competition
    ___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL ITEMS WITH DIRECTIONALITY AND SCALES

Legend:

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of my ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |

| | | | |
|---|---|---|---|
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

    i. _____

    ii. _____

    iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE HIGH SCHOOL STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION | CONTROL |
| 1. Sex: | | |
| Women | 70% | 73% |
| Men | 30% | 27% |
| | (n=43) | (n=15) |
| 6. Class: | | |
| .Freshmen | 0% | 0% |
| .Sophomores | 10% | 0% |
| .Juniors | 52% | 73% |
| .Seniors | 38% | 27% |
| | (n=42) | (n=15) |
| 7. Students taken a college entrance exam | 64% | 53% |
| | (n=42) | (n=15) |
| 8. Higher education expected: | | |
| .Less than high school graduation | 0% | 7% |
| .High school graduation | 0% | 0% |
| .Two years of college | 2% | 0% |
| .Four years of college | 22% | 13% |
| .One or more years after college | 76% | 80% |
| | (n=41) | (n=15) |
| 9. Studies most influenced by: | | |
| .Parents | 72% | 80% |
| .Another family member | 3% | 0% |
| .Teacher | 3% | 7% |
| .Counselor | 0% | 7% |
| .Minister | 3% | 0% |
| .Friend | 3% | 0% |
| .Science professional | 0% | 0% |
| .Nonscience professional | 0% | 0% |
| .No one at all | 18% | 7% |
| | (n=39) | (n=15) |
| 10. Sources of income:[b] | | |
| .Parents/guardians | 81% | 100%[a] |
| .Wife or husband | 0% | 0% |
| .Job | 44% | 27% |
| .Personal savings | 19% | 13% |
| .Family trust fund, etc. | 16% | 7% |
| .Other | 9% | 7% |
| | (n=43) | (n=15) |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION | CONTROL |
| 11. Student needs help in:[b] | | |
| .Counseling on educational plans | 51% | 40% |
| .Counseling on career plans | 56% | 53% |
| .Improving math ability | 51% | 67% |
| .Finding part-time work | 56% | 47% |
| .Counseling on personal problems | 7% | 13% |
| .Increasing reading ability | 21% | 40% |
| .Developing good study habits | 67% | 60% |
| .Improving writing ability | 51% | 47% |
| | (n=43) | (n=15) |
| 12. Sources of outside income: | | |
| .None | 0% | 7% |
| .One | 46% | 27% |
| .Two | 54% | 67% |
| | (n=41) | (n=15) |
| 13. Family income: | | |
| .Below U.S. average | 21% | 27% |
| .About average | 65% | 60% |
| .Above average | 15% | 13% |
| | (n=34) | (n=15) |
| 14. Birth order of student: | | |
| .Only child | 7% | 0% |
| .Oldest child | 49% | 60% |
| .Youngest child | 9% | 13% |
| .In-between child | 35% | 27% |
| | (n=43) | (n=15) |
| 15. Number of siblings: | | |
| .One | 23% | 20% |
| .Two | 28% | 20% |
| .Three | 44% | 60% |
| | (n=40) | (n=15) |
| 16. Father's education: | | |
| .Grade school or less | 5% | 0% |
| .Some high school | 13% | 13% |
| .High school graduate | 18% | 13% |
| .Some college | 33% | 27% |
| .College degree or more | 33% | 47% |
| | (n=40) | (n=15) |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION | CONTROL |
| 17. Mother's education: | | |
| .Grade school or less | 2% | 0% |
| .Some high school | 19% | 0% |
| .High school graduate | 29% | 40% |
| .Some college | 17% | 20% |
| .College degree or more | 33% | 40% |
| | (n=42) | (n=15) |
| 18. Language spoken most at home: | | |
| .English | 61% | 87%[a] |
| .Spanish | 30% | 13% |
| .Language of tribe | 5% | 0% |
| .Other | 5% | 0% |
| | (n=43) | (n=15) |
| 19. Parents' involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 40% | 53% |
| .Attend parent-teacher conferences | 65% | 80% |
| .Visit student's class | 63% | 73% |
| .Phone/visit if there's a problem | 70% | 93%[a] |
| .Do volunteer work | 58% | 87%[a] |
| .Assist student in course selection | 58% | 73% |
| .Assist in student's homework | 67% | 87% |
| | (n=43) | (n=15) |
| 20. Parent(s) read: | | |
| .Not at all | 2% | 0% |
| .Sometimes | 35% | 13% |
| .A lot | 63% | 87%[a] |
| | (n=43) | (n=15) |
| 21. Student reads: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 54% | 47% |
| .A lot | 46% | 53% |
| | (n=43) | (n=15) |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION | CONTROL |
| 22. Items in student's home:[b] | | |
| .Desk | 70% | 67% |
| .Daily newspaper | 63% | 40% |
| .Encyclopedia | 86% | 87% |
| .Typewriter | 74% | 73% |
| .Calculator | 95% | 100% |
| .Television | 95% | 100% |
| .Computer | 33% | 20% |
| .Video Cassette Recorder (VCR) | 79% | 87% |
| | (n=43) | (n=15) |
| 24. Member math/science club in high school | 37% | 47% |
| | (n=41) | (n=15) |
| 25. All activities student took part in:[b] | | |
| .Math/science club | 37% | 33% |
| .Field trip | 98% | 80%[a] |
| .Watching science programs on TV | 84% | 87% |
| .Listen to talk by scientist | 79% | 73% |
| .Science/math fair | 79% | 53%[a] |
| .Other science/math competition | 42% | 27% |
| .Play/work in computer lab | 91% | 87% |
| | (n=43) | (n=15) |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

# CASET RESEARCH REPORT:

# OUR LADY OF THE LAKE UNIVERSITY

# INTERVENTIONS

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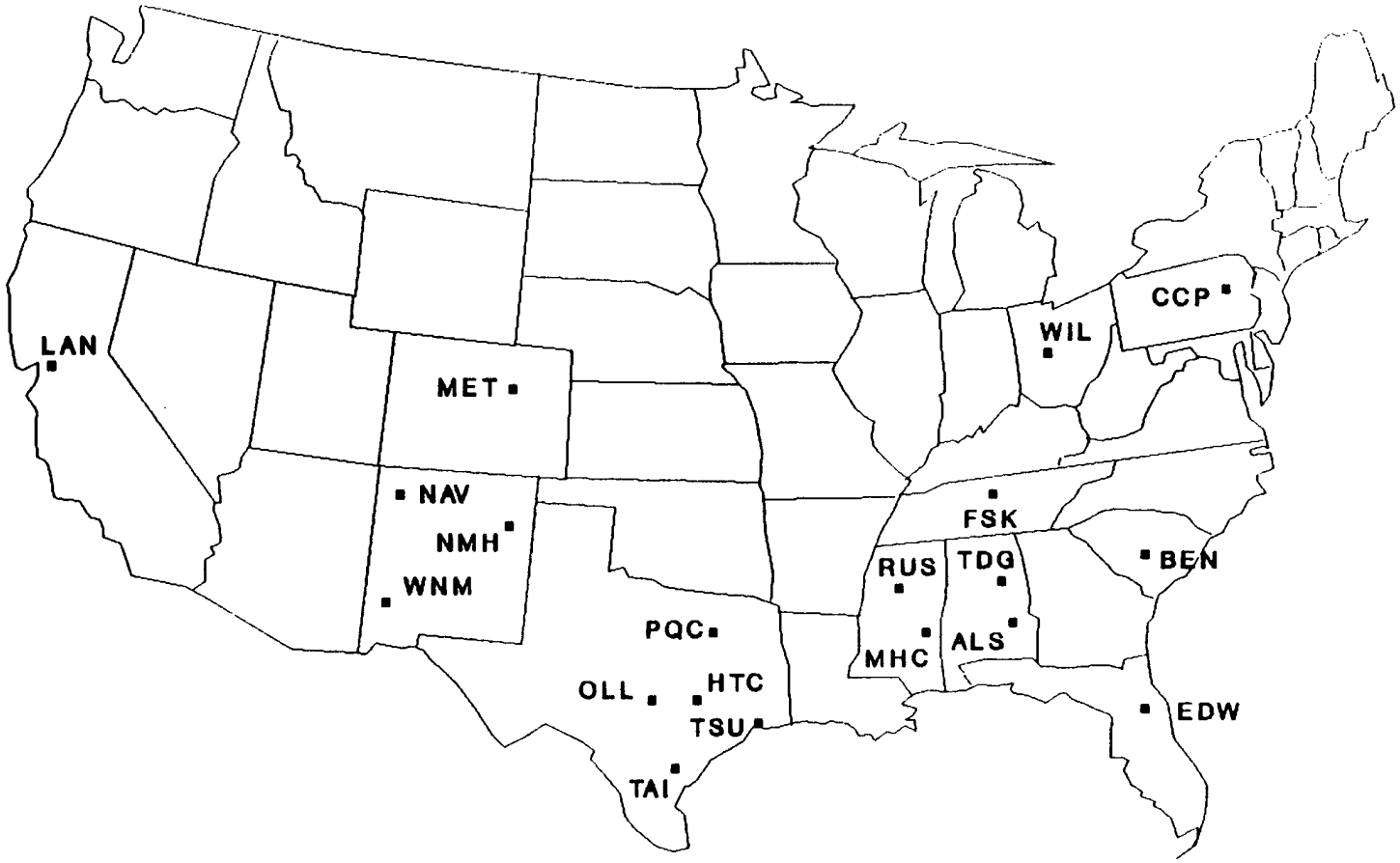
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enables CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of the set of project reports produced by CASET to present the findings of the individual colleges' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected included the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention-group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention strategies tested by individual colleges included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each college. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research will be described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF OUR LADY OF THE LAKE UNIVERSITY

The community of Our Lady of the Lake University (OLLU), located in San Antonio, Texas, consists of approximately 2300 students, 154 faculty and faculty associates, and 68 adjunct faculty. The University, organized into the College of Arts and Sciences, the School of Business and Public Administration, the School of Education and Clinical Studies, and the Worden School of Social Service, offers undergraduate and graduate degrees. The student body is 74 percent female and 26 percent male. Approximately 64 percent of the students are Hispanic, 9 percent are Black, and 27 percent are from other ethnic origins. The president of OLLU is Sister Elizabeth Anne Sueltenfuss, Ph.D.

Degrees offered at OLLU in quantitative subjects are Bachelor of Arts in chemistry, computer information systems, mathematics, and natural sciences, and Bachelor of Applied Studies in mathematics and natural sciences. The University also offers a 3+2 dual degree program in engineering in cooperation with Texas Tech University, in Lubbock, Texas and Washington University in St. Louis, Missouri.

San Antonio has a population of over 1.3 million in its metropolitan area, with more than half of the population being Hispanic. The state of Texas has a population of just over 17 million. In 1988, the U. S. Bureau of the Census reported that the population of Texas was 66 percent Anglo, 21 percent Hispanic, 11 percent Black, and 2 percent other ethnic origins. San Antonio has five other institutions of higher education: University of Texas at San Antonio, Trinity University, St. Mary's University, Incarnate Word College, and the Alamo Community College System.

# PART II

# SUMMARY OF THE

# OUR LADY OF THE LAKE UNIVERSITY

# INTERVENTIONS

This report summarizes the five interventions conducted by Our Lady of the Lake University (OLLU), a four-year private institution located in San Antonio, Texas. OLLU is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

OLLU Intervention Activities:

In Fall of 1988, Spring and Fall of 1989, and in Spring and Fall of 1990, OLLU conducted interventions consisting of cooperative learning groups in mathematics courses. These groups, locally called "math labs," stressed teamwork, "speaking the language" of mathematics, and active participation in the mathematics learning process. Students enrolled in those course sections which were designated as intervention group sections took part in cooperative learning groups in lieu of one mathematics class period per week. Intervention group students had three 50-minute periods per week of instruction, and one 75-minute period per week of cooperative learning groups. Other course sections, designated control group sections, were taught in the traditional way, with four 50-minute periods per week of instruction. Participants were college students, primarily freshmen and sophomores, enrolled in precalculus and calculus classes.

Findings:

- The intervention had positive effects on mathematics performance under several circumstances:

  when the same instructor taught the course and also served as group facilitator;

  when the intervention was in its first semester of implementation;

  when the intervention was conducted in the Fall as opposed to the Spring semester.

- Performance effects were variable under other circumstances. It appeared that the instructor was an important variable in the effect on performance: Just as some instructors are better teachers than others, it seems also that some instructors work better in conjunction with cooperative learning groups than do others.

- The strongest performance effects were for lower-achieving mathematics students and higher-potential mathematics students, suggesting the release of dormant potential in mathematics.

- Opinion effects of the intervention were positive as measured in the Fall interventions.

- Opinion was more negatively affected among intervention participants in the calculus sections than among those in the precalculus sections.

Recommendations:

- Since cooperative groups CAN have, but do not ALWAYS have, positive effects on both performance and opinion, they should be implemented only with careful monitoring of effects.
- Instructor cooperation with the cooperative learning process is essential and should be cultivated.
- In setting up learning groups, care should be taken that the time spent on group work does not detract from having sufficient time for instruction on course content.
- In implementing cooperative learning groups, existing sources dealing with the implementation of those groups should be utilized.

# PART III

# CASE STUDY OF THE

# OUR LADY OF THE LAKE UNIVERSITY (OLLU)

# 1988 FALL SEMESTER INTERVENTION

## DESCRIPTION OF THE INTERVENTION

The OLLU research project is an academic support intervention for undergraduate students taking precalculus (MT 1411) or calculus (MT 2412) during the University's regular fall and spring semesters. This report discusses the pilot project for this intervention, conducted in precalculus classes during the fall of 1988.

The primary mechanism of the intervention is the *study team*. Groups of students taking precalculus attended weekly academic support meetings in addition to attending their regular precalculus classes three times a week. The control group attended traditional precalculus classes four times a week.

The study team meetings lasted about seventy-five minutes each week. Students met with a faculty coordinator, Sister Mary Ellen Quinn, and had an opportunity for diagnosis and help with individual problems, as well as an opportunity to speak and hear the "language of mathematics." It was anticipated that the study team work would increase involvement and improve learning and retention in mathematics. It was felt that group discussion, unlike passive listening, was a way to enhance students' verbal facility and make them more comfortable with the subject matter. Study teams were selected as the method of intervention to provide an opportunity for students to discuss any weaknesses they might have in mathematics and seek assistance, as well as to provide an opportunity to use the language of mathematics in a group session. Although this was a collaborative system, the main purpose of the intervention was to improve individual achievement in mathematics.

The project director of the OLLU research project was Sister Isabel Ball, Dean of the College of Arts and Sciences. The program coordinator was Sister Mary Ellen Quinn, Professor of Mathematics; she conducted the study team sessions. The program instructors were Sister Marilyn Molloy, Professor of Mathematics, and Sister Dorothy Anne Vrba, Assistant Professor of Mathematics. The data analyzed in this report were from the students in the intervention and control precalculus classes taught by Sister Vrba, and the intervention class taught by Sister Molloy.

## METHOD

### Subjects

Subjects for this pilot study were university students, primarily freshmen, enrolled in precalculus courses at OLLU in the fall of 1988. The majority were Hispanic; over 80 percent were women. The ethnic/race and sex distribution of both intervention and control groups are presented in Table 1. Additional demographic information about the sample can be found in the Results section.

Table 1

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | 0 | 0 | 0 | 0 | 0 | 0 |
| Anglo | 2 | - | 9 | - | 11 | - |
| Black | 1 | 0 | 2 | 1 | 3 | 1 |
| Hispanic | 8 | 3 | 20 | 8 | 28 | 11 |
| Unknown | 0 | - | 0 | - | 0 | - |
| TOTAL | 11 | 3 | 31 | 9 | 42 | 12 |

A total of 61 sets of protocols were received from 44 intervention and 17 control students. Seven sets of data were eliminated because the students did not represent the populations that were the focus of this study: four of those eliminated were non-U.S. citizens; two were Anglo males; and one was an Asian American. Fifty-four sets of data were analyzed: forty from the two precalculus classes which constituted the intervention group, and 14 from the one precalculus class which was the control group.

CASET Protocols and Other Instruments

Demographic and descriptive data about the subjects were developed through the College Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support (see Appendix A).

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. These variables provided the framework for the Opinion Protocol. Opinion Protocol items, together with the scales they represent, are seen in Appendix B. The Opinion Protocol was developed for use before and after intervention activity to monitor any changes; however, in the pilot research reported here, the Opinion Protocol was administered only at the end of the intervention.

Mathematical performance measures were these: as pretest, the University-generated test of mathematical competence (MC1) and the mathematics portion of the SAT; as posttest, the final course examination in precalculus (MC2). The same final examination was given in all three sections of precalculus.

Procedure

At the beginning of the semester, students signed informed consent forms, and the University-generated pretest of mathematical competence was administered to intervention and control students. During the semester the students completed the CASET Student Protocol. In the last week of the semester, all students completed the CASET Opinion Protocol and the final course examination.

OLLU faculty scored the tests of mathematical competence and forwarded scores to CASET, along with the CASET instruments. University project staff also forwarded to CASET standardized test scores and college and high school transcripts for all students.

CASET staff evaluated the demographic information on each student and eliminated from the sample those students who were not members of the targeted minority groups.

The items of the Opinion Protocol were coded according to the thirteen scales they represent. Scoring of the negatively worded items on the Opinion Protocol was reversed so that scores could be totaled meaningfully (see Appendix B). The scales were organized into three constructs - SET Goal, Environmental Support, and Attitude, as shown in Appendix C.

## RESULTS

Methodological Issues

The intervention conducted at OLLU in the fall, 1988 semester was evaluated as a quasi-experimental design. This type of design has a greater burden in demonstrating a causal relationship than does an experimental design; rival hypotheses to the conclusion that the intervention caused significant differences in posttest scores must be considered and ruled out (Campbell & Stanley, 1966; Cook & Campbell, 1979).

Actually, the study of the OLLU intervention of fall 1988 relied upon two different designs: (a) the test of the hypothesis of improved performance was a quasi-experimental design, the untreated control group design with pretest and posttest ("nonequivalent control group design"); and (b) the test of the hypothesis of group differences in the opinion scales was an example of a pre-experimental design, the posttest-only design with nonequivalent groups ("static group comparison" or "ex post facto"), because there were no pretest opinion data.

The research design of the performance data allows the possibility of a few internal validity problems, of which selection-maturation was most likely operating. Selection-maturation appears as the possibility that the treatment and control groups were maturing at different rates in the same direction. This may be common when subjects self-select into treatment groups.

In this pilot study, the lack of a pretest considerably limits the interpretability of the opinion data. Selection, mortality, maturation, and the interaction of selection and maturation all pose threats to the validity of conclusions about differences between groups; most plausibly, selection may operate so that any preexisting differences between the intervention and control groups may have persisted and appeared as group differences at the end of the intervention. Subsequent semesters of research will provide pre- and post-intervention measurements of opinion data, permitting further interpretation of the opinion findings.

## Demographic Results

These analyses described characteristics of the participants and tested the equivalence of the intervention and control groups. Appendix D contains the percentages of students in each group who selected a particular response for each question. This narrative will discuss only the questions that showed significant group differences at $p < .10$.

A significantly greater percentage of intervention students had received scholarships (66 percent vs. 38 percent). More intervention students reported that they might want help in developing good study habits (64 percent vs. 33 percent) and in improving their writing (54 percent vs. 25 percent). When asked about parental involvement, more control students reported that their parents visited their classes (92 percent vs. 58 percent), but more intervention students reported that their parents assisted them in course selection (42 percent vs. 15 percent). When asked about supporting items, more intervention students said their families had typewriters (85 percent vs. 54 percent) and VCRs (90 percent vs. 62 percent) in their homes. Finally, more intervention students' families spoke English as their primary language (75 percent vs. 34 percent), and consequently more control students spoke Spanish at home (50 percent vs. 22 percent). This language difference seemed important and was followed up to examine the relationship between speaking English at home and score on the posttest; no statistically significant differences were found.

In summary, the eight demographic differences taken as a group do not appear to favor either the intervention group or the control group; the most plausibly important factor--language spoken at home--was not related to posttest performance. These eight differences were only 10 percent of the eighty demographic comparisons--precisely the percentage that one might expect to find by chance at a 10 percent probability level.

## Performance Measures

The hypothesis that the intervention group would outperform the control group was tested by comparing the posttest scores of the two groups. In this nonequivalent control group design with pretest and posttest measures, several methods of analysis are available (Reichardt, 1979); because each method has strengths and weaknesses, multiple methods are recommended. This report will include two methods of analysis: (a) $t$-tests on pretest and posttest, and (b) analysis of covariance (ANCOVA) of posttests, covarying pretests. (Scores for each student on each test may be found in Appendix F.)

The analysis of pretest scores comparing the intervention and control groups was nonsignificant, $t_{(49)} = -1.10$, $p > .10$, one-tailed (Intervention Mean = 46.7, Control Mean = 40.4). However, the intervention group was significantly better on the posttest, $t_{(49)} = -1.32$, $p < .10$, one-tailed (Intervention Mean = 71.7, Control Mean = 63.4). Table 2 contains the summaries of these two analyses.

Table 2

| DIFFERENCES ON GROUP PERFORMANCE MEASURES | | | | | | |
|---|---|---|---|---|---|---|
| **MEASURE** | **GROUP** | **n** | **MEAN** | **SD** | **t-TEST (df)** | **SIG p** |
| Math Pretest | Control<br>Intervention | 13<br>38 | 40.38<br>46.71 | 15.54<br>18.53 | -1.10<br>(49) | ns |
| Math Posttest | Control<br>Intervention | 12<br>39 | 63.42<br>71.74 | 19.41<br>19.01 | -1.32<br>(49) | ≤.10 |
| For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level. | | | | | | |

Some researchers have argued that the combination of a nonsignificant difference on the pretest and a significant difference on the posttest supports a conclusion of superior performance due to the intervention; however, methodologists (Campbell & Stanley, 1966; Cook & Campbell, 1979) have pointed out that this makes the fragile assumption of linear, non-interactive change. And in the OLLU pilot study, the pretest scores were nearly significantly different, $p < .15$, one-tailed. For this reason, this report includes another method of analysis that takes into account preexisting characteristics, ANCOVA.

If pretest scores are covaried, the test statistic for a group difference on the posttest just misses significance at $p = .10$, one-tailed, $F_{(1,44)} = 1.683$ (or $t_{(44)} = 1.297$, critical $t_{(44)} = 1.3011$ for $p = .10$, one-tailed). The traditional ANCOVA assumes that the regression lines are parallel, in other words, that the intervention does not interact with the pretest. However, in this study, the pretest and group membership did interact, $F_{(1,43)} = 1.705$, $p < .10$, one-tailed (or $t_{(43)} = 1.306$, $p < .10$, one-tailed, see Table 3); the effects of the intervention depended upon the student's pretest score.

Table 3

| HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE | | | | | | |
|---|---|---|---|---|---|---|
| **DEPENDENT VARIABLE** | **INDEPENDENT VARIABLE** | **Cumul. $R^2$** | **$sR^2$** | **F ($sR^2$)** | **df** | **Sig. p** |
| MATH POSTTEST | MATH PRETEST<br>+ GROUP<br>+ PRE-x-GROUP | .1044<br>.1374<br>.1703 | .1044<br>.0330<br>.0329 | 5.24<br>1.68<br>1.71 | 1,45<br>1,44<br>1,43 | ≤.05<br>ns<br>≤.10 |
| MATH POSTTEST | SAT-MATH<br>+ GROUP<br>+ SAT-x-GROUP | .1834<br>.2018<br>.2327 | .1834<br>.0134<br>.0309 | 10.56<br>1.06<br>1.81 | 1,47<br>1,46<br>1,45 | ≤.01<br>ns<br>≤.10 |
| Note. $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance. | | | | | | |

With a significant treatment-by-covariate interaction, one interprets the interaction (Cohen & Cohen, 1975) and determines the range of pretest scores for which the groups differ (Rogosa, 1980). As evidence for interpretation, examine Figure 1 which depicts the regression lines of pretest scores on posttest scores for the intervention and control groups.
In Figure 1, the significant interaction, or nonparallel lines, can be seen crossing at a pretest score of 59.28; the regression equations for the two groups differ in intercept and slope. The interpretation of this figure is clear: the intervention was most successful with students who scored below the mean on the pretest, and above-average students did well in either group.

The Johnson-Neyman technique (Rogosa, 1980) can identify a region of pretest values for which the groups differ significantly; this region can be expressed as a confidence interval around the intersection point of the regression lines. The 95 percent confidence interval around the pretest value of intersection was 59.28 ± 13.66 (45.62 to 72.94). This interval includes all of the pretest values for which the intervention and control groups did not differ. For any pretest value below 45 (the median pretest score was 47), the intervention group outperformed the control group on the posttest.

**Figure 1**

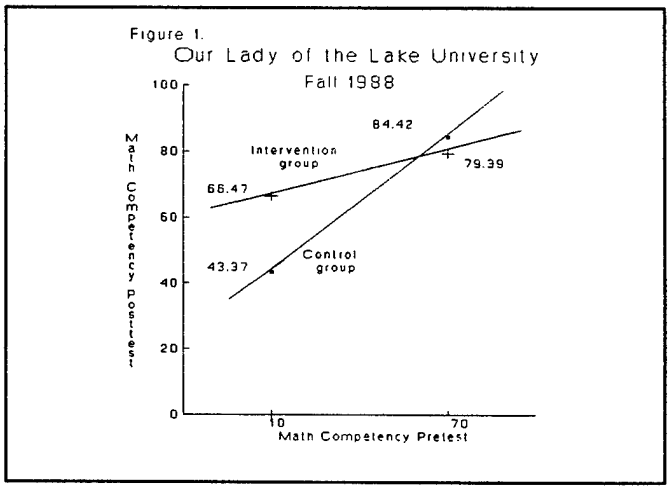
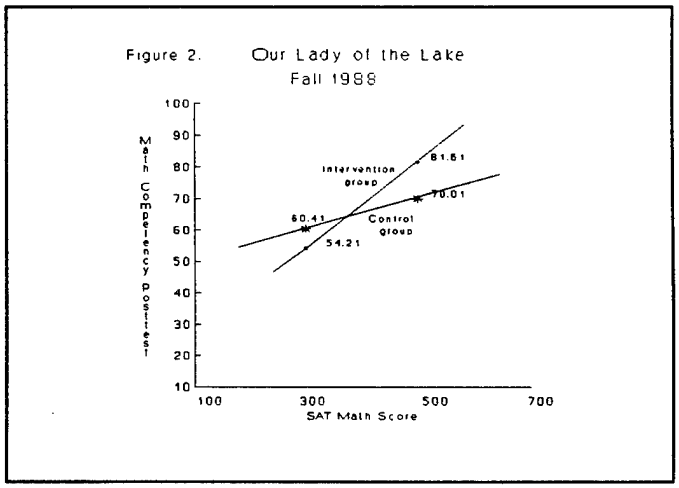



**Figure 2**




In addition to using the achievement pretest score as the covariate, an analysis examined the aptitude pretest score, the SAT Mathematics score. The results were similar with either covariate, though with an interesting difference. The effect of the intervention was nearly significant after adjusting the posttest for SAT math scores, $F_{(1,46)} = 1.06$, $p > .10$, one-tailed; however, the effects of the intervention interacted with SAT math scores significantly, $F_{(1,45)} = 1.81$, $p < .10$, one-tailed.

Figure 2 displays the regression lines of intervention and control groups for SAT math scores on math competency posttest scores. The regression lines intersect at a SAT score of 370, and the Johnson-Neyman technique established a 95 percent confidence interval that ranged from 302.40 to 436.92. This pattern of results demonstrated the success of the intervention in a different way than did the achievement pretest interaction; with aptitude, students who scored 437 or higher on the SAT math test did significantly better in the intervention group than in the control group.

The effects of the intervention interacted with pretest achievement and aptitude in different ways: Lower achieving students did better in the intervention group, and higher aptitude students did better in the intervention group. This suggests that the intervention helped math underachievers, i.e., students with low achievement and moderate aptitude. In support of this conclusion, note that of the 15 intervention students who scored less than 45 on the pretest, seven also scored 435 or higher on the SAT math test. One could conclude that the intervention helped students realize their math aptitude despite their poor math achievement in the past, thus the hypothesis of improved performance was supported.

Opinion Results

The 55 items of the Opinion Protocol represent 13 scales that can be grouped under three constructs: SET (Science, Engineering, and Technology) Goal, Environmental Support, and Attitude. Comparisons between the control and intervention means for each scale of the Opinion Protocol are given in Table 4; the intervention group's mean exceeded the control group's mean for two scales: Academic Support ($t_{(49)} = 2.75$, $p < .01$, one-tailed) and Equal Opportunity ($t_{(49)} = 1.35$, $p < .10$, one-tailed).

**Table 4**

**GROUP DIFFERENCES ON POSTTEST OPINION CONSTRUCTS AND SCALES**

| POSTTEST CONSTRUCT/Scale | CONTROL | | INTERVENTION | | d | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | Mean | N | Mean | N | | | |
| **SET GOAL** | | | | | | | |
| Value | 3.50 | 13 | 3.53 | 38 | .09 | 0.29 | ns |
| Cultural Value | 3.44 | 12 | 3.47 | 39 | .11 | 0.35 | ns |
| Self-Concept | 2.67 | 13 | 2.76 | 38 | .18 | 0.60 | ns |
| Aspiration | 2.88 | 13 | 2.97 | 38 | .24 | 0.60 | ns |
| **ATTITUDE** | | | | | | | |
| Math/Science Attitude | 2.99 | 13 | 3.09 | 38 | .27 | 0.79 | ns |
| Locus of Control | 3.41 | 13 | 3.29 | 39 | -.35 | -0.99 | ns |
| Persistence | 2.67 | 12 | 2.65 | 41 | -.03 | -0.09 | ns |
| Study Habits | 2.62 | 13 | 2.74 | 39 | .34 | 0.97 | ns |
| Anxiety | 2.14 | 13 | 2.15 | 39 | .02 | 0.08 | ns |
| ENVIRONMENTAL SUPPORT | | | | | | | |
| Academic Support | 2.20 | 13 | 3.30 | 38 | .73 | 2.75 | ≤.05 |
| Career Awareness | 2.98 | 13 | 3.12 | 38 | .35 | 1.15 | ns |
| Role Model | 2.52 | 13 | 2.73 | 37 | .31 | 1.06 | ns |
| Equal Opportunity | 2.88 | 12 | 3.23 | 39 | .37 | 1.35 | ≤.10 |

The statistic d is a measure of effect size: (Intervention mean - control mean)/control standard deviation.

Though two opinion differences were found, the research design does not allow one to conclude that the differences were due to the effects of the intervention. These differences may have been pre-existing differences that continued throughout the semester.

## DISCUSSION

Mathematics is the foundation upon which the quantitative disciplines rest. Skill in mathematical computation is acknowledged to be necessary for a student to progress toward a degree in disciplines such as physics and engineering. In a paper presented in 1973 at the Conference on Minority Graduate Education, University of California at Berkeley, Lucy Sells first identified mathematics as "the critical filter" through which a student must pass in order to achieve competence in the scientific and technical realm.

It has become a part of conventional wisdom that the reason more American Indians, Blacks, Hispanics and women do not engage in scientific, engineering, and technological study and careers is that they are ill-prepared in mathematics because of a variety of educational and cultural factors (Sells, 1979). OLLU recognizes that college mathematics courses present problems for some students, and further, that failure to achieve in early mathematics courses can destroy a potential quantitative major. To attack this problem, OLLU designed an intervention aimed at enhancing students' comfort and familiarity with mathematics, especially with the language of mathematics. OLLU used a "study team" approach featuring weekly workshops to provide precalculus students an opportunity to "speak" mathematics, as well as to work on individual weaknesses. The present pilot report was primarily concerned with the effect study teams had on performance.

The results of performance analyses indicated that the study group intervention improved students' performance in precalculus compared to a standard version of the course. The amount of improvement depended upon the students' level of achievement and aptitude at the beginning of the course: low-achieving students profited most, as did high aptitude students, suggesting that the treatment helped to release dormant potential in mathematics.

Note that the control students had four 50-minute periods of instruction (200 minutes) per week compared to the intervention group's three 50-minute periods of instruction (150 minutes) plus the 75-minute study team session (total = 225 minutes) per week. That is, the intervention group had less instruction time but more contact time. It may be said, then, that the improvement on the part of the intervention group was due to more contact time; on the other hand, it can be said that the improvement was all the more dramatic because it occurred in spite of less instruction time. The results do not allow one to decide whether the improvement was due to greater time on precalculus, the study group's content, or some of both.

The groups differed on two of 13 opinion scales, Academic Support and Equal Opportunity. The study group intervention was designed to increase students' feelings of support; the opportunity for active engagement in mathematical activity and in some cases for helping others in the team session may have enhanced the sense of equal opportunity for success.

The success of the intervention in improving performance suggests that both of these are constructive changes, and of course both are consistent with the goals of the intervention. However, the pre-experimental design makes these differences difficult to interpret.

Future semesters of this intervention will include opinion pretests; this will improve the quality of causal inferences about opinion differences due to the intervention. For the present intervention, the striking finding is that the institution appears to have developed an intervention that not only improves performance in mathematics, but *improves it specifically for the lower achieving mathematics students* who represent a largely untapped resource for enlarging the "SET pool" of talent available to meet the needs of our country in the future.

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# APPENDICES

# APPENDIX A

# COLLEGE STUDENT PROTOCOL

College Student Protocol

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. Am. Indian (Please specify the tribe which best describes your heritage.) _____
   ___ e. Hispanic Which of the following best describes your heritage?
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

6. Class:
   ___ a. College freshman
   ___ b. College sophomore
   ___ c. College junior
   ___ d. College senior
   ___ e. Other (e.g., special or temporary student, etc.)
      Specify _____

7. Have you declared a college major?
   ___ a. No
   ___ b. Yes ..... Please specify your major. _____

8. Have you taken any advanced placement tests for college credit?
   ___ a. No
   ___ b. Yes ..... Please list tests taken. _____

9. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Two years of college
   ___ b. Four years of college
   ___ c. One or more years after college
   ___ d. Other Specify _____

10. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

11. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)
   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Work-study
   ___ d. Job other than work-study
   ___ e. Tuition or other scholarship
   ___ f. Loan
   ___ g. Previous personal earnings and savings
   ___ h. GI Bill, ROTC, or other governmental assistance (other than scholarship or loan)
   ___ i. Family trust fund, insurance plan, or other similar arrangement
   ___ j. Other Specify _____

12. You may want to receive help outside your regular college course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems
   ___ f. Increasing reading ability
   ___ g. Developing good study habits
   ___ h. Improving writing ability

13. What is or was the occupation of the person(s) with whom you lived during the years you were growing up? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

_____ _____

14. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average

15. Are you:
___ a. An only child (skip to question 17)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

16. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

17. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

18. Indicate the extent of your mother's education. (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

19. What was the language spoken most often by adults in the household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe .... What is that language? _____
___ d. Other
Specify _____

20. Which of the following did your parent(s)/guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

21. Which of the following comes closest to describing your parent(s)/guardian(s)?
___ a. Do(es) not read at all
___ b. Sometimes read(s)
___ c. Read(s) a lot

22. Which of the following comes closest to describing you?
___ a. Do not read at all
___ b. Sometimes read
___ c. Read a lot

23. How many of these do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

24. From what kind of high school or secondary school did you graduate?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

25. Were you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes.....Please list the math and/or science clubs you belonged to.

_____

_____

_____

_____

26. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL WITH DIRECTIONALITY AND SCALES OF ITEMS

Legend:

| | |
|---|---|
| **SH Study Habits** | **PS Persistence** |
| **AT Attitude toward math/science** | **CV Cultural Value** |
| **SC Self-Concept** | **AS Academic Support** |
| **AX Anxiety** | **AP Aspiration** |
| **VL Value** | **EO Equal Opportunity** |
| **LC Locus of Control** | **RM Role Model** |
| **CA Career Awareness** | |

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of my ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |

| | | | |
|---|---|---|---|
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |

| | | | |
|---|---|---|---|
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

    i. _____

    ii. _____

    iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE COLLEGE STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 38 | CONTROL n = 13 |
| 7. Declared SET majors | 9% | 21% |
| 8. Students taken an advanced placement test | 0% | 7% |
| 9. Higher education expected: | | |
| .Two years of college | 2% | 0% |
| .Four years of college | 42% | 43% |
| .One or more years after college | 55% | 57% |
| 10. Studies most influenced by | | |
| .Parents | 59% | 54% |
| .Another family member | 8% | 8% |
| .Teacher | 18% | 0% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 0% |
| .Friend | 0% | 0% |
| .Science professional | 0% | 8% |
| .Nonscience professional | 0% | 0% |
| .No one at all | 13% | 31% |
| 11. Sources of income[b] | | |
| .Parents/guardians | 58% | 62% |
| .Spouse | 0% | 0% |
| .Work study | 74% | 62% |
| .Job other than work study | 47% | 31% |
| .Tuition or scholarship | 66% | 38%[a] |
| .Loan | 61% | 38% |
| .Grant | 0% | 0% |
| .Personal savings | 29% | 8% |
| .GI Bill, ROTC, etc. | 18% | 15% |
| .Family trust, etc. | 0% | 0% |
| 12. Student needs help in:[b] | | |
| .Counseling on educational plans | 36% | 25% |
| .Counseling on career plans | 62% | 75% |
| .Improving math ability | 56% | 67% |
| .Finding part-time work | 36% | 33% |
| .Counseling on personal problems | 8% | 8% |
| .Increasing reading ability | 15% | 33% |
| .Developing good study habits | 64% | 33%[a] |
| .Improving writing ability | 54% | 25%[a] |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 38 | CONTROL n = 13 |
| 13. Sources of outside income | | |
| .None | 6% | 0% |
| .One | 44% | 62% |
| .Two | 50% | 38% |
| 14. Family income: | | |
| .Below U.S. average | 26% | 36% |
| .About average | 69% | 43% |
| .Above average | 5% | 21% |
| 15. Birth order of student: | | |
| .Only child | 5% | 0% |
| .Oldest child | 48% | 42% |
| .Youngest child | 15% | 29% |
| .In-between child | 32% | 21% |
| 16. Number of siblings: | | |
| .One | 18% | 29% |
| .Two | 32% | 36% |
| .Three or more | 45% | 36% |
| 17. Father's education: | | |
| .Grade school or less | 15% | 14% |
| .Some high school | 15% | 29% |
| .High school graduate | 32% | 7% |
| .Some college | 20% | 36% |
| .College degree or more | 18% | 14% |
| 18. Mother's education: | | |
| .Grade school or less | 20% | 14% |
| .Some high school | 8% | 21% |
| .High school graduate | 38% | 29% |
| .Some college | 25% | 21% |
| .College degree or more | 10% | 14% |
| 19. Language spoken most at home: | | |
| .English | 75% | 43%[a] |
| .Spanish | 22% | 50%[a] |
| .Language of tribe | 0% | 0% |
| .Other | 2% | 7% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 38 | CONTROL n = 13 |
| 20. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 37% | 54% |
| .Attend parent-teacher conferences | 37% | 38% |
| .Visit student's class | 58% | 92%[a] |
| .Phone/visit if there's a problem | 58% | 46% |
| .Do volunteer work | 34% | 46% |
| .Assist student in course selection | 42% | 15%[a] |
| .Assist in student's homework | 61% | 54% |
| 21. Parent(s) read: | | |
| .Not at all | 3% | 0% |
| .Sometimes | 47% | 31% |
| .A lot | 50% | 69% |
| 22. Student reads: | | |
| .Not at all | 5% | 0% |
| .Sometimes | 58% | 54% |
| .A lot | 37% | 46% |
| 23. Items in student's home:[b] | | |
| .Desk | 92% | 85% |
| .Daily newspaper | 79% | 77% |
| .Encyclopedia | 90% | 85% |
| .Typewriter | 85% | 54%[a] |
| .Calculator | 97% | 92% |
| .Television | 95% | 100% |
| .Computer | 36% | 46% |
| .Video Cassette Recorder (VCR) | 90% | 62%[a] |
| Number of support items * | | |
| 25. Member math/science club in high school | 27% | 46% |
| 26. All activities student took part in:[b] | | |
| .Math/science club | 26% | 23% |
| .Field trip | 53% | 54% |
| .Watching science programs on TV | 74% | 62% |
| .Listen to talk by scientist | 32% | 31% |
| .Science/math fair | 32% | 31% |
| .Other science/math competition | 21% | 15% |
| .Play/work in computer lab | 76% | 85% |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

# APPENDIX E

# PERFORMANCE DATA

| INTERVENTION GROUP | | | | CONTROL GROUP | | | |
|---|---|---|---|---|---|---|---|
| NUM | MC1 | MC2 | SATM | NUM | MC1 | MC2 | SATM |
| 001 | 17 | 87 | -- | 501 | 57 | 89 | 600 |
| 002 | 33 | 65 | 340 | 502 | 37 | 66 | 380 |
| 003 | 20 | 16 | 330 | 503 | 57 | 66 | 550 |
| 004 | 43 | 86 | 380 | 504 | 40 | 64 | 380 |
| 005 | 23 | 100 | 450 | 505 | 40 | 66 | 430 |
| 006 | 60 | 54 | 410 | 506 | 27 | -- | 400 |
| 007 | 63 | 68 | 420 | 507 | 27 | 54 | 550 |
| 008 | 63 | 80 | 500 | 508 | 47 | 66 | 310 |
| 009 | 40 | 81 | 380 | 509 | 30 | -- | 390 |
| 010 | -- | 56 | 350 | 510 | -- | 39 | 390 |
| 011 | 53 | 88 | 510 | 511 | 73 | 73 | 460 |
| 012 | 87 | 96 | 500 | 512 | 20 | 18 | -- |
| 013 | 23 | 71 | 405 | 516 | 47 | 86 | 520 |
| 014 | 40 | 80 | 360 | 517 | 23 | 74 | 330 |
| 015 | 63 | -- | 405 | | | | |
| 016 | 47 | 65 | 420 | | | | |
| 017 | 53 | 100 | 505 | | | | |
| 018 | 50 | 43 | 320 | | | | |
| 020 | 37 | 75 | 470 | | | | |
| 022 | 73 | 78 | 405 | | | | |
| 023 | 57 | 79 | 480 | | | | |
| 024 | 30 | 73 | 440 | | | | |
| 025 | 60 | 82 | 480 | | | | |

| INTERVENTION GROUP | | | | CONTROL GROUP | | | |
|---|---|---|---|---|---|---|---|
| NUM | MC1 | MC2 | SATM | NUM | MC1 | MC2 | SATM |
| 027 | 77 | 88 | 540 | | | | |
| 028 | 23 | -- | 480 | | | | |
| 040 | 83 | 75 | 470 | | | | |
| 041 | 33 | 81 | 450 | | | | |
| 042 | 47 | 86 | 360 | | | | |
| 043 | 30 | 64 | 405 | | | | |
| 044 | 47 | 61 | 435 | | | | |
| 045 | -- | 27 | 320 | | | | |
| 047 | 30 | 77 | 600 | | | | |
| 048 | 67 | 86 | 520 | | | | |
| 049 | 57 | 69 | 420 | | | | |
| 050 | 13 | 82 | 480 | | | | |
| 051 | 43 | 54 | 320 | | | | |
| 052 | 63 | 76 | 340 | | | | |
| 053 | 47 | 77 | 380 | | | | |
| 054 | 47 | 91 | 390 | | | | |
| 055 | 33 | 45 | 435 | | | | |
| 056 | -- | 36 | 480 | | | | |
| 057 | -- | -- | 360 | | | | |

NOTE: Missing data are indicated by "--".

# APPENDIX F

# PERCENT RESPONSE ON ITEMS OF THE OPINION PROTOCOL

| OPINION ITEMS | INTERVENTION N = 39 | | | | CONTROL N = 13 | | | |
|---|---|---|---|---|---|---|---|---|
| | % SA | % A | % D | % SD | % SA | % A | % D | % SD |
| SA = Strongly Agree A = Agree D = Disagree SD = Strongly Disagree | | | | | | | | |
| 1. Science is of great importance to a country's development | 79 | 21 | 0 | 0 | 69 | 31 | 0 | 0 |
| 2. I feel I have the ability to learn more science | 49 | 49 | 3 | 0 | 69 | 23 | 8 | 0 |
| 3. I worry about being able to understand my science assignments | 23 | 59 | 15 | 3 | 23 | 38 | 31 | 8 |
| 4. I want too improve my math skills | 77 | 21 | 3 | 0 | 54 | 46 | 0 | 0 |
| 5. I would like to spend less of my school time studying science. | 3[b] | 31 | 49 | 15 | 0 | 31 | 62 | 8 |
| 6. Word problems in math make me nervous | 44 | 36 | 21 | 0 | 46 | 31 | 8 | 15 |
| 7. I try to be one of the best students in my classes | 18 | 46 | 36 | 0 | 8 | 77 | 15 | 0 |
| 8. Math is boring | 5 | 18 | 44 | 33 | 8 | 31 | 54 | 8 |
| 9. There is little need for mathematics in most jobs | 0 | 10 | 38 | 51 | 0 | 8 | 23 | 69 |
| 10. I am not very good at math | 8 | 28 | 41 | 23 | 23 | 23 | 31 | 23 |
| 11. Science is not as important as people think | 0 | 3 | 41 | 56 | 0 | 0 | 46 | 54 |
| 12. I enjoy solving math problems | 23 | 51 | 21 | 5 | 15 | 54 | 31 | 0 |
| 13. I am afraid I am not going to know the answer when I am called on in my math class | 23 | 51 | 26 | 0 | 23 | 62 | 15 | 0 |
| 14. I don't want to take any more math courses | 5 | 26 | 47 | 23 | 15 | 38 | 46 | 0 |
| 15. Science is interesting to me | 36 | 44 | 21 | 0 | 38 | 46 | 15 | 0 |
| 16. Most science courses are too hard for me | 5 | 31 | 59 | 5 | 0 | 23 | 69 | 8 |
| 17. Mathematics comes in handy even outside of class | 38 | 59 | 0 | 0 | 15 | 85 | 0 | 0 |
| 18. I feel tense when I have to work a math problem | 8 | 33 | 49 | 10 | 0 | 62 | 38 | 8 |
| 19. I only do as much as I have to in my science classes | 3 | 51 | 38 | 8 | 0 | 54 | 38 | 8 |

| OPINION ITEMS | INTERVENTION N = 39 | | | | CONTROL N = 13 | | | |
|---|---|---|---|---|---|---|---|---|
| | % SA | % A | % D | % SD | % SA | % A | % D | % SD |
| SA = Strongly Agree A = Agree D = Disagree SD = Strongly Disagree | | | | | | | | |
| 20. I am good at figuring out math problems | 8 | 51 | 36 | 5 | 8 | 15 | 77 | 0 |
| 21. School counselors are a real help | 21 | 51 | 23 | 0 | 15 | 38 | 46 | 0 |
| 22. I prefer to study alone | 18 | 38 | 26 | 18 | 23 | 38 | 31 | 8 |
| 23. Many people of my ethnic/racial group are successful scientists | 18 | 36 | 38 | 5 | 8 | 38 | 38 | 15 |
| 24. None of my friends have ever been good at math | 3 | 15 | 51 | 31 | 0 | 15 | 38 | 46 |
| 25. There are many opportunities for women in engineering | 46[b] | 49 | 26 | 0 | 31 | 69 | 0 | 0 |
| 26. In my ethnic/ racial group we think highly of someone who succeeds in a field like engineering | 54 | 46 | 0 | 0 | 38[b] | 46 | 0 | 8 |
| 27. Most scientists enjoy their work | 59[b] | 36 | 0 | 3 | 23 | 77 | 0 | 0 |
| 28. I am seriously considering a career in science | 31[b] | 15 | 33 | 18 | 38 | 15 | 38 | 8 |
| 29. I cannot imagine myself as an engineer or a scientist | 18 | 31 | 33 | 18 | 15 | 23 | 62 | 0 |
| 30. My high school counselors would have preferred that I had taken basic math rather than algebra | 3[b] | 3 | 36 | 56 | 8 | 15 | 31 | 46 |
| 31. Success is more a matter of luck than of ability | 5 | 0 | 21 | 74 | 0 | 0 | 31 | 69 |
| 32. I don't know what I'd need to do in order to become a scientist | 8 | 38 | 44 | 10 | 8 | 38 | 54 | 0 |
| 33. Scientists tend to be unfriendly people | 5 | 8 | 56 | 31 | 0 | 8 | 69 | 23 |
| 34. I've never met an engineer | 0 | 28 | 46 | 26 | 8 | 23 | 54 | 15 |
| 35. Scientists do boring work. | 5[b] | 10 | 54 | 31 | 0 | 8 | 69 | 23 |
| 36. There is practically no discrimination against women in science jobs | 8 | 46 | 36 | 10 | 0[b] | 15 | 54 | 23 |

| OPINION ITEMS | INTERVENTION N = 39 | | | | CONTROL N = 13 | | | |
|---|---|---|---|---|---|---|---|---|
| | % SA | % A | % D | % SD | % SA | % A | % D | % SD |
| SA = Strongly Agree A = Agree D = Disagree SD = Strongly Disagree | | | | | | | | |
| 37. When I make plans I am almost certain I can make them work | 10 | 72 | 18 | 0 | 31 | 54 | 15 | 0 |
| 38. I have trouble keeping my mind from wandering as I study | 15 | 54 | 26 | 5 | 23 | 54 | 23 | 0 |
| 39. You have to be a lot smarter than average to be a scientist | 10 | 46 | 36 | 8 | 23 | 23 | 54 | 0 |
| 40. Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. | 62 | 31 | 8 | 0 | 54 | 38 | 0 | 8 |
| 41. There are lots of jobs I can do with a college degree in science | 38 | 56 | 5 | 0 | 31 | 54 | 15 | 0 |
| 42. Women are not as good in science as men are | 3 | 0 | 28 | 69 | 0 | 0 | 15 | 85 |
| 43. I make it a point to get my assignments in on time | 38 | 54 | 8 | 0 | 38 | 46 | 15 | 0 |
| 44. I dread taking tests even when I am reasonably well prepared | 18 | 54 | 23 | 5 | 8 | 69 | 23 | 0 |
| 45. The things that happen to me are my own doing | 41 | 49 | 10 | 0 | 38 | 61 | 0 | 0 |
| 46. I find myself losing interest in my studies by the middle of the semester | 15 | 41 | 36 | 8 | 15 | 31 | 54 | 0 |
| 47. There is an adult whom I look up to who is a scientist | 21[b] | 18 | 49 | 10 | 15 | 31 | 31 | 23 |
| 48. My family cares a lot about education | 77 | 21 | 3 | 0 | 69 | 31 | 0 | 0 |
| 49. I often feel like quitting school | 8 | 18 | 44 | 31 | 8[b] | 8 | 31 | 46 |
| 50. Tests make me so nervous that I don't do as well on them as I could | 13 | 41 | 41 | 5 | 31 | 15 | 54 | 0 |
| 51. I could never understand physics | 18[b] | 28 | 36 | 15 | 31 | 15 | 54 | 0 |
| 52. If I run into problems concerning school, I have some- one who will listen to me and help me | 46 | 44 | 10 | 0 | 23 | 46 | 31 | 0 |

| OPINION ITEMS | INTERVENTION N = 39 | | | | CONTROL N = 13 | | | |
|---|---|---|---|---|---|---|---|---|
| | % SA | % A | % D | % SD | % SA | % A | % D | % SD |
| **SA = Strongly Agree A = Agree D = Disagree SD = Strongly Disagree** | | | | | | | | |
| 53. It matters to me to be considered a successful member of my ethnic/racial group | 62 | 28 | 10 | 0 | 54 | 38 | 8 | 0 |
| 54. I study each day rather than just before exams | 15 | 44 | 36 | 5 | 0 | 54 | 38 | 8 |
| 55. Once I start something, I finish it | 26[b] | 56 | 15 | 0 | 23 | 54 | 23 | 0 |

[b] One case missing

# CASET RESEARCH REPORT:

# PAUL QUINN COLLEGE

# INTERVENTIONS

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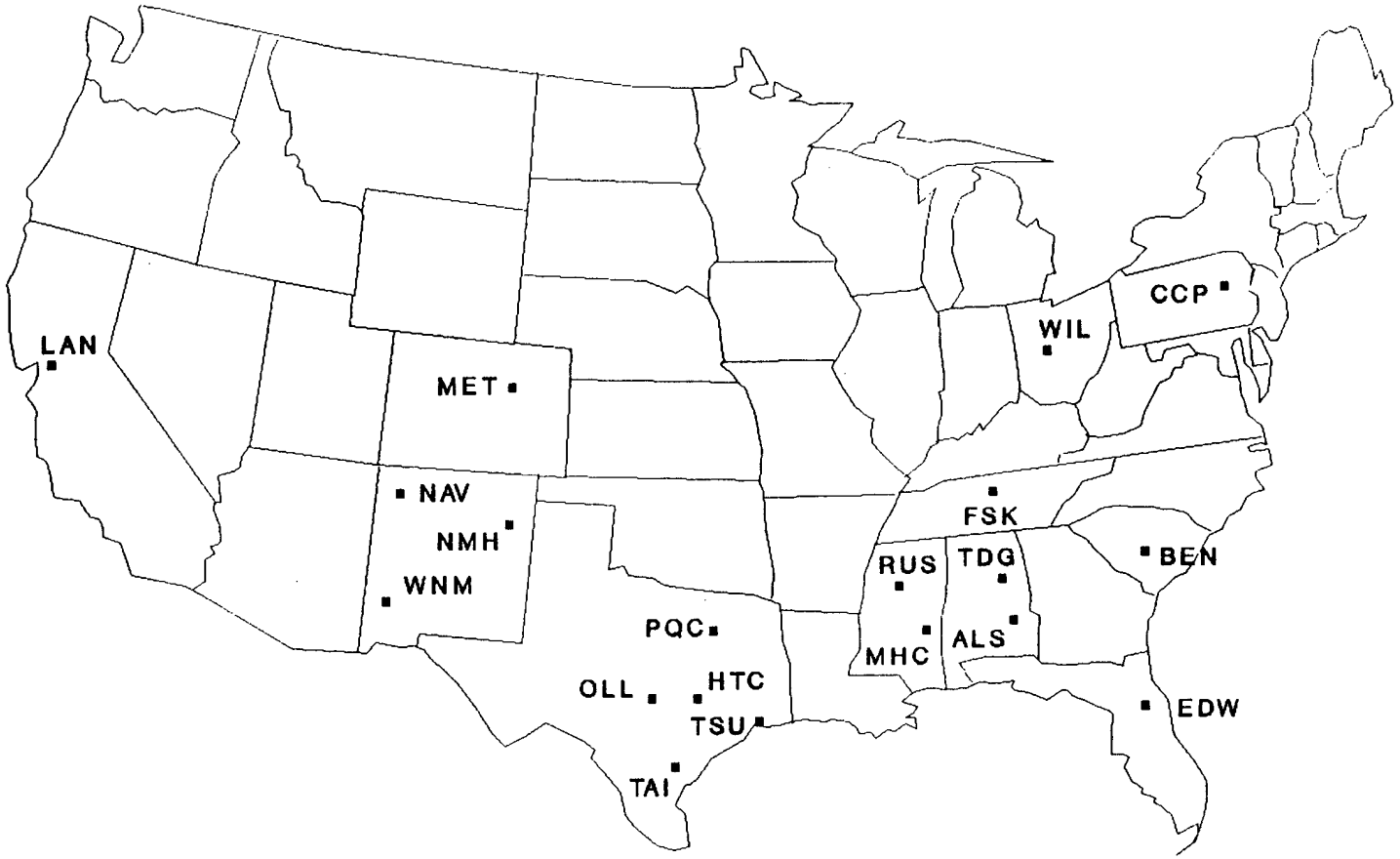
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enables CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during the years 1988 through 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, with students; each collected data to measure the effects of those interventions. Data collected came from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention-group students, as well as on a control-group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research are described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF PAUL QUINN COLLEGE

Paul Quinn College is a historically Black, four-year, private, coeducational institution located in Waco, Texas. The campus community consists of approximately 500 students and 51 faculty members. The student body is approximately 49 percent female and 51 percent male and is predominantly Black. The president of Paul Quinn College is Dr. Warren Morgan.

The College offers undergraduate degrees in a number of academic areas. Majors in quantitative subjects include biological sciences, biomedical technologies, botany/plant sciences, computer science, and mathematics.

Waco has a population of approximately 103,000 in its metropolitan area. The state of Texas has a population of just over 17 million. According to U.S. Census Bureau estimates, the adult population of Texas is 66 percent Anglo, 11 percent Black, 21 percent Hispanic, and 2 percent other ethnic origins. Waco has a number of other institutions of higher learning, including Baylor University, McLennan Community College, and Texas State Technical Institute - Waco Campus.

# PART II

# SUMMARY OF THE PAUL QUINN COLLEGE

# INTERVENTIONS

This report summarizes the two interventions conducted by Paul Quinn College, a historically Black, four-year private institution which at the time of these interventions was located in Waco, Texas. The College has since relocated to Dallas, Texas. Paul Quinn College is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Paul Quinn College Intervention Activities:

In Spring and Summer of 1990, Paul Quinn College conducted enrichment classes for middle-school students in mathematics, computer science, and natural science. Supplementary activities included viewing of science videos, and field trips. Participants were minority and female seventh- and eighth-grade students recruited from area schools. The Spring intervention was conducted on eight sequential Saturdays; the Summer intervention was a three-week summer academy.

Findings:

- Both interventions showed more positive performance effects in science than in mathematics.
- The Summer intervention showed stronger positive effects on performance than did the Spring intervention.
- The Spring intervention also tested for effects on students' opinions, and found a positive effect.

Recommendations:

- The discrepancy in performance gain between science and math content points up a fundamental challenge for designers of mathematics interventions: Identifying the specific topics that students are **ready to learn.**
- Careful and sensitive testing, coupled with frank communication with regular teachers of the target age group, can illuminate "gaps" in background knowledge, particularly in mathematics, which need to be filled before students progress further. These may also point up opportunities for enrichment which students are ready to understand.

# PART III

# CASE STUDY OF THE PAUL QUINN COLLEGE (PQC)

# 1990 SPRING SEMESTER INTERVENTION

## ABSTRACT

In the spring of 1990 Paul Quinn College, Waco, Texas, conducted and tested against a control group a Saturday Academy in science and mathematics for middle school and intermediate school students. Participants were 81 7th- and 8th-grade students (56 girls and 25 boys) from four Waco-area schools; a majority of the students were Black. The intervention was repeated in the summer of 1990.

The Paul Quinn College program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance in biology, chemistry, computer science, and mathematics, and (b) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* Major components of the intervention were instruction in biology, chemistry, computer science, and mathematics provided by college professors and instructors, along with question-and-answer periods and science videos. Intervention group students also took three field trips to scientific facilities, including an all-day trip to the NASA/Johnson Space Center in Houston, Texas.

*DATA:* All the participants furnished demographic data through the CASET Middle/Junior High School Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were nationally standardized achievement test scores and pretest and posttest scores on institution-specific content tests in biology, chemistry, computer science, and mathematics.

The outcome measures of performance were posttest scores on the four content tests and an overall mean posttest score for all four content tests. The preintervention measures of performance were California Test of Basic Skills (CTBS) percentile, Science Research Associates (SRA) achievement test percentile, pretest scores on the four content tests, and an overall mean pretest score for all four content tests.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design; comparisons on all preintervention measures found significant differences between the intervention and control groups, most favoring the control group.

*FINDINGS:* The intervention had some positive effect on the participants and can be considered a successful intervention in that the hypotheses of enhanced performance on the content tests and enhanced opinions about SET fields and careers received some support. Most significant preexisting differences between the intervention and control groups favored the control group, and results showed that some of these differences were maintained at the posttest. The control group displayed superior mathematics performance on both the pretest and the posttest. In biology and computer science, the intervention enhanced the performance of students who began with low pretest scores. The intervention had significant positive effects on the opinions of students with low pretest SET Goal, Academic Support, and Career Awareness scores. Because over one-third of all students had no posttest data, these findings are difficult to interpret.

## DESCRIPTION OF THE INTERVENTION

A Saturday Science Academy for seventh- and eighth-grade students was conducted at Paul Quinn College during the spring of 1990. The primary objective was to motivate minority and women students at an early age to develop interests and awareness of the opportunities available in science and technology.
A second goal of the program was to encourage young students to choose the college preparatory curriculum upon entering high school.

The program was intended to allow college professors and instructors an opportunity to play an active and productive role in meeting these objectives by serving as role models and by providing lectures and "hands on" laboratory experiences. An expected outcome of the project was an enhancement of the capability of Paul Quinn College to improve the access for pre-college minority students to career choices in science, engineering, and technology.

Fifty-four seventh- and eighth-grade students recruited from four local middle schools in the Waco, Texas area participated in the nine-week program. Students were divided into two groups which rotated through four 60-minute instructional periods each Saturday, with breaks and other activities.

The schedule was set up as follows:

| TIME | STUDENT GROUP I SUBJECT/ACTIVITY | STUDENT GROUP II SUBJECT/ACTIVITY |
|---|---|---|
| 9:00 - 10:00 a.m. | Mathematics | Biology |
| 10:00 - 11:00 a.m. | Biology | Mathematics |
| 11:00 - 11:15 a.m. | Break (refreshments) | |
| 11:15 - 12:00 noon | Video (Scientific Adventures) | |
| 12:00 noon - 1:00 p.m. | Lunch/Question & Answer Period | |
| 1:00 - 2:00 p.m. | Chemistry | Computer Science |
| 2:00 - 3:00 p.m. | Computer Science | Chemistry |

The videos shown were as follows:

- Life on Earth: Conquest of the Air
- Life on Earth: Mammals
- Life on Earth: Carnivores and Prey
- Life on Earth: The Primates
- NOVA: Meteorites and Volcanos
- Dinosaurs and Asteroids
- Nature: The Wild Otter
- Nature: Insect Secret Weapons

Topics covered during the instructional periods were as follows:

- *Biology*

The Cell and the Microscope: Development of Infusion for Protozoan Culture

Diffusion and Osmosis

Properties of Chlorophyll: Paper Chromatography of Chlorophyll; Photosynthesis

Study of Protozoa from Developed Infusion;

Preparation of Agar and Plating in Petri Dishes: Bacteria from air, hands, hair, etc.

Observation of Petri plates with the naked eye and microscopically

The Animal and Plant Kingdoms

Ecology and Man's Impact on the Environment

- *Chemistry*

How to do an experiment and what scientists do: Experimenting with food and common kitchen items; explanation of laboratory procedure and why a procedure is necessary; laboratory safety

Solutions: Examples of solutions; sourball ade; red cabbage indicator (RCI)

Suspensions, Colloids, and Emulsions: Examples of each; salad dressing (a liquid suspended in a liquid); liquid food and the Tyndall Effect

Carbohydrates and Fats: Examples of each; nut butter (pressing out oils); test for starches using iodine solution

Proteins: Examples of proteins; the properties of egg whites; gelatin (sol-gel transformation)

Chemical reactions: Explanation of reactions and types; lemon fizz (a reaction forms a gas); fruit and tea punch (testing for iron)

Plants we eat: Food for energy; how water moves up stems; spinach (changes in chlorophyll)

Enzymes: Explanation and examples; acids, bases, and enzyme action

- *Computer Science*

Microcomputer Concepts and Terminology: Historical Overview; Components of a Microcomputer System; Storage Methods and Devices; Peripheral Devices

Word Processing: General Concepts and Terminology; Functions; Exercises

BASIC Programming: Concepts and Terminology; a fun BASIC Exercise

A General Mathematics Program: Functions; Exercises

- *Mathematics*

  Ordering Numbers; Rounding Numbers; Equivalent Numbers Exponents; Fractions; Decimals
  Integer: Addition, Subtraction, Multiplication, and Division; Word Problems
  Formulas; Proportions; Percentages; Measurement; Averages; Probability; Graphs and Tables; Geometric Formulas; Geometric Properties; Variables

Students in the intervention-group went on three field trips: One to the Texas State Technological Institute, another to Chrysler Technologies Airborne Systems, both in Waco, and an all-day trip to the NASA/Johnson Space Center, in Houston, Texas.

Saturday Academy sessions were held on eight of the Saturdays from March 24, 1990, through May 26, 1990, inclusive. On Saturday, May 5, 1990, the intervention participants traveled to Houston to tour NASA/Johnson Space Center.

The CASET Project Director for this project was Dr. Weldon J. Walton, Chairman, Division of Arts and Sciences, Paul Quinn College. The Administrative Assistant and Co-director was Mrs. Delores Brown, Science Teacher, Waco Independent School District; Mrs. Brown also served as School Liaison Officer. Secretary was Mrs. Dorothy K. Johnson, Secretary, Division of Arts and Sciences, Paul Quinn College. Saturday Academy instructors were: Biology, Dr. Norman G. Ashford, Professor of Biology, Paul Quinn College; Chemistry: Mr. Ross Marano, Assistant Professor of Chemistry, Paul Quinn College; Mathematics: Dr. Bob Haley, Instructor of Mathematics, Waco Independent School District, and Adjunct Instructor of Mathematics, Paul Quinn College; and Computer Science: Mr. Anthony C. Billings, Instructor of Computer Science, McLennan Community College. Mr. James A. Terry, senior biology major at Paul Quinn College, served as Laboratory Coordinator and Student Assistant for the project.

The intervention's two major hypotheses were that the intervention laboratory activities would: (a) enhance performance in biology, chemistry, mathematics, and computer science, and (b) enhance opinions about SET fields and careers.

## METHOD

### SUBJECTS

Subjects were minority and female seventh- and eighth- grade students from four Waco-area middle and intermediate schools. A control-group was identified, consisting of students demographically similar to the intervention-group. The control-group did not participate in any intervention activities. All demographic, opinion and performance data were collected from the control-group as well as the intervention-group.

Ninety sets of protocols were received from intervention-and control-group students. Nine were removed because they did not represent the populations that are the focus of this study: one of those eliminated was not a United States citizen, and eight belonged to groups which are not underrepresented in SET fields: one was an Asian-American, and seven were Anglo males.

Eighty-one sets of data were analyzed: 54 from the intervention-group and 27 from the control-group. Table 1 shows the sex and ethnic breakdown for the intervention-and control-groups.

Table 1

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | 1 | 0 | 0 | 0 | 1 | 0 |
| Anglo | 11 | - | 4 | - | 15 | - |
| Black | 1 | 8 | 29 | 15 | 30 | 23 |
| Hispanic | 4 | 2 | 4 | 0 | 8 | 2 |
| Unknown | 0 | - | 2 | - | 2 | - |
| **TOTAL** | **17** | **10** | **39** | **15** | **56** | **25** |

CASET Protocols and Other Instruments

Demographic and descriptive data about the subjects were developed through the CASET Middle/Junior High School Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

The hypotheses tested were that the intervention would enhance the performance of participants in biology, chemistry, mathematics, and computer science, and would change opinions of participants in ways thought to be favorable to continuing in SET studies and careers. To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gives a scalar measurement for that variable. Thus the completed Opinion Protocol provides a scalar measuring each of the thirteen variables.

For middle school and junior high school students, CASET adapted the CASET Opinion Protocol items, simplifying wording and concepts to make them more appropriate to the younger age group, while addressing the same thirteen attitudinal variables as the older-level Opinion Protocol. An additional change is that for the younger students, there are only two possible answers: "yes" and "no" rather than the four-point scale of the older students' Opinion Protocol.

The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B.

The protocol was administered to intervention-and control-group students before and after the intervention activity.

To assess student performance before and after the intervention, a number of measures were used. Pre- and posttests of content in each of the four content areas were developed, administered, and scored by project faculty, and the scores

submitted to CASET. The mean of the four scores provided a total content score. The biology section consisted of 17 questions: eight true-or-false, eight multiple-choice, and one short-answer; the chemistry test consisted of 10 questions: 5 true-or-false and 5 multiple-choice; the computer science test had 15 questions: 2 true-or-false and 14 multiple-choice; and the mathematics test consisted of 18 multiple- choice questions.

In addition, the institution supplied school transcripts for intervention-and control-group students, which included scores on a number of nationally standardized achievement tests. Scores for the California Test of Basic Skills (CTBS) were available for a number of students, as were the Science Research Associates (SRA) achievement test scores. All these performance scores, together with the completed CASET Student Protocols and preintervention and postintervention Opinion Protocols, were submitted to CASET for analysis.

### Procedure

At the beginning of the intervention, parents of participants and control-group members signed consent forms and transcript release forms. The CASET Student Protocol and the Opinion Protocol: were administered to intervention-and control-group students, along with the faculty-developed tests of content described above.

Intervention-group students then took part in the intervention activities. Attendance records for each student were maintained by the institution and submitted to CASET, so that in analyzing the impact of the intervention CASET had documentation of each student's level of participation. After the intervention, the postintervention Opinion Protocol was administered to intervention-and control-group students, along with the postintervention tests of content mastery. The attendance records, content test scores, school transcripts, and standardized test scores were forwarded to CASET, along with the completed CASET instruments.

The items of the Opinion Protocol were coded by CASET according to the thirteen scales they represented. Scoring of the positively worded items on the Opinion Protocol was reversed so that scores could be totaled meaningfully (see Appendix B). The scales were organized into three constructs - SET Goal, Environmental Support, and Attitude--as shown in Appendix C.

## RESULTS

### Methodological Issues

The intervention's two major hypotheses were that the intervention activities would: (a) enhance performance on the content tests, and (b) enhance opinions about SET fields and careers. The intervention had preintervention and postintervention measures of opinion and performance for most participants, and was analyzed as a *nonequivalent control-group* design. This type of quasi-experimental design has one major weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty may be addressed by analyzing the influence of preexisting characteristics on students' performance and opinion; the analysis of covariance (ANCOVA), adjusting for preintervention performance or opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that may have existed prior to the intervention.

Demographic Results

The comparability of the intervention-and control-groups was examined by testing for differences on the items of the Student Protocol. The complete results are given in Appendix D. Of the 48 comparisons, the groups differed on only two: (a) more students in the intervention-group reported that they were influenced in their studies most by their parents (intervention = 76%, control = 52%); and (b) more control-students had calculators in their homes (96% vs. 74%). Based on finding only two differences, the groups were judged to be comparable on demographic characteristics prior to the intervention.

Performance Measures

*Group differences in performance.* The six preintervention measures and the four postintervention measures of performance were tested for group differences, and the results are given in Table 2. Note that the control-group outperformed the intervention-group on two pretest measures--the SRA achievement test and the faculty-generated mathematics test--and one posttest measure--the same mathematics test. To control for potential differences in changes between the groups, ANCOVAs that adjusted for preintervention scores were completed.

**Table 2**

**GROUP COMPARISONS OF PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | SIG P |
|---|---|---|---|---|---|---|
| CTBS Percentile | Control<br>Intervention | 11<br>28 | 62.55<br>53.25 | 20.91<br>23.78 | -1.13<br>(37) | ns |
| SRA Percentile | Control<br>Intervention | 5<br>18 | 89.40<br>56.11 | 10.69<br>21.08 | -3.37<br>(21) | ≤.01 |
| Biology Pretest | Control<br>Intervention | 27<br>54 | 38.07<br>41.83 | 12.22<br>12.10 | 1.31<br>(79) | ns |
| Chemistry Pretest | Control<br>Intervention | 27<br>54 | 75.56<br>73.89 | 9.74<br>11.88 | -0.63<br>(79) | ns |
| Computer Science Pretest | Control<br>Intervention | 27<br>54 | 64.07<br>68.63 | 11.54<br>13.07 | 1.54<br>(79) | ns |
| Math Pretest | Control<br>Intervention | 27<br>52 | 60.41<br>49.98 | 11.87<br>13.96 | -3.31<br>(77) | ≤.01 |
| Content Pretest | Control<br>Intervention | 27<br>52 | 59.53<br>58.62 | 8.02<br>7.65 | -0.49<br>(77) | ns |
| Biology Posttest | Control<br>Intervention | 21<br>32 | 40.38<br>44.88 | 11.62<br>13.08 | 1.28<br>(51) | ns |

GROUP COMPARISONS OF PERFORMANCE MEASURES

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | SIG p |
|---|---|---|---|---|---|---|
| Chemistry Posttest | Control<br>Intervention | 21<br>33 | 80.48<br>77.27 | 9.74<br>12.32 | -1.01<br>(52) | ns |
| Computer Science Posttest | Control<br>Intervention | 21<br>33 | 65.62<br>69.24 | 11.39<br>13.16 | 1.04<br>(52) | ns |
| Math Posttest | Control<br>Intervention | 20<br>33 | 66.70<br>51.91 | 12.19<br>16.31 | -3.50<br>(51) | ≤.01 |
| Content Posttest | Control<br>Intervention | 20<br>31 | 63.45<br>61.42 | 7.48<br>9.04 | -0.84<br>(49) | ns |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

*Group differences after adjusting for pretests.* A hierarchical ANCOVA procedure adjusted for pretest scores before comparing groups on postintervention performance measures; the results are given in Table 3. This table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding the first and each subsequent variable to the multiple regression equation (one variable per row), and the significance test of each variable's contribution toward explaining the dependent variable. The columns of the table include the cumulative percentage of explained variance (cum $R^2$), the variable's contribution to explained variance ($sR^2$), test of the variable's contribution ($F(sR^2)$), and the test's degrees of freedom (df). Because the hypothesis was directional--improvement for the intervention-group the test statistics were compared to one-tailed probability levels; for F statistics, this involved converting from the F to t statistic ($F = t^2$), and determining the corresponding one-tailed critical value.

The results in Table 3 demonstrated that the control-group outperformed the intervention-group on the mathematics test, and that there were significant interactions between prior performance and group membership for biology test scores and computer science test scores. These significant interactions indicated that the relationship between prior scores and the final scores was different in the two groups.

**Table 3**

HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION - PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Biology | PRETEST | .0859 | .0859 | 4.79 | 1,51 | ≤.05 |
| | + GROUP | .1077 | .0218 | 1.22 | 1,50 | ns |
| | + PRE-x-GROUP | .1823 | .0746 | 4.47 | 1,49 | ≤.05 |

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION - PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Chemistry | PRETEST | .2106 | .2106 | 13.87 | 1,52 | ≤.01 |
| | + GROUP | .2178 | .0073 | 0.47 | 1,51 | ns |
| | + PRE-x-GROUP | .2357 | .0178 | 1.17 | 1,50 | ns |
| Computer Science | PRETEST | .3037 | .3037 | 22.68 | 1,52 | ≤.01 |
| | + GROUP | .3070 | .0033 | 0.24 | 1,51 | ns |
| | + PRE-x-GROUP | .3399 | .0328 | 2.49 | 1,50 | ≤.10 |
| Mathematics | PRETEST | .4356 | .4356 | 39.37 | 1,51 | ≤.01 |
| | + GROUP | .4843 | .0486 | 4.71 | 1,50 | ≤.05 |
| | + PRE-x-GROUP | .4844 | .0001 | 0.01 | 1,49 | ns |
| Content Total | PRETEST | .5198 | .5198 | 53.03 | 1,49 | ≤.01 |
| | + GROUP | .5222 | .0024 | 0.25 | 1,48 | ns |
| | + PRE-x-GROUP | .5246 | .0024 | 0.24 | 1,47 | ns |

All models were analyzed as one-tailed tests.

* Three models of independent variables were tested for each dependent variable: (1) PRETEST alone; (2) PRETEST and ('+') GROUP; (3) PRETEST and GROUP and PRE-by-GROUP INTERACTION.

The interactions were analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of pretest scores for which the groups differed.

Figures 1 and 2 show the nonparallel regression lines which indicate that for students with lower prior performance, the intervention-group students outperformed the control-group students.

**Figure 1**

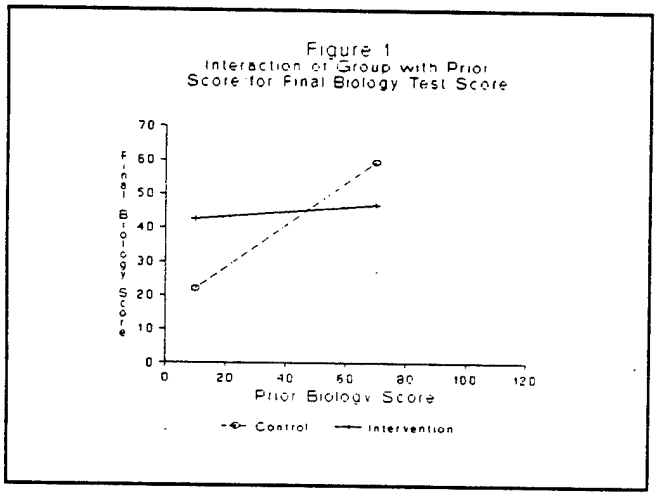
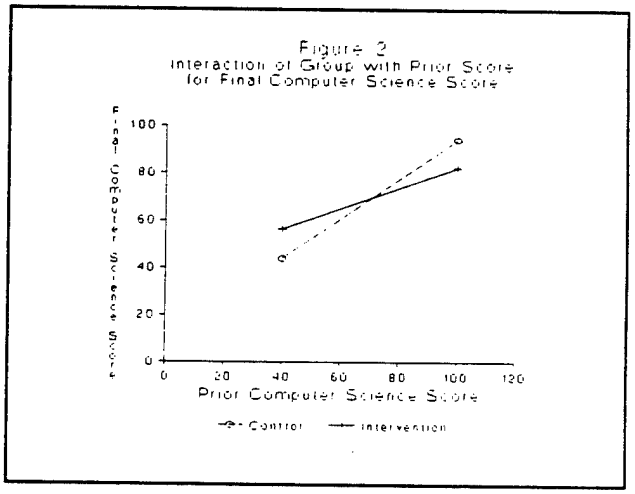



**Figure 2**



In Figure 1, for students with prior biology test scores at or below 39 (overall $\underline{M}$ = 41), the intervention-group outperformed the control-group on the final biology test; the control-group outperformed the intervention-group only for students with prior biology test scores ranging from 56 to 70.

Figure 2 indicates that of those students with prior computer science test scores less than 64, the intervention-group had higher final computer science test scores than did the control-group students; for students with prior computer science scores ranging from 78 to 100, the control-group had higher final computer science test scores.

For both biology and computer science tests, the intervention enhanced the performance of the students who began with lower scores.

*Interrelationships among performance.* The interrelatedness of the performance measures was examined through intercorrelations, presented in Table 4. The significant correlations between pretest and posttest occasions indicated that the tests were somewhat reliable over the time period of this intervention. The nonsignificant correlations between some content tests indicated that the different content tests were measuring different aspects of academic performance, and not some unitary characteristic, such as intelligence.

**Table 4**

**INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a]**

| TEST (n) | PreB Sig p | PreC Sig p | PreCS Sig p | PreM Sig p | PreCt Sig p | PstB Sig p | PstC Sig p | PstCS Sig p | PstM Sig p |
|---|---|---|---|---|---|---|---|---|---|
| PreC (81) | .08 ns | 1.00 | | | | | | | |
| PreCS (81) | .42 ≤.05 | .10 ns | 1.00 | | | | | | |
| PreM (79) | -.02 ns | .27 ≤.01 | .17 ≤.10 | 1.00 | | | | | |
| PreCt (79) | .59 ≤.01 | .55 ≤.01 | .69 ≤.01 | .61 ≤.01 | 1.00 | | | | |
| PstB (53) | .29 ≤.05 | .12 ns | .27 ≤.05 | .21 ≤.05 | .38 ≤.01 | 1.00 | | | |
| PstC (54) | .19 ≤.05 | .46 ≤.01 | .27 ≤.05 | .33 ≤.01 | .52 ≤.01 | .17 ns | 1.00 | | |
| PstCS (54) | .30 ≤.05 | .16 ns | .55 ≤.01 | .14 ns | .47 ≤.01 | .34 ≤.01 | .12 ns | 1.00 | |
| PstM (53) | -.05 ns | .38 ≤.01 | .17 ns | .66 ≤.01 | .50 ≤.01 | .01 ns | .48 ≤.01 | .21 ≤.10 | 1.00 |

| INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| PstCt (51) | .26 ≤.05 | .45 ≤.01 | .46 ≤.01 | .55 ≤.01 | .72 ≤.01 | .55 ≤.01 | .66 ≤.01 | .63 ≤.01 | .71 ≤.01 |

[a] All correlations were analyzed as two-tailed tests.
PreC/PstC = Pre- & Post-Chemistry;
PreCt/PstCt = Pre- & Post-Content
PreB/PstB = Pre- & Post-Biology
PreCt/PstCt = Pre- & Post-Computer Science
PreM/PstM = Pre- & Post-Math

*Correlations between participation and performance.* The five postintervention performance measures were correlated with attendance at the eight Saturday classes and the three field trips. There were no significant correlations between these two sets of measures. Since content tests were relatively brief, the failure to find significant correlations between participation and performance is hard to assess.

**Table 5**

| CORRELATIONS BETWEEN PARTICIPATION AND PERFORMANCE | | |
|---|---|---|
| | **Saturday Classes** | **Field Trips** |
| Post-Biology (n = 32) | .18 | .05 |
| Post-Chemistry (n = 33) | -.12 | -.18 |
| Post-Computer Sci. (n = 33) | -.11 | -.16 |
| Post-Mathematics (n = 33) | .09 | -.10 |
| Post-Content (n = 31) | .04 | -.12 |

Opinion Measures

*Group differences on pre- and postintervention measures.* The means of the intervention- and control-group students were compared for the 13 opinion variables, three constructs, and total opinion score, before and after the intervention. These results are given in Table 6. Before the intervention began, the control-group had more positive opinions than did the intervention-group on two of the seventeen opinion measures: Environmental Support and Role Model. After the intervention ended, the intervention-group had higher scores on the Career Awareness scale, and the control-group had

higher scores on the Value scale. To control for the possibility that the two postintervention differences may have been due to the maturation of preexisting differences and not due to the intervention, the final opinion variables were adjusted for preexisting differences via ANCOVA.

**Table 6**

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| OPINION, Total | Pretest | 1.76 | .10 | 1.74 | .11 | -0.98 | ns |
| | Posttest | 1.75 | .16 | 1.73 | .13 | -0.42 | ns |
| SET GOAL | Pretest | 1.80 | .13 | 1.78 | .13 | -0.45 | ns |
| | Posttest | 1.79 | .16 | 1.76 | .15 | -0.64 | ns |
| Value | Pretest | 2.00 | .00 | 1.93 | .16 | -2.27 | ≤.05 |
| | Posttest | 1.99 | .06 | 1.95 | .12 | -1.40 | ≤.10 |
| Cultural Value | Pretest | 1.81 | .21 | 1.85 | .18 | 1.01 | ns |
| | Posttest | 1.82 | .17 | 1.81 | .23 | -0.17 | ns |
| Self-Concept | Pretest | 1.71 | .28 | 1.71 | .21 | 0.00 | ns |
| | Posttest | 1.71 | .32 | 1.66 | .25 | -0.65 | ns |
| Aspiration | Pretest | 1.73 | .19 | 1.69 | .22 | -0.83 | ns |
| | Posttest | 1.70 | .26 | 1.69 | .19 | -0.09 | ns |
| ATTITUDE | Pretest | 1.72 | .14 | 1.69 | .15 | -0.61 | ns |
| | Posttest | 1.68 | .21 | 1.67 | .18 | -0.25 | ns |
| Math/Science Attitude | Pretest | 1.83 | .15 | 1.79 | .17 | -0.97 | ns |
| | Posttest | 1.78 | .18 | 1.78 | .24 | 0.06 | ns |
| Locus of Control | Pretest | 1.86 | .17 | 1.81 | .21 | -1.06 | ns |
| | Posttest | 1.83 | .20 | 1.79 | .26 | -0.67 | ns |
| Persistence | Pretest | 1.73 | .25 | 1.66 | .27 | -1.14 | ns |
| | Posttest | 1.56 | .34 | 1.56 | .28 | -0.05 | ns |
| Study Habits | Pretest | 1.52 | .24 | 1.56 | .28 | 0.74 | ns |
| | Posttest | 1.56 | .22 | 1.54 | .28 | -0.28 | ns |
| Anxiety | Pretest | 1.63 | .35 | 1.63 | .30 | 0.06 | ns |
| | Posttest | 1.66 | .33 | 1.65 | .30 | -0.17 | ns |
| ENVIRONMENTAL SUPPORT | Pretest | 1.80 | .12 | 1.75 | .12 | -1.78 | ≤.10 |
| | Posttest | 1.80 | .11 | 1.80 | .09 | -0.18 | ns |

GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES

| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| Academic Support | Pretest | 1.93 | .14 | 1.90 | .24 | -0.61 | ns |
| | Posttest | 1.95 | .16 | 1.91 | .19 | -0.80 | ns |
| Career Awareness | Pretest | 1.93 | .14 | 1.91 | .17 | -0.32 | ns |
| | Posttest | 1.83 | .20 | 1.95 | .15 | 1.40 | ≤.10 |
| Role Model | Pretest | 1.46 | .34 | 1.29 | .28 | -2.35 | ≤.05 |
| | Posttest | 1.46 | .31 | 1.40 | .33 | -0.65 | ns |
| Equal Opportunity | Pretest | 1.90 | .18 | 1.92 | .18 | 0.43 | ns |
| | Posttest | 1.92 | .18 | 1.94 | .16 | 0.48 | ns |

All pretests were analyzed as two-tailed tests.
All posttests were analyzed as one tailed tests.
Pretests n's: Control = 27; Intervention = 54
Posttest n's: Control = 20; Intervention = 33

*Group differences on opinion adjusting for prior scores.* Table 7 reports the tests of the effects of group membership on opinion after adjusting for preintervention opinion scores. By this analysis, the groups differed overall on two opinion measures: the control-group had higher Value scores, and the intervention-group had significantly higher Career Awareness scores, results that paralleled the t-test results. In addition, the preintervention opinion score interacted with group membership for four opinion measures: SET Goal, Cultural Value, Academic Support, and Career Awareness.

**Table 7**

HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLES MODELS | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| OPINION, Overall | PREINTERVENTION | .5261 | .5261 | 55.50 | 1,50 | ≤.01 |
| | +GROUP | .5364 | .0104 | 1.10 | 1,49 | ns |
| | +PRE-x-GROUP | .5428 | .0064 | 0.67 | 1,48 | ns |
| SET GOAL | PREINTERVENTION | .5371 | .5371 | 58.02 | 1,50 | ≤.01 |
| | +GROUP | .5386 | .0015 | 0.16 | 1,49 | ns |
| | +PRE-x-GROUP | .5547 | .0161 | 1.74 | 1,48 | ≤.10 |
| Value | PREINTERVENTION | .0007 | .0007 | 0.03 | 1,50 | ns |
| | +GROUP | .0480 | .0473 | 2.43 | 1,49 | ≤.10 |
| | +PRE-x-GROUP | | | | | |

HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLES MODELS | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Cultural Value | PREINTERVENTION | .2770 | .2770 | 19.16 | 1,50 | ≤.01 |
| | +GROUP | .2936 | .0166 | 1.15 | 1,49 | ns |
| | +PRE-x-GROUP | .3302 | .0367 | 2.63 | 1,48 | ≤.10 |
| Self-Concept | PREINTERVENTION | .4317 | .4317 | 37.98 | 1,50 | ≤.01 |
| | +GROUP | .4380 | .0063 | 0.55 | 1,49 | ns |
| | +PRE-x-GROUP | .4519 | .0140 | 1.22 | 1,48 | ns |
| Aspiration | PREINTERVENTION | .3241 | .3241 | 23.97 | 1,50 | ≤.01 |
| | +GROUP | .3288 | .0047 | 0.34 | 1,49 | ns |
| | +PRE-x-GROUP | .3428 | .0140 | 1.02 | 1,48 | ns |
| ATTITUDE | PREINTERVENTION | .3310 | .3310 | 24.73 | 1,50 | ≤.01 |
| | +GROUP | .3353 | .0043 | 0.32 | 1,49 | ns |
| | +PRE-x-GROUP | .3424 | .0071 | 0.52 | 1,48 | ns |
| Math/Science Attitude | PREINTERVENTION | .1874 | | 11.53 | 1,50 | ≤.01 |
| | +GROUP | .1897 | .0022 | 0.14 | 1,49 | ns |
| | +PRE-x-GROUP | .2107 | .0210 | 1.28 | 1,48 | ns |
| Locus of Control | PREINTERVENTION | .1980 | .1980 | 12.34 | 1,50 | ≤.01 |
| | +GROUP | .2006 | .0026 | 0.16 | 1,49 | ns |
| | +PRE-x-GROUP | .2020 | .0014 | 0.08 | 1,48 | ns |
| Persistence | PREINTERVENTION | .1994 | .1994 | 12.45 | 1,50 | ≤.01 |
| | +GROUP | .2047 | .0053 | 0.33 | 1,49 | ns |
| | +PRE-x-GROUP | .2298 | .0252 | 1.57 | 1,48 | ns |
| Study Habits | PREINTERVENTION | .2663 | .2663 | 18.15 | 1,50 | ≤.01 |
| | +GROUP | .2687 | .0024 | 0.16 | 1,49 | ns |
| | +PRE-x-GROUP | .2733 | .0046 | 0.30 | 1,48 | ns |
| Anxiety | PREINTERVENTION | .0820 | .0820 | 4.47 | 1,50 | ≤.05 |
| | +GROUP | .0826 | .0006 | 0.03 | 1,49 | ]ns |
| | +PRE-x-GROUP | .1071 | .0244 | 1.31 | 1,48 | ns |
| ENVIRONMENTAL SUPPORT | PREINTERVENTION | .4219 | .4219 | 36.49 | 1,50 | ≤.01 |
| | +GROUP | .4348 | .0130 | 1.12 | 1,49 | ns |
| | +PRE-x-GROUP | .4407 | .0058 | 0.50 | 1,48 | ns |
| Academic Support | PREINTERVENTION | .1046 | .1046 | 5.84 | 1,50 | ≤.01 |
| | +GROUP | .1149 | .0102 | 0.57 | 1,49 | ns |
| | +PRE-x-GROUP | .1572 | .0424 | 2.41 | 1,48 | ≤.10 |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLES MODELS | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Career Awareness | PREINTERVENTION | .1466 | .1466 | 8.59 | 1,50 | ≤.01 |
| | +GROUP | .1766 | .0300 | 1.78 | 1,49 | ≤.10 |
| | +PRE-x-GROUP | .2592 | .0826 | 5.35 | 1,48 | ≤.05 |
| Role Model | PREINTERVENTION | .1749 | .1749 | 10.60 | 1,50 | ≤.01 |
| | +GROUP | .1769 | .0020 | 0.12 | 1,49 | ns |
| | +PRE-x-GROUP | .1935 | .0165 | 0.98 | 1,48 | ns |
| Equal Opportunity | PREINTERVENTION | .0158 | .0158 | 0.80 | 1,50 | ns |
| | +GROUP | .0184 | .0026 | 0.13 | 1,49 | ns |
| | +PRE-x-GROUP | .0246 | .0062 | 0.30 | 1,48 | ns |

All models were analyzed as one-tailed tests.

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

As with the performance interactions, the nonparallel regression lines were graphed and the Johnson-Neyman technique used to determine the intersection point and range of values for which the groups differed.

Figures 3, 5, and 6 show the same pattern of differences--the intervention was most successful at enhancing the opinions of students who entered with low opinions of the value of SET fields and low levels of academic support.

**Figure 3**

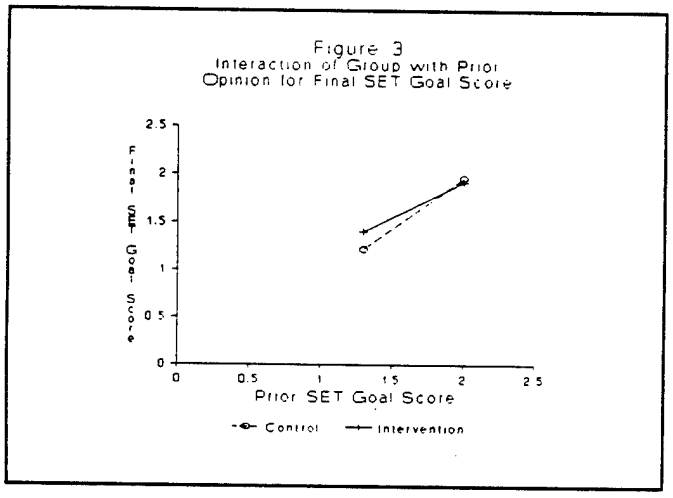



**Figure 5**

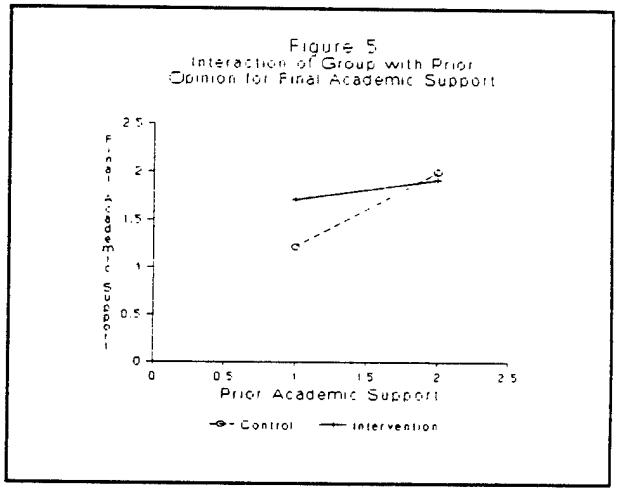



Figure 3 indicates that the intervention raised the SET Goal opinion scores of students who had low prior opinions. Figure 5 shows that the intervention raised the Academic Support opin- ion scores of students who entered with lower opinions.

**Figure 6**

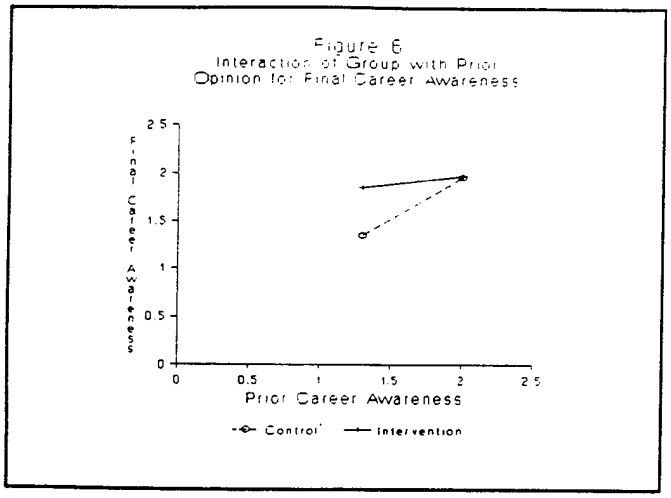



**Figure 4**

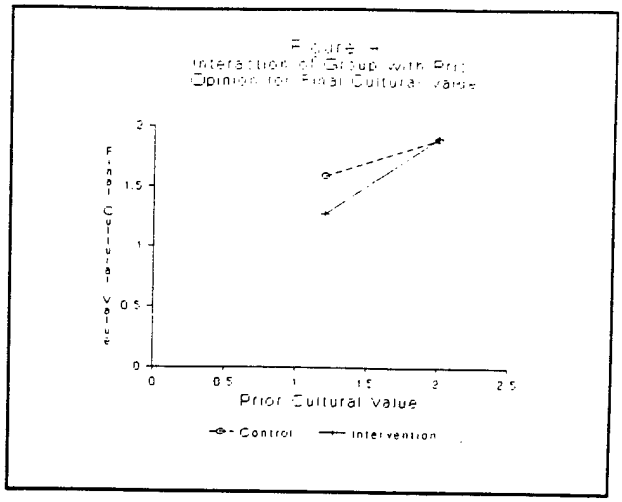



Figure 6 displays the interaction for Career Awareness scores; for students who had scores lower than average on the prior scale, the intervention-group produced significantly higher scores on the final Career Awareness scale.

However, Figure 4 differed from Figures 3, 5, and 6; Figure 4 indicates that relative to the control-group, the intervention had a less positive effect on Cultural Value scores for students who had entered with lower Cultural Value scores.

To summarize these interactions, the intervention had significant, positive effects on the opinions of students with low prior SET Goal, Academic Support, and Career Awareness scores. The control- group began with and maintained higher Value scores, and students who entered with lower Cultural Value scores showed greater increases in the control-group.

*Correlations between participation and performance.* The seventeen opinion measures were correlated with attendance at the Saturday classes and field trips, and these correlations are given in Table 8. Attendance at the Saturday classes was positively correlated with more positive opinion scores for four measures--Persistence, lower Anxiety, Academic Support, and Equal Opportunity--and more negative opinion scores for three measures--Value, Locus of Control, and Career Awareness. Only one opinion measure was correlated with field trip participation--Locus of Control--and the relationship was negative. On balance, the correlations between opinion and participation over the nine weeks of the intervention suggest that the field trips were the less influential of the two components of the intervention.

**Table 8**

**POST-OPINION MEASURES CORRELATED WITH DEGREE OF PARTICIPATION IN THE INTERVENTION COMPONENTS[a]**

| OPINION CONSTRUCT/Scale | Saturday Classes | Field Trips |
|---|---|---|
| OPINION, Total | .11 | -.07 |
| SET GOAL | .06 | .01 |
| Value | -.29 ($p \leq .10$) | .03 |

| POST-OPINION MEASURES CORRELATED WITH DEGREE OF PARTICIPATION IN THE INTERVENTION COMPONENTS[a] | | |
|---|---|---|
| OPINION CONSTRUCT/Scale | Saturday Classes | Field Trips |
| Cultural Value | -.02 | -.12 |
| Self Concept | .19 | .01 |
| Aspiration | .06 | .11 |
| ATTITUDE | .11 | -.10 |
| Math/Science Attitude | -.06 | -.05 |
| Locus of Control | -.32 ($p \leq .05$) | -.24 |
| Persistence | .26 ($p \leq .10$) | -.18 |
| Study Habits | .04 | .09 |
| Anxiety | .27 ($p \leq .10$) | -.03 |
| ENVIRONMENTAL SUPPORT | .12 | -.06 |
| Academic Support | .37 ($p \leq .05$) | -.11 |
| Career Awareness | -.23 ($p \leq .10$) | .09 |
| Role Model | -.16 | -.10 |
| Equal Opportunity | .34 ($p \leq .05$) | .11 |

[a] All two-tailed tests.

NOTE: r, the Pearson correlation coefficients, were computed on 33 cases.

## DISCUSSION

The hypotheses of enhanced performance and opinion as a result of the intervention received some support. Intervention participants as a group showed higher Career Awareness in the SET fields after the intervention: an important finding as well as a significant one. This benefit applies to the whole group of intervention students.

The intervention may have been particularly beneficial for students entering with lower content scores or lower opinions in areas thought to be important to selection of SET majors and careers. Adjusting for pretest measurements shows some particular effects for students entering the intervention with low scores in content or opinion: After adjusting for prior content score, the students who entered the intervention-group with lower biology and computer science test scores had

higher scores on final tests in these two areas than did comparable control-group students. Students who entered with relatively low opinion scores on the SET Goal, Academic Support, and Career Awareness scales showed the greatest positive changes in opinion as a result of the intervention.

The above mentioned successes of the intervention are particularly important in light of preintervention differences which favored the control-group. As shown in Table 2, the control-group students' standardized test scores were above the national mean (63rd and 89th percentiles for the CTBS and SRA, respectively), and the intervention-group's students' test scores were closer to the national mean (53rd and 56th percentiles for the CTBS and SRA, respectively) (Table 2). Several preintervention differences favoring the control-group were maintained in the postintervention measurements. In the performance areas, the control-group students displayed their superior math performance on both the pretest and posttest. For opinion, the control-group maintained their higher Value scores on both the preintervention and postintervention measurements.

Comparisons on all 73 preintervention measures found significant differences on 10 percent of the measures, most of which favored the control group. The control-group outperformed the intervention group on 20 percent of the performance and opinion preintervention measures (five out of twenty-five measures); no preintervention difference on performance or opinion favored the intervention-group. As the results showed, some of the preexisting differences on performance and opinion measures were maintained at the posttest.

Of course the true measure of the effectiveness of this intervention would be in long-term effects, not measured in the present research. It is hoped that the enhanced SET Career Awareness and the other gains shown by the intervention group will be instrumental in increasing the amount of new talent required to meet the needs of our nation's technological work-force.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# APPENDICES

# APPENDIX A

# MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

Participant Number: _____

## MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

Thank you for agreeing to participate in this important project. It is geared to help us develop new programs for students and improve existing programs.

Your opinions and experience are important to us. Please read each question carefully and answer completely and accurately to the best of your ability. All of your answers will be kept in confidence. Your answers will be grouped with those of other students in other places, and together they will help us better understand students' needs and preferences today.

Please ask your administrator if any of these questions are unclear to you.

Thanks for your help!

1. Sex:
   - ___ a. Male
   - ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   - ___ a. Anglo
   - ___ b. Black
   - ___ c. Asian American
   - ___ d. American Indian (Please specify the tribe which best describes your heritage.)

     _____
   - ___ e. Hispanic (Which of the following best describes your heritage?)
     - ___ a. Cuban-American
     - ___ b. Mexican-American
     - ___ c. Puerto Rican
     - ___ d. Other Specify _____
   - ___ f. Other Specify _____

4. Are you a United States citizen?
   - ___ a. Yes
   - ___ b. No

5. Name of your school: _____

   City: _____ State: _____

6. Class:
   ___ a. 4th grade
   ___ b. 5th grade
   ___ c. 6th grade
   ___ d. 7th grade
   ___ e. 8th grade

7. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Less than high school graduation
   ___ b. High school graduation
   ___ c. Two-year college degree (community college or junior college)
   ___ d. Four-year college degree
   ___ e. Education beyond four years of college
   ___ f. Other Specify _____

8. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

9. What is or are the occupation(s) of the person(s) with whom you live? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

   _____ _____

10. Would you say that your family's income is:
   ___ a. Below the U.S. average
   ___ b. About average
   ___ c. Above average
   ___ d. Don't know

11. Are you:
   ___ a. An only child (skip to question 13)
   ___ b. The oldest child
   ___ c. The youngest child
   ___ d. An in-between child

12. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

13. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

14. What was the highest level of school your mother completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

15. What is the language spoken most often by adults in your household? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe (What is that language?) _____
___ d. Another language - Specify _____

16. Which of the following did your parent(s) or guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Help you with your homework

17. Which of the following comes closest to describing how much your parent(s) or guardian(s) read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

18. Which of the following comes closest to describing how much you read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

19. Which of these items do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

20. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL ITEMS WITH DIRECTIONALITY AND SCALES

## Opinion Protocol Items with Directionality and Scales

Legend:

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | Do you study each day rather than just before exams? |
| 2. | + | AT | Are scientists smarter than most people? |
| 3. | + | SC | Can you imagine yourself as a scientist? |
| 4. | - | AX | Do word problems in mathematics make you nervous? |
| 5. | + | VL | Do you think mathematics is needed in most jobs? |
| 6. | + | VL | Is science important to our country? |
| 7. | + | LC | When you make plans, can you usually make them work? |
| 8. | + | CA | Do girls have a good chance of becoming scientists when they grow up? |
| 9. | + | PS | Do you usually finish the things you start? |
| 10. | + | CV | Is it important to you that your people be proud of you? |
| 11. | - | SH | Do you prefer to study alone? |
| 12. | - | AT | Do scientists do boring work? |
| 13. | + | AS | If you have problems at school, is there someone who will help you? |

| | | | |
|---|---|---|---|
| 14. | - | AX | Do tests make you nervous? |
| 15. | + | SH | Do you get your homework done on time? |
| 16. | - | SC | Are science experiments hard for you to understand? |
| 17. | + | AP | Do you want to take any more mathematics courses? |
| 18. | + | CV | Are your friends good at mathematics? |
| 19. | - | EO | Does a person's color make a difference in whether or not they get to be a scientist? |
| 20. | - | PS | Do you get bored with your school work by the middle of the school year? |
| 21. | - | PS | Do you have trouble keeping your mind on your homework? |
| 22. | + | EO | Do people care if a good scientist is a man or a woman? |
| 23. | + | AP | Are you thinking of becoming a scientist? |
| 24. | - | AT | Is mathematics boring? |
| 25. | + | RM | Are many people of your ethnic/racial group successful scientists? |
| 26. | + | AP | Do you try to get good grades in science? |
| 27. | - | LC | Is success mostly a matter of luck? |
| 28. | + | AT | Do most scientists enjoy their work? |
| 29. | + | AT | Do you enjoy solving mathematics problems? |
| 30. | + | VL | Does mathematics come in handy outside of class? |
| 31. | - | AX | Do you feel scared when you have to work a mathematics problem? |

| | | | |
|---|---|---|---|
| 32. | + | CA | Can you really become a scientist if you want to? |
| 33. | + | CA | Do you think there are a lot of jobs for scientists? |
| 34. | - | AX | Do tests scare you even when you have studied for them? |
| 35. | + | SC | Do you think you are a good science student? |
| 36. | + | SH | Do you like to read about science? |
| 37. | + | RM | Have you ever met a scientist? |
| 38. | + | VL | Is science an important subject? |
| 39. | + | SC | Are you good at figuring out mathematics problems? |
| 40. | + | AP | Do you want to improve your mathematics skills? |
| 41. | + | AS | Do the teachers in your school care how well you do in school? |
| 42. | + | CV | Do your people think highly of scientists? |
| 43. | - | AP | Would you like to spend less time on science in school? |
| 44. | - | AS | Do your teachers think you don't do very well? |
| 45. | + | CV | Does your family care a lot about education? |
| 46. | - | AT | Are scientists unfriendly? |
| 47. | - | AX | Do you worry about being able to understand your science assignments? |
| 48. | + | RM | Is there a scientist you look up to? |
| 49. | - | EO | Are boys better in science than girls? |

| | | | |
|---|---|---|---|
| 50. | + | LC | Can you control whether or not you have a good day? |
| 51. | - | SC | Is science too hard for you? |
| 52. | - | PS | Do you often quit when things get tough? |
| 53. | - | AX | Do you get scared when you are called on to answer a question in mathematics? |
| 54. | + | AT | Is science interesting? |
| 55. | + | SC | Are you very good at mathematics? |

56. What do you want to be when you grow up?

a. _____

b. _____

c. _____

57. Please describe the work you feel scientists do in a typical work day. If you don't know, just use your imagination.

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE MIDDLE/JUNIOR HIGH STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 53 | CONTROL n = 27 |
| 1. Sex | | |
| Women | 69% | 63% |
| Men | 31% | 37% |
| 2. Age | 13.86 | 14.04 |
| 6. Class | | |
| .Seventh grade | 47% | 37% |
| .Eighth grade | 53% | 63% |
| 7. Higher education expected: | | |
| .Less than high school | 0% | 0% |
| .High school graduation | 34% | 22% |
| .Two-year college | 24% | 37% |
| .Four-year college | 42% | 41% |
| 8. Studies most influenced by | | |
| .Parents | 76% | 52%[a] |
| .Another family member | 0% | 15% |
| .Teacher | 6% | 18% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 0% |
| .Friend | 2% | 7% |
| .Science professional | 4% | 0% |
| .Nonscience professional | 6% | 4% |
| .No one at all | 4% | 4% |
| .Missing | 4% | 0% |
| 9. Sources of outside income | | |
| .None | 6% | 7% |
| .One | 51% | 56% |
| .Two | 32% | 37% |
| | 11% | 0% |
| 10. Family income: | | |
| .Below U.S. average | 0% | 7% |
| .About average | 40% | 52% |
| .Above average | 6% | 4% |
| .Unknown | 55% | 37% |

| | PERCENT RESPONSE | |
|---|---|---|
| 11. Birth order of student: | | |
| .Only child | 9% | 15% |
| .Oldest child | 32% | 33% |
| .Youngest child | 24% | 18% |
| .In-between child | 30% | 33% |
| .Missing | 4% | 0% |
| 12. Number of siblings: | | |
| .None | 9% | 15% |
| .One | 30% | 7% |
| .Two | 19% | 37% |
| .Three or more | 40% | 37% |
| | 2% | 4% |
| 13. Father's education: | | |
| .Grade School or less | 0% | 7% |
| .Some high school | 8% | 15% |
| .High school graduate | 17% | 26% |
| .Some college | 8% | 7% |
| .College degree or more | 21% | 15% |
| .Missing | 45% | 30% |
| 14. Mother's education: | | |
| .Grade school or less | 4% | 4% |
| .Some high school | 8% | 22% |
| .High school graduate | 19% | 15% |
| .Some college | 11% | 15% |
| .College degree or more | 36% | 22% |
| .Missing | 23% | 22% |
| 15. Language spoken most at home: | | |
| .English | 94% | 93% |
| .Spanish | 4% | 7% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| .Missing | 2% | 0% |
| 16. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 43% | 52% |
| .Attend parent-teacher conferences | 30% | 33% |
| .Visit student's class | 23% | 33% |
| .Phone/visit if there's a problem | 49% | 59% |
| .Do volunteer work | 28% | 26% |
| .Assist in student's homework | 76% | 78% |
| Number of parental involvements * | 2.49 | 2.81 |

| | PERCENT RESPONSE | |
|---|---|---|
| 17. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 40% | 44% |
| .A lot | 58% | 56% |
| .Missing | 2% | 0% |
| 18. Student reads: | | |
| .Not at all | 4% | 0% |
| .Sometimes | 60% | 59% |
| .A lot | 34% | 41% |
| .Missing | 2% | 0% |
| 19. Items in student's home:[b] | | |
| .Desk | 70% | 78% |
| .Daily newspaper | 72% | 82% |
| .Encyclopedia | 70% | 67% |
| .Typewriter | 68% | 63% |
| .Calculator | 74% | 96%[a] |
| .Television | 92% | 100% |
| .Computer | 34% | 22% |
| .Video Cassette Recorder (VCR) | 77% | 70% |
| Number of support items * | 5.57 | 5.78 |
| 20. All activities student took part in:[b] | | |
| .Math/science club | 17% | 7% |
| .Field trip | 60% | 63% |
| .Watching science programs on TV | 55% | 63% |
| .Listen to talk by scientist | 13% | 15% |
| .Science/math fair | 41% | 48% |
| .Other science/math competition | 9% | 15% |
| .Play/work in computer lab | 62% | 70% |
| Number of activities * | 2.58 | 2.81 |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# RUST COLLEGE

# INTERVENTIONS

Prepared by:

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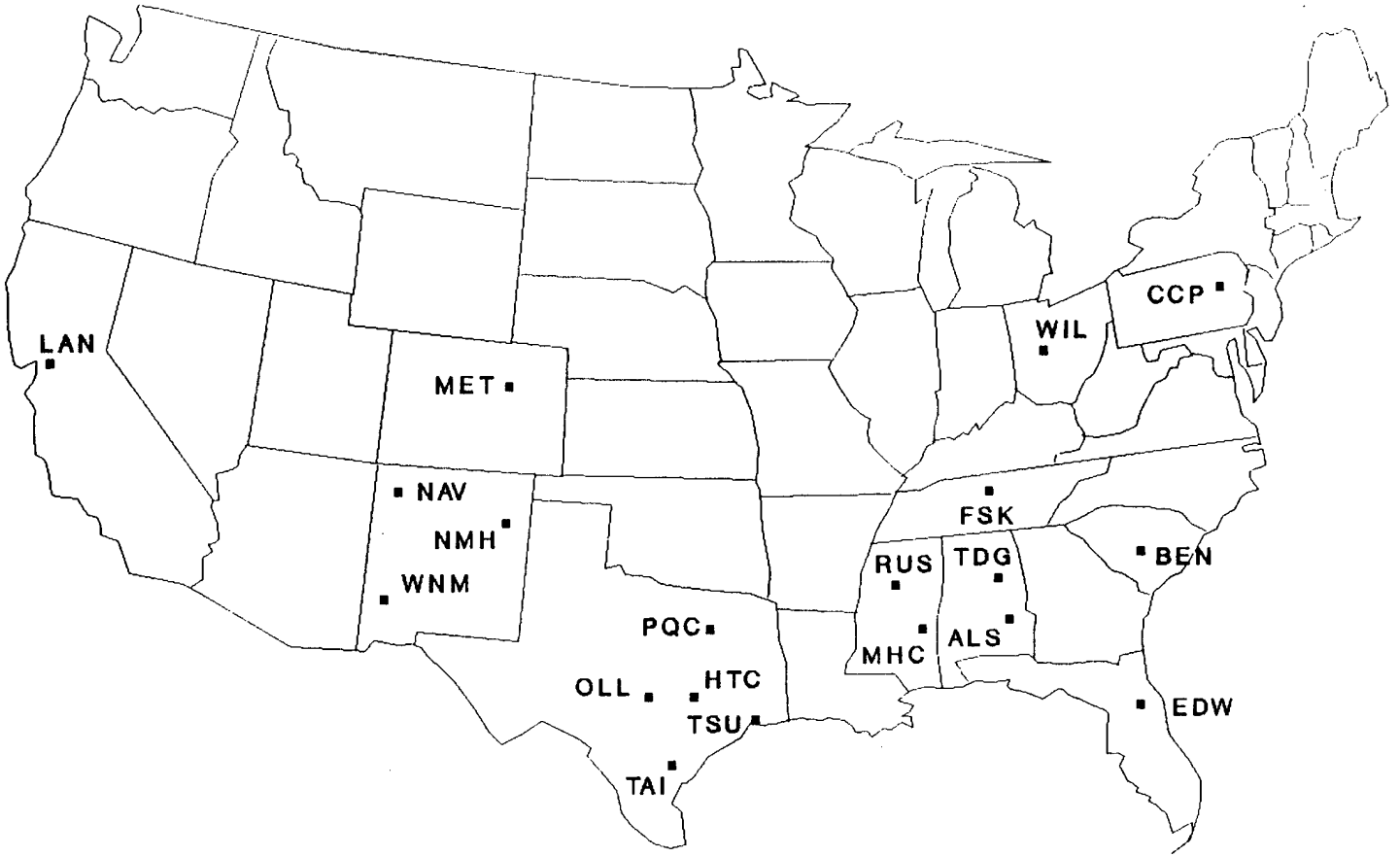
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected came from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention- group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF RUST COLLEGE

Rust College is a historically Black, four-year, private, coeducational institution located in Holly Springs, Mississippi. The community of Rust College consists of approximately 1000 students and 60 faculty members. The College, organized into the Division of Business, Division of Education, Division of Humanities, Division of Science and Mathematics, and Division of Social Sciences, offers undergraduate degrees. The student body is approximately 61 percent female and 39 percent male and is predominantly Black. The president of Rust College is Dr. William McMillan.

Degrees offered at Rust College in quantitative subjects are Bachelor of Science in chemistry, computer science, mathematics, and physics. The College also offers a dual degree program in engineering and chemistry, mathematics, or interdisciplinary science in cooperation with Georgia Institute of Technology in Atlanta, Georgia; Tuskegee Institute in Tuskegee, Alabama; Memphis State University in Memphis, Tennessee; Mississippi State University in Starkville, Mississippi; and Auburn University in Auburn, Alabama.

Holly Springs has a population of approximately 7300. The state of Mississippi has a population of approximately 2.7 million. According to U.S. Census Bureau estimates, the adult population of Mississippi is 68 percent Anglo, 31 percent Black, and 1 percent other ethnic origins. Holly Springs is located near Memphis, Tennessee, the location of Christian Brothers College, Draughons Junior College, Fisk University, LeMoyne-Owen College, Memphis State University, Shelby State Community College, State Technical Institute at Memphis, and the University of Tennessee at Memphis.

# PART II

# SUMMARY OF THE RUST COLLEGE (RC)

# INTERVENTIONS

This page is a summary of the two interventions conducted by Rust College, a historically Black, four-year private institution located in Holly Springs, Mississippi. The college is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Rust College Intervention Activities:

In Spring 1989 and in Spring 1990, Rust College conducted two intervention programs for high school students. Each intervention was a sixteen-week Saturday Academy, with classes offered in computer science, communication skills, mathematics (for the 9th and 10th graders) and physical science (for the 11th and 12th graders), as well as field trips. Participants were high school students recruited from the Holly Springs area; most participants were Black.

Findings:

- The intervention had high positive effects on performance in both of the two semesters of intervention.
- The intervention improved performance on the Test of Adolescent Language for those students who entered the program with low scores on this test.
- Recruitment proved to be more difficult than the project director had anticipated: Part-time jobs and other programs which offered monetary compensation competed for students' time.

Recommendations:

The recruitment difficulties experienced in setting up this intervention underscore the importance of investigating students' circumstances in planning activities for them. For students who are old enough to earn money, participation without monetary compensation may amount to lost income which may have more immediate value to the students than the program does. Some possible counters:

- Offering a monetary incentive to students puts the program on a par to compete with jobs and other programs.
- If a monetary offering is not possible, promotional materials for the program should speak frankly about the good salaries that are possible in the SET fields.
- Offering a program on a college campus is an excellent way to recruit students, not only for that campus, but to consider college at all. This can be particularly true for first-generation college candidates.
- When working with lower-income students who do not have access to public transportation, provide transportation to and from the intervention activities. This should be done even for students who are old enough to drive.

# PART III

# CASE STUDY OF THE RUST COLLEGE

# 1990 SPRING SEMESTER INTERVENTION

## ABSTRACT

In the summer of 1990 Rust College, Holly Springs, Mississippi, conducted and tested against a control group a Saturday Academy in science and mathematics for high school students. Participants were 46 Black 9th through 12th graders (32 women and 14 men) who were recommended by high school counselors, mathematics teachers, and science teachers as having the potential to succeed in a science, engineering, or technology (SET) field. The intervention was initially conducted in the spring of 1989.

The Rust College program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance in academic areas important to success in SET courses, and (b) enhance opinions about SET fields and careers.

*COMPONENTS:* A major component of the intervention was instruction in mathematics, physical science, computer science, and communications. The intervention group was divided into one group of 9th and 10th graders and another group of 11th and 12th graders. The 9th and 10th graders attended math classes and a math lab, and the 11th and 12th graders attended physical science classes and a physical science lab. All students attended classes in computer science and communications skills and could attend tutoring sessions in all subject areas. Additional activities included two field trips to science facilities and presentations given by two successful role models.

*DATA:* All the participants furnished demographic data through the CASET High School Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were pretest and posttest scores on a variety of institution-specific content tests, including a computer science test and the Test of Adolescent Language (TOAL) communications skills test.

The outcome measures of performance were posttest scores on four subtests of the TOAL (Listening/Vocabulary, Reading/Vocabulary, Reading/Grammar, and Writing/Grammar) and posttest score on the computer science content test. The preintervention measures of performance were pretest scores on the four subtests of the TOAL and pretest score on the computer science content test.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design; through analyses of preintervention measures it appeared that the intervention and control groups were comparable.

*FINDINGS:* The intervention had some positive effect on the participants and can be considered a successful intervention in that the hypothesis that the intervention would enhance student performance was supported. The intervention was associated with enhanced computer science performance and was associated with higher TOAL posttest scores for intervention-group students who began the program with better language skills or who were 16 years old or older. The hypothesis that the intervention would enhance opinions about SET fields and careers, however, was not supported, although there were limited benefits for intervention-group students who began with very low Attitude and Career Awareness opinion scores.

## DESCRIPTION OF THE INTERVENTION

In order to increase the representation of minorities and women, in the quantitative fields, Rust College developed an intervention for high-ability high school students living within commuting distance of the College. This plan was expected to increase the number of Blacks enrolled in SET-related college courses more quickly than would other possible interventions, for example, those targeting younger or "high-risk," lower ability students.

Two different implementations of this program were conducted by Rust College: one in the spring and summer of 1989, and a second one in the summer of 1990. Each intervention consisted of 16 Saturday sessions. Findings from the second intervention, which began on June 2, 1990 and ended September 22, 1990, are reported here.

The students were transported by van from their homes and brought to the College for Saturday Academy classes in mathematics and mathematics lab (for 9th and 10th graders), physical science and physical science lab (for 11th and 12th graders), and computer science and communication skills for all students. Classes were held in the new Business, Computer Science, and Social Science Building and were scheduled on Saturdays from 9:00 a.m. to 4:00 p.m. In addition to classes, the regular Saturday activities also included a study hall and time to meet with their teachers for questions. Lunch was served to the participating students each Saturday.

The intervention-group students included 9th through 12th graders. For instruction the students were divided into two groups: 9th and 10th graders, and 11th and 12th graders. The schedule for the two groups was as follows:

| Time | 9th & 10th Graders | 11th & 12th Graders |
|---|---|---|
| 9:00 - 10:00 a.m. | Computer Science | Physical Science |
| 10:00 - 11:00 a.m. | Computer Science lab | Physical Science lab |
| 11:00 - 11:30 a.m. | Faculty office | Study hall |
| 11:30 - 12:00 noon | Study hall | Faculty office |
| 12:00 - 1:00 p.m. | Lunch | Lunch |
| 1:00 - 2:00 p.m. | Communication Skills | Computer Science II |
| 2:00 - 3:00 p.m. | Mathematics | Computer Science II lab |
| 3:00 - 4:00 p.m. | Mathematics lab | Communication Skills |

The courses in computer science, mathematics, and communication skills included "hands-on" computer experience, and the physical science course included "hands-on" lab experiments. In the communication skills classes, students' presentations were videotaped and critiqued. For each subject area, a specialized tutor was available to assist the students. The intervention included field trips to the Marshall Space Flight Center in Huntsville, Alabama, and to the Pink Palace Museum in Memphis, Tennessee. In addition, two speakers who also served as role models for the students were featured: Dr. Sue Watson, a widely published biologist, and Dr. Olympia P. Lowe, a 79-year-old scientist who has been a professor of biology and an administrator at several colleges.

A final closing ceremony featured readings of poems, occasions, words of thanks, and a speech by Mr. William D. Scott, III, Department of Chemistry, University of Mississippi.

All of the CASET project staff were from Rust College. The Project Director for this CASET project was Ms. Cheryl Richards, instructor in computer science, with support from Dr. M. I. Shafi, Chairman, Science and Mathematics. Ms. Richards also taught the computer science classes.

Other faculty for the Saturday Academy were communication skills instructor Ms. Marjorie Marshall, and physical science and mathematics instructor Ms. Helen Hampton, a retired mathematics instructor from Rust College with experience in teaching elementary and high school. The tutors were Ms. Cynthia Parker, communication skills tutor and office assistant; Ms. Sharon Smith, computer science tutor; and Mr. Carl Taylor, physical science and mathematics tutor. The tutors also helped with classroom management and materials.

## METHOD

### Subjects

Subjects were minority high school students in the Holly Springs, Mississippi area who had been recommended by their high school counselors, mathematics teachers, and science teachers as having the potential to succeed in a SET major. Students were required to have at least a 2.0 high school GPA, and 12th graders had to have successfully completed at least one algebra course. A control group of comparable students was identified to provide comparative information in order to assess the effects of the intervention. The intervention-group students participated in the intervention classes and activities; the control-group students supplied the same information and filled out the same protocols as the intervention students, but did not take part in the intervention activities. High school counselors assisted in obtaining the needed data from the control-group students.

Forty-six sets of protocols were received from 25 intervention-group and 21 control-group students. All the students were American citizens and were representative of the groups who are the target populations for this study; all were included in the sample for analysis.

Table 1 shows the distribution of men and women in the intervention and control groups.

**Table 1**

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | | | 1 | | 1 | |
| Anglo | | | | | | |
| Black | 14 | 7 | 16 | 7 | 30 | 14 |
| Hispanic | | | | | | |
| Unknown | | | 1 | | 1 | |
| **TOTAL** | **14** | **7** | **18** | **7** | **32** | **14** |

CASET Protocols and Other Instruments

The two hypotheses were that the intervention would: (a) enhance performance in academic areas important to success in SET courses, and (b) enhance opinions about SET fields and careers.

Demographic and descriptive data about the subjects were developed through the CASET High School Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of 13 attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. CASET used these 13 attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gave a scalar measurement for that variable. Thus the completed Opinion Protocol provided a scale measuring each of the thirteen variables. The Opinion Protocol was administered to intervention- and control-group students before and after the intervention. The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B.

The institution developed and administered several content tests to assess student academic performance. Of the content tests submitted to CASET, only two were selected for analysis because there was an adequate number of pre- and posttest scores on these tests, providing a representative sample of intervention- and control-group students. The tests selected were the standardized Test of Adolescent Language (TOAL), four subtests of which were administered to assess language performance, and the computer science content test.

The following TOAL subtests were included in assessing the effects of this intervention:

*Listening/Vocabulary*: a 28-item subtest in which the examiner says a word and asks the student to select from a set of four pictures the two that relate to the spoken or stimulus word; this test examines a broad range of vocabulary knowledge because students must demonstrate that they know more than a single meaning for the stimulus word.

*Reading/Vocabulary*: a 25-item subtest emphasizing relational rather than referential meaning; the student first reads three stimulus words, all related to a common concept; then, from four possible responses, the student selects the two words associated most closely with the three stimulus words.

*Reading/Grammar*: a 20-item subtest designed to measure students' ability to recognize meaningfully similar but syntactically different sentence structures; given five sentences to read, the student selects the two that most nearly have the same meaning.

*Writing/Grammar*: a subtest measuring how well students understand English syntax; presented with a series of brief sentences, the student must formulate a single sentence that incorporates all the important elements in the stimulus sentences; the student must know how to form possessives, alter tenses, and embed and transform phrases.

The computer science pre- and posttest was a 77-item test developed by the college project staff. The test included 25 matching questions, 25 true-or-false questions, 5 multiple-choice questions, and 22 short-answer questions.

Both the TOAL and the computer science test were administered to intervention- and control-group students before and after the intervention. They were administered and scored by the college project staff, and the scores were submitted to CASET for analysis. Additional performance-related information sent on some students was not included in the analysis because it was available only on a relatively small number of students. This information included pre- and postintervention performance tests in mathematics and physical science, and scores on the following standardized tests: California Achievement Test (CAT), Stanford Achievement Test (SAT), Preliminary Scholastic Aptitude Test (PSAT), and American College Test (ACT).

### Procedure

At the beginning of the intervention, intervention- and control-group members signed consent forms and transcript release forms. The first measures of opinion and the measures of demographic information were taken in mid-May, 1990. The pretests of content were also administered and scored by college personnel at this time. The Saturday Academy classes and other activities were conducted only with the intervention-group students. The project staff recorded the students' attendance in the classes and activities and sent this information to CASET.

After the intervention, the CASET Opinion Protocol was administered a second time to intervention-group and control-group students in mid-to-late September, 1990. The content tests were once again administered and scored. These scores and copies of the tests were forwarded to CASET, along with the completed CASET Student Protocols, the preintervention and postintervention Opinion Protocols, standardized tests scores, and high school transcripts.

The items of the Opinion Protocol were coded by CASET according to the thirteen scales they represent. Items on the Opinion Protocol were scored in such a way that a larger number reflected a positive outcome (see Appendix B). The scales were organized into three constructs--SET Goal, Environmental Support, and Attitude--as shown in Appendix C.

## RESULTS

### Methodological Issues

The two hypotheses were that the intervention would: (a) enhance performance in computer science and language skills, and (b) enhance opinions about SET fields and careers. Most participants had preintervention and postintervention measures of performance and opinion, and the intervention was analyzed as a nonequivalent control group design. This type of quasi-experimental design has one common weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty may be addressed by analyzing the influence of preexisting characteristics on students' performance and opinion; the analysis of covariance (ANCOVA), adjusting for preintervention performance or opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that existed before the intervention.

### Demographic Results

The comparability of the intervention and control groups was examined by testing for differences on the items of the College Student Protocol. The complete results are given in Appendix D. Of the 58 comparisons, the groups differed on only two: (a) more of the intervention-group students had jobs (72%) than did the control-group students (38%); and (b) more control-group students were members of math/science clubs (43%) than were intervention-group students (16%). The two significant differences between the groups on preexisting characteristics were not significantly different from the number of differences expected by chance at the 10-percent probability level. Based on these results, the groups were judged to be comparable on demographic characteristics before the intervention.

Performance Measures

*Group differences in performance.* The two preintervention and postintervention measures of computer science knowledge and the TOAL were tested for group differences, and the results are given in Table 2. Note that the intervention and control groups did not differ on either of the preintervention measures, but the groups did differ on one postintervention measure: The intervention-group students had higher computer science posttest scores ($\underline{M}$ = 37.45) than did the control-group students ($\underline{M}$ = 18.74), $\underline{t}$ (39) = 3.94, $\underline{p} \leq .01$, one-tailed. The groups' mean TOAL posttest scores did not differ.

The intervention-group students' advantage on the computer science posttest was investigated in a further analysis--ANCOVA--that provided a more sensitive test of the intervention's effects and that adjusted for preintervention differences between the groups.

**Table 2**

**GROUP COMPARISONS OF PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | Sig.p |
|---|---|---|---|---|---|---|
| Comp Science Pretest | Control<br>Intervention | 20<br>25 | 16.75<br>16.00 | 11.67<br>11.91 | -0.21<br>(43) | ns |
| Comp Science Posttest | Control<br>Intervention | 19<br>22 | 18.74<br>37.45 | 13.35<br>16.56 | 3.94<br>(39) | $\leq$.01 |
| TOAL Pretest | Control<br>Intervention | 18<br>22 | 41.17<br>46.00 | 21.29<br>19.41 | 0.75<br>(38) | ns |
| TOAL Posttest | Control<br>Intervention | 19<br>22 | 53.47<br>54.18 | 14.07<br>16.83 | 0.14<br>(39) | ns |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

*Group differences after adjusting for pretests.* A hierarchical ANCOVA adjusted for preintervention test scores before comparing groups on two postintervention performance measures; the results are given in Table 3. This table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding each variable to the multiple regression equation (one variable per row), and the significance test of each variable's contribution toward explaining the dependent measure. The columns of the table include the cumulative percentage of variance explained by all entered variables (cum $R^2$), added contribution in explained variance of the new variable ($sR^2$), test of the contribution of the new variable ($\underline{F}(sR^2)$), and the degrees of freedom (df) for the test.

Table 3

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Computer Science Posttest | COMP SCI PRETEST | .00 | .00 | 0.02 | 1,38 | ns |
| | + GROUP | .28 | .28 | 14.72 | 1,37 | $\leq$.01 |
| | + PRE-x-GROUP | .28 | .00 | 0.00 | 1,36 | ns |
| TOAL Posttest | TOAL PRETEST | .24 | .24 | 10.36 | 1,33 | $\leq$.01 |
| | + GROUP | .25 | .01 | 0.42 | 1,32 | ns |
| | + PRE-x-GROUP | .34 | .10 | 4.49 | 1,31 | $\leq$.05 |

All models were analyzed as two-tailed tests.

* Three models of independent variables were tested for each dependent variable: (1) PRETEST alone; (2) PRETEST and ('+') GROUP; (3) PRETEST and GROUP and PRETEST-by-GROUP INTERACTION ('-x-').

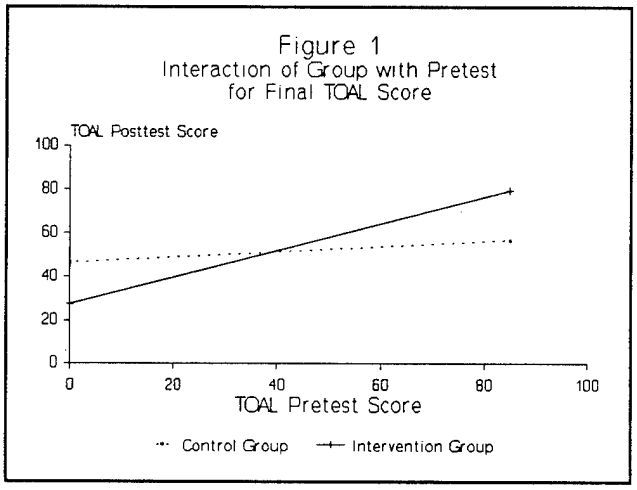
The results in Table 3 demonstrated that the intervention-group students outperformed the control-group students on the computer science posttest. In addition, group membership interacted significantly with preintervention score for the postintervention TOAL score. The significant interaction indicated that the relationship between prior TOAL score and the final TOAL score was different in the two groups. The interaction was analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of preintervention scores for which the groups differed.

Figure 1 shows the nonparallel regression lines that indicate that for students with higher preintervention TOAL scores, the students in the intervention group outperformed those in the control group.

**Figure 1**

In Figure 1, for students with prior TOAL scores at or above 50 (total $\underline{M}$ = 44.5), the intervention group out performed the control group on the final TOAL score; the control group out performed the intervention group only for students with prior TOAL scores at or below 27.

The findings from Table 2 had indicated that intervention-group students had significantly higher postintervention computer science scores; the ANCOVA findings indicated that adjusting for preintervention scores did not affect the intervention group's advantage on postintervention computer science, and the ANCOVA approach discovered a significant interaction between group membership and prior TOAL score.

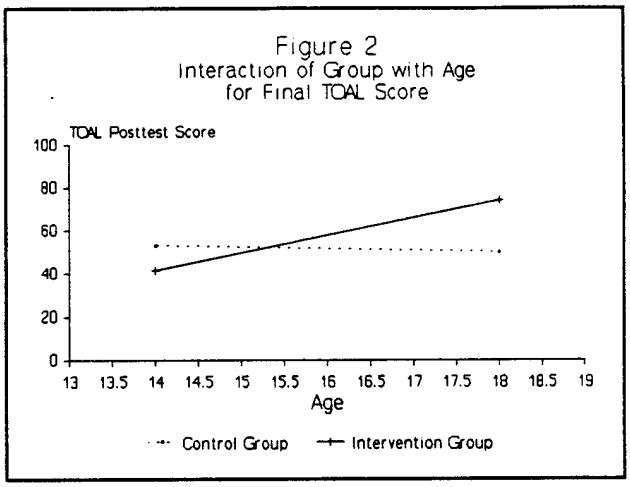


*Interrelationships among performance.* The interrelatedness of the performance measures was examined through intercorrelations, presented in Table 4. As expected, the preintervention and postintervention measures of TOAL were correlated significantly; surprisingly, the pretest and posttest measures of computer science were not significantly correlated.

*Group differences after adjusting for another covariate.* In order to insure that intervention activities were associated with the computer science gains of the intervention group and not the result of some preexisting characteristics, additional demographic covariates were sought. Several candidate demographic variables (age, number of parental involvements in school-related activities, number of academic support items in the home, and number of prior math/science activities) were correlated with postintervention performance measures; only age was significantly correlated with the postintervention performance measures (see Table 4). Additional ANCOVAs were completed that included age as an additional covariate before the test of the group effect. The computer science results changed some: The intervention had a larger significant effect (the percentage of explained variance increased from 28 to 34%) and the cumulative variance increased from 28 to 46 percent. The TOAL ANCOVA results with age showed similar changes, i.e., the cumulative variance increased from 34 to 50 percent. However, if the group-by-age interaction variable was entered before the group-by-TOAL-pretest variable, the group-by-pretest interaction was no longer significant, but the group-by-age interaction was significant, $F(1,30) = 8.12$, $p \leq .01$. The group-by-age interaction for the TOAL posttest was a larger effect than the group-by-pretest interaction (15% vs. 10%); the group-by-age interaction is plotted in Figure 2.

**Figure 2**

In Figure 2, the Johnson-Neyman region of significance in favor of the intervention group was at or above 16 years, i.e., students who were 16 years of age or older at the start of the intervention did better on the postintervention TOAL in the intervention group than in the control group. The very youngest students (younger than 14.5 years) did better on the postintervention TOAL in the control group than the intervention group. (In this analysis, postintervention TOAL scores were adjusted for prior TOAL scores before testing the age interaction; Figure 2 shows the adjusted TOAL posttest scores.)




After adjusting for pretest scores and age, the ANCOVA results were roughly consistent with those reported in Table 3. Adding age to the analysis significantly increased the percentage of explained variance for both postintervention measures; in addition, the age-by-group interaction was significant for the TOAL posttest. This significant interaction raised questions about which covariate--TOAL pretest or age--was the best predictor of postintervention TOAL performance; both analyses were reported.

In summary, tests supported the first hypothesis: The intervention was generally associated with higher computer science posttest scores and was associated with higher TOAL posttest scores for students entering with better language skills or who were 16 years of age or older.

Table 4

| INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a] | | | | |
|---|---|---|---|---|
| | Pretest Comp Sci (n) Sig. p-Value | Posttest Comp Sci (n) Sig. p-Value | Pretest TOAL (n) Sig. p-Value | Posttest TOAL (n) Sig. p-Value |
| Posttest Computer Science | .02<br>(40)<br>ns | 1.00 | | |
| Pretest TOAL | .44<br>(40)<br>≤.01 | .20<br>(35)<br>ns | 1.00 | |
| Posttest TOAL | .09<br>(40)<br>ns | .23<br>(41)<br>≤.10 | .49<br>(35)<br>≤.01 | 1.00 |
| Age | .08<br>(40)<br>ns | .29<br>(41)<br>≤.05 | .26<br>(35)<br>ns | .40<br>(41)<br>≤.01 |

[a] All correlations were analyzed as one-tailed tests.

*Interrelationships among performance and participation.* The interrelatedness of the postintervention performance and participation measures was examined through intercorrelations, presented in Table 5. Attendance at lectures was correlated significantly with computer science and TOAL posttest scores, and attendance at tutorials was significantly correlated with computer science posttest scores. Field trip attendance was not significantly related to either postintervention measure of performance. These correlations support the possibility that participation in the intervention's components was causally related to performance gains.

Table 5

| CORRELATIONS BETWEEN PERFORMANCE MEASURES AND PARTICIPATION | | | | |
|---|---|---|---|---|
| | Tutoring Hours | Field Trips | Lectures | n |
| Comp Science Posttest | .34* | .05 | .40** | 22 |
| TOAL Posttest | .16 | -.20 | .40** | 22 |

* $p \leq .10$, one-tailed
** $p \leq .05$, one-tailed

Opinion Measures

*Group differences on pre- and postintervention measures.* The means of the intervention- and control-group students were compared for the 13 opinion scales, 3 constructs, and total opinion score, before and after the intervention. These results are given in Table 6. Before the intervention began, the students in the intervention and control groups differed significantly on one of the 17 opinion measures: The intervention-group students had significantly higher scores on the Study Habits scale. Finding only one difference on 17 measures strengthened the conclusion that the groups were comparable before the intervention. After the intervention ended, the intervention-group and control-group students did not differ on any of the 17 measures. However, the absence of any postintervention differences may have been partly due to the relatively insensitive test of group differences, i.e., t-test. To adjust for preexisting differences and provide a more sensitive test of the intervention's effects on opinion, the final opinion measures were adjusted for preexisting opinion scores via ANCOVA.

**Table 6**

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| OPINION, Total | Pretest | 3.08 | .32 | 3.07 | .28 | -0.06 | ns |
| | Posttest | 3.09 | .42 | 2.97 | .32 | -1.02 | ns |
| SET GOAL | Pretest | 3.27 | .37 | 3.24 | .33 | -0.32 | ns |
| | Posttest | 3.28 | .47 | 3.17 | .41 | -0.80 | ns |
| Value | Pretest | 3.44 | .46 | 3.37 | .44 | -0.53 | ns |
| | Posttest | 3.62 | .45 | 3.37 | .70 | -1.32 | ns |
| Cultural Value | Pretest | 3.52 | .28 | 3.46 | .36 | -0.62 | ns |
| | Posttest | 3.47 | .44 | 3.35 | .44 | -0.92 | ns |
| Self-Concept | Pretest | 3.13 | .59 | 3.03 | .50 | -0.62 | ns |
| | Posttest | 3.07 | .72 | 2.95 | .61 | -0.60 | ns |
| Aspiration | Pretest | 3.11 | .55 | 3.21 | .41 | 0.67 | ns |
| | Posttest | 3.11 | .54 | 3.14 | .47 | 0.23 | ns |
| ATTITUDE | Pretest | 2.94 | .34 | 2.96 | .31 | 0.28 | ns |
| | Posttest | 2.96 | .44 | 2.84 | .31 | -0.97 | ns |
| Math/Science Attitude | Pretest | 3.15 | .40 | 3.23 | .36 | 0.68 | ns |
| | Posttest | 3.17 | .41 | 3.12 | .44 | -0.43 | ns |

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| Locus of Control | Pretest | 3.06 | .53 | 3.19 | .54 | 0.81 | ns |
| | Posttest | 3.23 | .39 | 3.10 | .63 | -0.79 | ns |
| Persistence | Pretest | 3.10 | .41 | 3.08 | .56 | -0.10 | ns |
| | Posttest | 2.96 | .68 | 2.83 | .48 | -0.69 | ns |
| Study Habits | Pretest | 2.61 | .48 | 2.85 | .35 | 1.94 | ≤.10 |
| | Posttest | 2.83 | .50 | 2.73 | .34 | -0.76 | ns |
| Anxiety | Pretest | 2.73 | .65 | 2.53 | .48 | -1.18 | ns |
| | Posttest | 2.66 | .76 | 2.48 | .61 | -0.84 | ns |
| ENVIRONMENTAL SUPPORT | Pretest | 3.04 | .39 | 3.01 | .34 | -0.30 | ns |
| | Posttest | 3.05 | .44 | 2.91 | .40 | -1.05 | ns |
| Academic Support | Pretest | 3.43 | .44 | 3.36 | .48 | -0.50 | ns |
| | Posttest | 3.29 | .47 | 3.18 | .48 | -0.71 | ns |
| Career Awareness | Pretest | 3.14 | .42 | 3.01 | .56 | -0.87 | ns |
| | Posttest | 3.32 | .53 | 3.06 | .43 | -1.67 | ns |
| Role Model | Pretest | 2.46 | .56 | 2.49 | .74 | 0.19 | ns |
| | Posttest | 2.72 | .75 | 2.46 | .73 | -1.10 | ns |
| Equal Opportunity | Pretest | 3.14 | .59 | 3.20 | .54 | 0.34 | ns |
| | Posttest | 2.86 | .60 | 2.94 | .65 | 0.39 | ns |

All pretests were analyzed as two-tailed tests.
All posttests were analyzed as one-tailed tests.
Pretest n's: Control = 21; Intervention = 25
Posttest n's: Control = 19; Intervention = 21

*Group differences on opinion adjusting for prior scores.* Table 7 reports the tests of the effects of group membership on opinion after adjusting for preintervention opinion scores. By this analysis, the groups did not differ generally on any opinion measures. However, group membership interacted with preintervention opinion score for two measures: Attitude construct and Career Awareness opinion scale. The significant interactions indicated that the relationship between prior opinion score and the final opinion scores were different in the two groups. As before, the interactions were analyzed further using the Johnson-Neyman technique (Rogosa, 1980) to determine the intersection point of the two regression lines and the range of preintervention scores for which the groups differed.

**Figure 3**

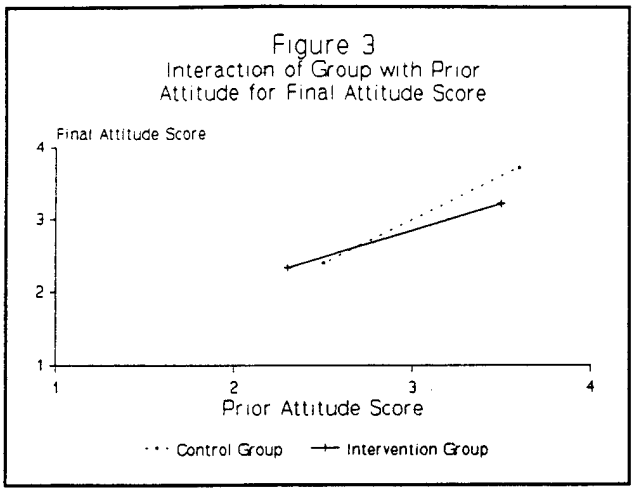



**Figure 4**

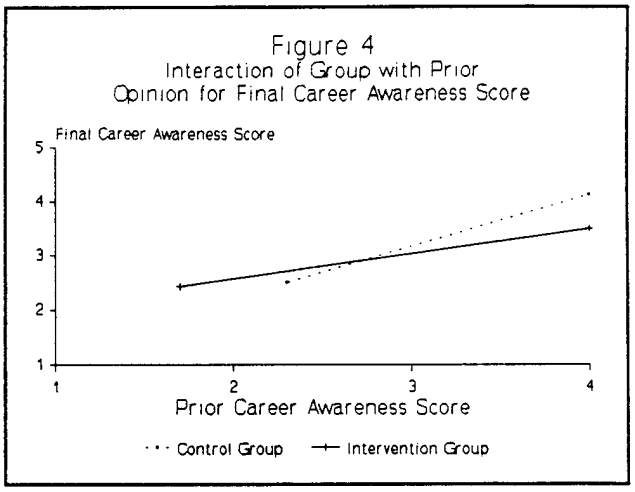



Figure 3 shows the nonparallel regression lines that indicate that for the students with the lowest preintervention Attitude construct scores, the students in the intervention group outperformed those in the control group; however, for most students, specifically for those with prior Attitude scores above 2.9 (total $\underline{M}$ = 3.0), the control-group students had higher adjusted post-intervention Attitude construct scores.

Figure 4 shows a similar relationship between group membership and prior Career Awareness. For students with prior Career Awareness scores at or below 2.4, the intervention group scored higher than the control group on the final opinion scale; the control group scored higher than the intervention group for one half of the students, i.e., students with prior Career Awareness scores at or above 3.1 (total $\underline{M}$ = 3.1).

Tests of the second hypothesis lead to the conclusion that the intervention had little or no positive effect on students' opinions about SET fields and careers.

**Table 7**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| OPINION, Total | PREINTERVENTION | .66 | .66 | 72.28 | 1,38 | $\leq$.01 |
| | +GROUP | .67 | .02 | 1.85 | 1,37 | ns |
| | +PRE-x-GROUP | .69 | .02 | 2.66 | 1,36 | ns |
| SET GOAL | PREINTERVENTION | .50 | .50 | 38.28 | 1,38 | $\leq$.01 |
| | +GROUP | .50 | .00 | 0.13 | 1,37 | ns |
| | +PRE-x-GROUP | .51 | .01 | 0.66 | 1,36 | ns |

HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Value | PREINTERVENTION | .29 | .29 | 15.17 | 1,38 | $\leq$.01 |
| | +GROUP | .30 | .01 | 0.68 | 1,37 | ns |
| | +PRE-x-GROUP | .35 | .05 | 2.84 | 1,36 | ns |
| Cultural Value | PREINTERVENTION | .21 | .21 | 9.83 | 1,38 | $\leq$.01 |
| | +GROUP | .22 | .01 | 0.60 | 1,37 | ns |
| | +PRE-x-GROUP | .22 | .00 | 0.00 | 1,36 | ns |
| Self-Concept | PREINTERVENTION | .54 | .54 | 45.29 | 1,38 | $\leq$.01 |
| | +GROUP | .54 | .00 | 0.02 | 1,37 | ns |
| | +PRE-x-GROUP | .56 | .02 | 1.35 | 1,36 | ns |
| Aspiration | PREINTERVENTION | .10 | .10 | 4.43 | 1,38 | $\leq$.05 |
| | +GROUP | .10 | .00 | 0.02 | 1,37 | ns |
| | +PRE-x-GROUP | .11 | .00 | 0.16 | 1,36 | ns |
| ATTITUDE | PREINTERVENTION | .67 | .67 | 77.45 | 1,38 | $\leq$.01 |
| | +GROUP | .70 | .02 | 2.93 | 1,37 | $\leq$.10 |
| | +PRE-x-GROUP | .74 | .04 | 5.64 | 1,36 | $\leq$.05 |
| Math/Science Attitude | PREINTERVENTION | .33 | .33 | 18.55 | 1,38 | $\leq$.01 |
| | +GROUP | .35 | .02 | 0.97 | 1,37 | ns |
| | +PRE-x-GROUP | .37 | .02 | 1.16 | 1,36 | ns |
| Locus of Control | PREINTERVENTION | .20 | .20 | 9.53 | 1,38 | $\leq$.01 |
| | +GROUP | .24 | .04 | 1.77 | 1,37 | ns |
| | +PRE-x-GROUP | .29 | .05 | 2.66 | 1,36 | ns |
| Persistence | PREINTERVENTION | .29 | .29 | 15.63 | 1,38 | $\leq$.01 |
| | +GROUP | .30 | .01 | 0.42 | 1,37 | ns |
| | +PRE-x-GROUP | .31 | .01 | 0.62 | 1,36 | ns |
| Study Habits | PREINTERVENTION | .16 | .16 | 7.20 | 1,38 | $\leq$.05 |
| | +GROUP | .20 | .04 | 1.78 | 1,37 | ns |
| | +PRE-x-GROUP | .21 | .01 | 0.38 | 1,36 | ns |
| Anxiety | PREINTERVENTION | .58 | .58 | 51.76 | 1,38 | $\leq$.01 |
| | +GROUP | .58 | .00 | 0.05 | 1,37 | ns |
| | +PRE-x-GROUP | .58 | .00 | 0.15 | 1,36 | ns |
| ENVIRONMENTAL SUPPORT | PREINTERVENTION | .39 | .39 | 24.47 | 1,38 | $\leq$.01 |
| | +GROUP | .42 | .03 | 1.90 | 1,37 | ns |
| | +PRE-x-GROUP | .43 | .01 | 0.58 | 1,36 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Academic Support | PREINTERVENTION | .14 | .14 | 6.33 | 1,38 | $\leq$.05 |
| | +GROUP | .15 | .01 | 0.39 | 1,37 | ns |
| | +PRE-x-GROUP | .21 | .06 | 2.78 | 1,36 | ns |
| Career Awareness | PREINTERVENTION | .46 | .46 | 32.39 | 1,38 | $\leq$.01 |
| | +GROUP | .50 | .04 | 2.92 | 1,37 | $\leq$.10 |
| | +PRE-x-GROUP | .56 | .06 | 4.95 | 1,36 | $\leq$.05 |
| Role Model | PREINTERVENTION | .21 | .21 | 10.22 | 1,38 | $\leq$.01 |
| | +GROUP | .25 | .04 | 2.07 | 1,37 | ns |
| | +PRE-x-GROUP | .25 | .00 | 0.03 | 1,36 | ns |
| Equal Opportunity | PREINTERVENTION | .06 | .06 | 2.34 | 1,38 | ns |
| | +GROUP | .06 | .00 | 0.07 | 1,37 | ns |
| | +PRE-x-GROUP | .06 | .00 | 0.12 | 1,36 | ns |

All models were analyzed as two-tailed tests.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure): (1) PRETEST OPINION SCORE; (2) PRETEST OPINION SCORE and GROUP ('+'); (3) PRETEST OPINION SCORE and GROUP and PRETEST OPINION SCORE-by-GROUP INTERACTION ('-x-').

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

*Correlations between opinions and participation measures.* The 17 opinion measures were tested for their relationship to the level of participation in each of the five intervention components. The correlation coefficients are given in Table 8. Of the 51 tested relationships between participation and posttest opinion scores, 20 were significant at the $p \leq .10$ level (one-tailed); of these, eight of these relationships were between tutoring attendance and opinion measures, seven were between lecture attendance and opinion measures, and five were between field trip attendance and opinion measures. Because the intervention was not associated with positive opinion gains (see Tables 6 and 7), these positive correlations should be interpreted as likely indicating that the students with more positive opinions about SET fields and careers had better attendance in the intervention's components.

**Table 8**

**CORRELATIONS BETWEEN POSTINTERVENTION OPINION MEASURES AND PARTICIPATION**

| CONSTRUCT/Scale | TUTORING | FIELD TRIPS | LECTURES |
|---|---|---|---|
| OPINION | .31* | .29* | .29 |
| SET GOAL | .26 | .31* | .31* |

**CORRELATIONS BETWEEN POSTINTERVENTION OPINION MEASURES AND PARTICIPATION**

| CONSTRUCT/Scale | TUTORING | FIELD TRIPS | LECTURES |
|---|---|---|---|
| Value | .10 | .15 | .14 |
| Cultural Value | -.06 | .02 | .06 |
| Self-Concept | .34* | .22 | .26 |
| Aspiration | .25 | .50** | .41** |
| ATTITUDE | .19 | .19 | .11 |
| Math/Science Attitude | .42** | .26 | .45** |
| Locus of Control | .39** | .40** | .27 |
| Persistence | -.12 | .01 | -.14 |
| Study Habits | -.18 | .21 | -.37 |
| Anxiety | -.04 | -.13 | -.09 |
| ENVIRONMENTAL SUPPORT | .43** | .26 | .37** |
| Academic Support | .55*** | .44** | .30* |
| Career Awareness | .53*** | .18 | .53*** |
| Role Model | .32* | .15 | .31* |
| Equal Opportunity | -.06 | .03 | .00 |

* $p \leq .10$ All were one-tailed tests.
** $p \leq .05$
*** $p \leq .01$

NOTE: Each r, the Pearson correlation coefficient, was computed on 21 cases.

Summary of Results

Table 9 summarizes the findings as effect sizes. As the effect sizes indicate, the intervention had a large positive effect on computer science performance, a moderately large interaction for TOAL, and small-to-moderate negative effects on opinion. The hypothesis of enhanced performance in computer science and language skills was supported, but the hypothesis of enhanced opinions about SET fields and careers received no support from these results.

Table 9

| EFFECT SIZES | | | |
|---|---|---|---|
| **VARIABLE** | **Posttest** | **Adjusted Posttest** | **Group-by-Pre Interaction** |
| **PERFORMANCE** | | | |
| Comp Science Posttest | 1.23*** | 1.22*** | .00 |
| TOAL Posttest | .04 | .22 | -.72** |
| **OPINION** | | | |
| **Total Opinion** | -.32 | -.43 | .52 |
| SET Goal | -.25 | -.11 | .26 |
| Attitude | -.31 | -.54* | .75** |
| Environmental Support | -.33 | -.44 | .24 |

* $p \leq .10$ All were one-tailed tests.
** $p \leq .05$
*** $p \leq .01$

The measure of effect size is in pooled standard deviation units calculated according to B. T. Johnson (1989). A positive sign indicates that the intervention group outperformed the control group; a negative sign indicates that the control group had the higher score.

## DISCUSSION

The intervention-group students outperformed the control-group students on the computer science posttest, and the intervention enhanced TOAL posttest scores for students with higher pretest scores or who were at least 16 years old. The groups did not differ generally on any opinion measure; two significant interactions between group membership and prior opinions had limited benefits for intervention-group students who began with very low Attitude and Career Awareness scores. The hypothesis of enhanced performance in computer science and language skills was supported; the hypothesis of enhanced opinions about SET fields and careers was not supported.

Though the intervention was analyzed as a quasi-experiment with the ensuing caution about causal conclusions, the groups appeared comparable before the intervention. Comparisons on a total of 77 preintervention measures found significant differences on only four percent, which included a broad range of demographic measures (the groups differed on 2 of 58 measures), performance (the groups differed on 0 of 2), and opinion measures (the groups differed on 1 of 17).

It should be noted that the circumstances related to recruitment for this project may affect the generalizability of the findings. It was necessary to postpone the beginning of intervention activity until many months after the recruitment effort began. It seems likely that under these circumstances, the more strongly motivated students would be inclined to remain committed to the program and wait for activities to begin. Accordingly, the intervention's success in teaching computer science may not generalize to other groups of students.

A replication of this intervention would provide an opportunity to verify that the intervention is associated with greater success in computer science and improved performance on the TOAL for the older or better prepared students.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# APPENDICES

# APPENDIX A

# HIGH SCHOOL STUDENT PROTOCOL

Participant Number: _____

## HIGH SCHOOL STUDENT PROTOCOL

Thank you for agreeing to participate in this important project. It is geared to help us develop new programs for students and improve existing programs.

Your opinions and experience are important to us. Please read each question carefully and answer completely and accurately to the best of your ability. All of your answers will be kept in confidence. Your answers will be grouped with those of other students in other places, and together they will help us better understand students' needs and preferences today.

Please ask your administrator if any of these questions are unclear to you.

Thanks for your help!

1. Sex:
   - ___ a. Male
   - ___ b. Female

2. When were you born? _____ _____ _____
   month day year

3. Ethnicity/race:
   - ___ a. Anglo
   - ___ b. Black
   - ___ c. Asian American
   - ___ d. American Indian (Please specify the tribe which best describes your heritage.)

     _____
   - ___ e. Hispanic (Which of the following best describes your heritage?)
     - ___ a. Cuban-American
     - ___ b. Mexican-American
     - ___ c. Puerto Rican
     - ___ d. Other Specify _____
   - ___ f. Other Specify _____

4. Are you a United States citizen?
   - ___ a. Yes
   - ___ b. No

5. Name of your school: _____

   City: _____ State: _____

6. Class:
   ___ a. High School Freshman
   ___ b. High School Sophomore
   ___ c. High School Junior
   ___ d. High School Senior
   ___ e. Other Specify _____

7. Which of the following college entrance exams have you taken?
   ___ a. I haven't taken any
   ___ b. ACT
   ___ c. PSAT or SAT
   ___ d. Other Specify _____

8. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Less than high school graduation
   ___ b. High school graduation
   ___ c. Two-year college degree (community college or junior college)
   ___ d. Four-year college degree
   ___ e. Education beyond four years of college
   ___ f. Other Specify _____

9. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

10. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)
   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Job
   ___ d. Previous personal earnings and savings
   ___ e. Family trust fund, insurance plan, or other similar arrangement
   ___ f. Other Specify _____

11. You may want to receive help outside your regular high school course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems

___ f. Increasing reading ability
___ g. Developing good study habits
___ h. Improving writing ability

12. What is or are the occupation(s) of the person(s) with whom you live? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

_____ _____

13. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average
___ d. Don't know

14. Are you:
___ a. An only child (skip to question 13)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

15. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

16. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

17. What was the highest level of school your mother completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

18. What is the language spoken most often by adults in your household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe (What is that language?) _____
___ d. Another language - Specify _____

19. Which of the following did your parent(s) or guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

20. Which of the following comes closest to describing how much your parent(s) or guardian(s) read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

21. Which of the following comes closest to describing how much you read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

22. Which of these items do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

23. What kind of high school or secondary school do you attend?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

24. Are you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes (Please list them.)

_____

_____

_____

_____

_____

25. Have you ever taken part in any of these activities? (Check all that apply)
    ___ a. Math and science clubs
    ___ b. Field trip to science museum, laboratory, or other place where scientists work
    ___ c. Watching science programs on TV
    ___ d. A talk by a scientist
    ___ e. Science/math fair
    ___ f. Other science/math competition
    ___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL ITEMS WITH DIRECTIONALITY AND SCALES

**Legend:**

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of my ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |

| | | | |
|---|---|---|---|
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

    i. _____

    ii. _____

    iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE HIGH SCHOOL STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 25 | CONTROL n = 21 |
| 1. Sex: | | |
| Women | 72% | 67% |
| Men | 28% | 33% |
| 2. Age | 15.56 | 16.04 |
| 6. Class: | | |
| .Freshmen | 60% | 33% |
| .Sophomores | 8% | 29% |
| .Juniors | 28% | 24% |
| .Seniors | 4% | 14% |
| .Other | 0% | 0% |
| .Missing | 0% | 0% |
| 7. Students taken a college entrance exam | 28% | 33% |
| .Missing | 4% | 5% |
| 8. Higher education expected: | | |
| .Less than high school graduation | 0% | 5% |
| .High school graduation | 12% | 5% |
| .Two years of college | 20% | 33% |
| .Four years of college | 52% | 29% |
| .One or more years after college | 12% | 29% |
| .Other | 4% | 0% |
| 9. Studies most influenced by: | | |
| .Parents | 76% | 57% |
| .Another family member | 4% | 10% |
| .Teacher | 8% | 24% |
| .Counselor | 0% | 0% |
| .Minister | 4% | 0% |
| .Friend | 4% | 0% |
| .Science professional | 0% | 0% |
| .Nonscience professional | 0% | 0% |
| .No one at all | 4% | 5% |
| .Missing | 0% | 5% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 25 | CONTROL n = 21 |
| 10. Sources of income:[b] | | |
| .Parents/guardians | 56% | 71% |
| .Spouse | 0% | 0% |
| .Job | 72% | 38%[a] |
| .Personal savings | 12% | 14% |
| .Family trust, etc. | 0% | 10% |
| .Other | 8% | 0% |
| Number of sources of income * | 1.52 | 1.33 |
| 11. Student needs help in: [b] | | |
| .Counseling on educational plans | 16% | 38% |
| .Counseling on career plans | 44% | 29% |
| .Improving math ability | 60% | 48% |
| .Finding part-time work | 40% | 43% |
| .Counseling on personal problems | 12% | 14% |
| .Increasing reading ability | 12% | 0% |
| .Developing good study habits | 32% | 38% |
| .Improving writing ability | 20% | 14% |
| Number of areas needing help * | 2.36 | 2.24 |
| 12. Sources of outside income: | | |
| .None | 4% | 14% |
| .One | 28% | 43% |
| .Two | 56% | 33% |
| .Missing | 12% | 10% |
| 13. Family income: | | |
| .Below U.S. average | 8% | 10% |
| .About average | 28% | 43% |
| .Above average | 28% | 43% |
| .Unknown or missing | 48% | 33% |
| 14. Birth order of student: | | |
| .Only child | 0% | 10% |
| .Oldest child | 40% | 33% |
| .Youngest child | 20% | 19% |
| .In-between child | 40% | 33% |
| .Missing | 0% | 5% |
| 15. Number of siblings: | | |
| .None | 0% | 10% |
| .One | 16% | 19% |
| .Two | 32% | 29% |
| .Three or more | 52% | 38% |
| .Missing | 0% | 5% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 25 | CONTROL n = 21 |
| 16. Father's education: | | |
| .Grade school or less | 12% | 14% |
| .Some high school | 32% | 19% |
| .High school graduate | 36% | 43% |
| .Some college | 4% | 10% |
| .College degree or more | 16% | 5% |
| .Missing | 0% | 10% |
| 17. Mother's education: | | |
| .Grade school or less | 4% | 10% |
| .Some high school | 32% | 24% |
| .High school graduate | 36% | 48% |
| .Some college | 4% | 5% |
| .College degree or more | 24% | 14% |
| 18. Language spoken most at home: | | |
| .English | 100% | 100% |
| .Spanish | 0% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| 19. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 44% | 57% |
| .Attend parent-teacher conferences | 24% | 24% |
| .Visit student's class | 40% | 29% |
| .Phone/visit if there's a problem | 44% | 48% |
| .Do volunteer work | 32% | 19% |
| .Assist student in course selection | 44% | 29% |
| .Assist in student's homework | 76% | 67% |
| Number of parental involvements * | 3.04 | 2.71 |
| 20. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 32% | 57% |
| .A lot | 68% | 43% |
| 21. Student reads: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 64% | 52% |
| .A lot | 36% | 48% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 25 | CONTROL n = 21 |
| 22. Items in student's home:[b] | | |
| .Desk | 48% | 57% |
| .Daily newspaper | 56% | 57% |
| .Encyclopedia | 80% | 86% |
| .Typewriter | 48% | 57% |
| .Calculator | 76% | 71% |
| .Television | 92% | 95% |
| .Computer | 12% | 14% |
| .Video Cassette Recorder (VCR) | 84% | 86% |
| Number of support items * | 4.96 | 5.24 |
| 23. Type of high school attended: | | |
| .Public | 96% | 81% |
| .Private | 4% | 5% |
| .No formal high school | 0% | 14% |
| 24. Member math/science club in high school | 16% | 43%[a] |
| 25. All activities student took part in:[b] | | |
| .Math/science club | 12% | 14% |
| .Field trip | 56% | 48% |
| .Watching science programs on TV | 56% | 71% |
| .Listen to talk by scientist | 16% | 24% |
| .Science/math fair | 20% | 33% |
| .Other science/math competition | 8% | 14% |
| .Play/work in computer lab | 48% | 38% |
| Number of activities * | 2.16 | 2.43 |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# TALLADEGA COLLEGE

# INTERVENTIONS

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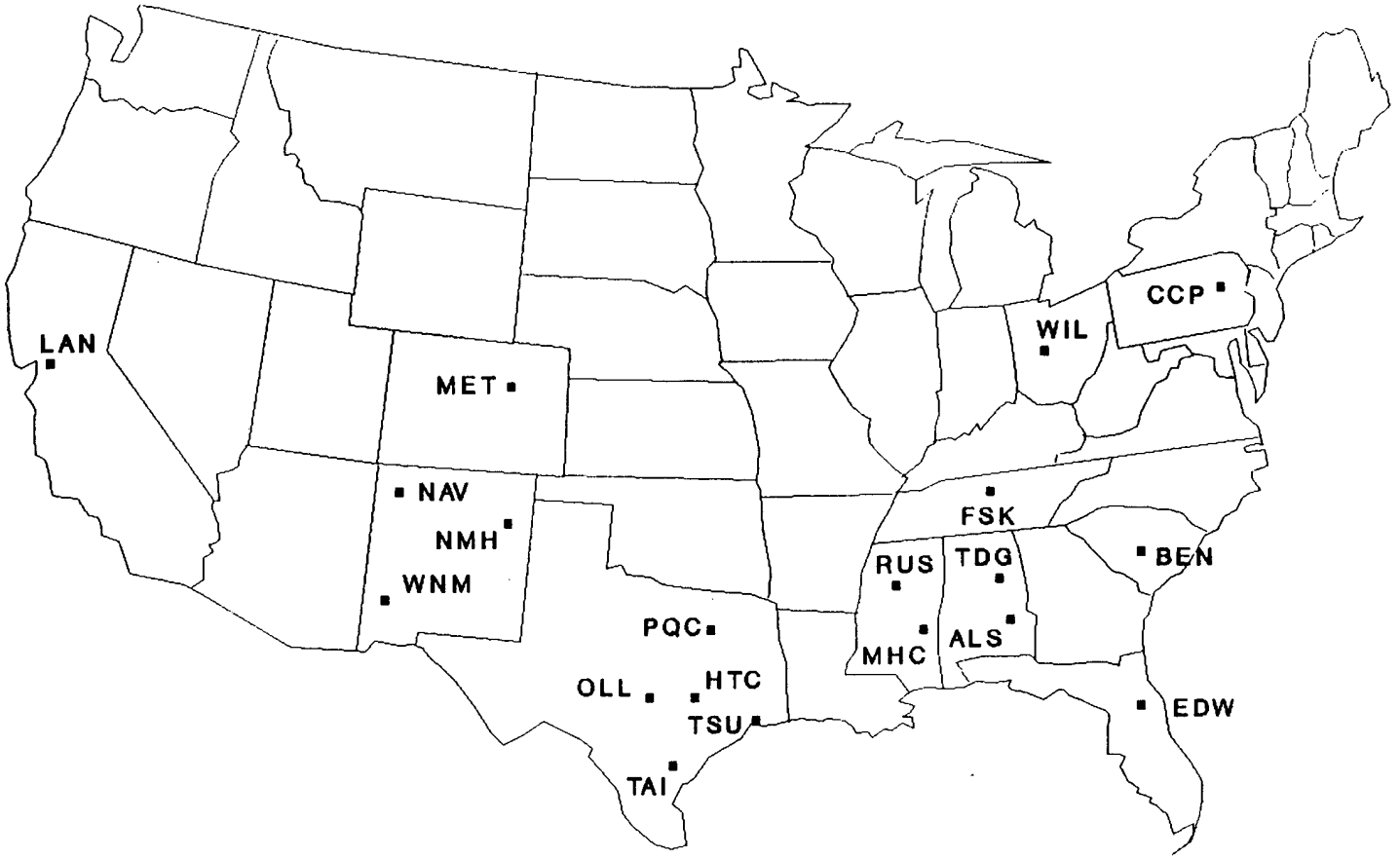
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected came from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention-group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF TALLADEGA COLLEGE

Talladega College is a historically Black, four-year, private, coeducational institution located in Talladega, Alabama. The College serves approximately 530 students and has 49 faculty members. The College, organized into the Division of Humanities, Division of Natural and Computational Sciences, and Division of Human Resources, offers undergraduate degrees. The student body is approximately 67 percent female and 33 percent male and is predominantly Black. The president of Talladega College is Dr. Joseph Thompson.

Degrees offered at Talladega College in quantitative subjects are Bachelor of Arts in chemistry, computer science, mathematics, and physics. The College also offers dual degree programs in high technology (engineering and computer science) in cooperation with Auburn University and Tuskegee Institute and in earth sciences (geology and marine sciences) in cooperation with Auburn University and the University of Alabama.

Talladega, located 50 miles southeast of Birmingham, has a population of over 19,000. The state of Alabama has a population of approximately 4.1 million. According to U.S. Census Bureau estimates, the adult population of Alabama is 75 percent Anglo, 23 percent Black, 1 percent Hispanic, and 1 percent other ethnic origins. Talladega College is near other institutions of higher education including Auburn University, Birmingham-Southern College, Tuskegee Institute, and the University of Alabama.

# PART II

# SUMMARY OF THE TALLADEGA COLLEGE (TC)

# INTERVENTIONS

This report summarizes the three interventions conducted by Talladega College, a historically Black, four-year private institution located in Talladega, Alabama. The college is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Talladega College Intervention Activities:

In Spring and Fall of 1989 and in Spring of 1990, Talladega College conducted three intervention programs for college students majoring in science. The major components of the intervention were mathematics tutoring, counseling, group meetings, field trips, and reading workshops. Participants were college students, primarily freshmen and sophomores, majoring in science; most participants were Black.

Findings:

- Unfortunately this intervention did not succeed in improving performance of SET majors. The control group consistently performed better than the intervention group on both counts.
- In opinion outcomes likewise, this intervention had consistently negative results as assessed by the Opinion Protocol.

Recommendations:

- This intervention points up the importance of evaluation of programs. It is not true that every well-intentioned program is effective in meeting its stated goals.
- These findings also underscore the importance of identifying the specific goals of a program, and taking care that those particular goals are measured. We certainly cannot say that this intervention did no good, since it is not possible to measure every conceivable outcome. There may have been some excellent outcomes here which were not evaluated.

# PART III

# CASE STUDY OF THE TALLADEGA COLLEGE

# 1989 SPRING SEMESTER INTERVENTION

## ABSTRACT

In the spring of 1989 Talladega College, Talladega, Alabama, initiated and tested against a control group an intervention program designed to reduce the attrition rate of science majors. Participants were 21 Black undergraduate college students (13 women and 8 men) who had expressed an interest in science, engineering, or technology-related (SET-related) fields. The intervention was repeated in the fall of 1989 and in the spring of 1990.

The Talladega College program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance student performance in college courses, (b) increase the percentage of students who complete their enrolled courses, and (c) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* Major components of the intervention were workshops on reading and study skills; counseling; tutoring; and seminars featuring student presentations of individual research projects. Successful upper-division science majors provided tutoring and peer counseling and served as role models. Students in the control group did not participate in any of the program activities except some counseling.

*DATA:* All the participants furnished demographic data through the CASET College Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were college GPAs, ACT and SAT percentiles, Nelson-Denny Reading Test scores, final grades in mathematics courses, and the number of hours each student studied each week as recorded by the counselor.

The outcome measures of performance were final grades in mathematics courses, postintervention college GPA, and Nelson-Denny posttest score. The preintervention measures of performance were ACT and SAT percentiles, preintervention college GPA, and Nelson-Denny pretest score.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design; through analyses of preintervention measures it appeared that the intervention and control groups were comparable.

*FINDINGS:* The intervention did not have a positive effect on the participants; the program's success was not clearly demonstrated for the variables that were measured. The hypotheses that the intervention would enhance student performance in college courses, enhance opinions about SET fields and careers, and increase retention rates in courses were not supported. The intervention had a small-to-moderate negative effect on performance and opinion; at the end of the intervention, the control-group students performed significantly better than the intervention-group students and had significantly more positive opinions about SET fields and careers. The two groups did not differ in their course completion, with both groups completing at about a 75-percent rate.

## DESCRIPTION OF THE INTERVENTION

Talladega College, in an effort to improve retention of freshmen and sophomores majoring in SET fields, developed an intensive program combining tutoring and social support with teaching of specific academic skills. In addition, participants were exposed to role models and were offered an opportunity to experience both original research and the presentation of research findings to their colleagues.

The primary purpose of this intervention was to reduce attrition of freshman and sophomore science majors. The drop-out rate at Talladega is reported as 50% for all students and is even higher for those majoring in the sciences.

The intervention took place during the Spring, 1989 semester; intervention activities ended on May 11, 1989. The CASET group met every Tuesday and Thursday for workshops, counseling, tutoring, and seminars. Students chose a research project to present to their fellow CASET participants in the seminars so that they could experience both the research and the professional presentation of findings.

The project director, Dr. Arthur Bacon, cited improved reading skills as the greatest need of the students. Dr. Carmelita K. Williams, Head of the Reading Department at Norfolk State University in Norfolk, Virginia, conducted a two-day workshop for participants entitled "Reading: Organizing for Success." Her topics included Developing Questions, Active Thinking Method, Note-taking, and Information Mapping. Other workshops focused on study skills, including time management and test-taking skills.

The tutors available to the participants were Black junior and senior science majors in good academic standing. The tutors also provided peer counseling, role modeling, and occasional seminars. Mrs. Daisy Brockington, a former high school biology department chair, and Dr. Woodrow Dorsey, a college chemistry teacher, were available full-time to counsel and advise the participants.

A distinguishing characteristic of this intervention is the amount of staff time available for students: Two full-time senior staff members, as well as upperclassmen tutors and the project director made a great deal of time available to the students.

The intervention's three major hypotheses were that the intervention would: (a) enhance performance in college courses; (b) increase the percentage of students who completed their enrolled courses; and (c) enhance student opinions about SET fields and careers.

## METHOD

### Subjects

Subjects were Black college students, primarily freshmen and sophomores, who had expressed an interest in SET-related fields. A control group of comparable students was identified to provide comparative information in order to assess the effects of the intervention. The intervention-group students participated in the intervention meetings and activities; the control-group students supplied the same information and filled out the same protocols as the intervention-group students, but did not take part in any intervention activities except some counseling.

A total of 22 sets of protocols was received from 12 intervention-group students and 10 control-group students. One control-group student was eliminated from the sample because he declared that he was not an American citizen and thus was not a member of the target populations which are the subject of this study. Data from the remaining students were analyzed and are presented in this report. All students were Black Americans; Table 1 shows the distribution of men and women in the intervention and control groups.

**Table 1**

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | | | | | | |
| Anglo | | | | | | |
| Black | 4 | 5 | 9 | 3 | 13 | 8 |
| Hispanic | | | | | | |
| Unknown | | | | | | |
| **TOTAL** | **4** | **5** | **9** | **3** | **13** | **8** |

CASET Protocols and Other Instruments

The three major hypotheses were that the intervention would: (a) enhance student performance in college courses; (b) increase the percentage of students who completed their enrolled courses; and (c) enhance student opinions about SET fields and careers.

Demographic and descriptive data about the subjects were developed through the CASET College Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gave a scalar measurement for that variable. Thus the completed Opinion Protocol provided a scale measuring each of the thirteen variables. The Opinion Protocol was administered to intervention- and control-group students before and after the intervention. The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B.

The institution also developed and implemented several instruments to assess student attitude and performance. The CASET Participant Survey was a 30-item instrument designed to measure feelings of disillusionment and alienation. Academic Summary Sheets and Counseling Forms filled out by the counselor for each intervention- and control-group student documented study hours and attitudes of students; Timeline Summaries documented the extent of participation in CASET activities.

The preintervention measures of performance for intervention- and control-group students were ACT and SAT scores, prior college GPA, and preintervention scores on the Nelson-Denny Reading Test. The hours studied per week by each intervention- and control-group student during the semester were monitored by the counselor and submitted to CASET. The postintervention measures of performance were the course grades in calculus and other mathematics courses, the postintervention GPA, and the scores on a postintervention administration of the Nelson-Denny Reading Test.

### Procedure

At the beginning of the intervention, intervention- and control-group members signed consent forms and transcript release forms. The first measures of opinion and the measures of demographic information were taken on March 9, 1989. The CASET Participant Survey and the preintervention Nelson-Denny Reading Test were also administered and scored by college personnel at this time. After the intervention, the CASET Opinion Protocol was administered a second time to all students; this was done on May 11, 1989. Postintervention administrations and scorings of the CASET Participant Survey and the Nelson-Denny Reading Test were also performed at this time. These scores, midterm and final course grades, and pre- and postintervention GPA's for intervention- and control-group students were forwarded to CASET, along with the CASET Student Protocol and the preintervention and postintervention Opinion Protocols.

For both the intervention and control groups, the college supplied college transcripts, copies of examinations in mathematics and science courses taken, and information on study habits, participation, and attitudes documented on Counseling Forms, Academic Summary Sheets, and Timeline Summaries.

The items of the Opinion Protocol were coded by CASET according to the thirteen scales they represent. Items on the Opinion Protocol were scored in such a way that a larger number reflected a more positive outcome (see Appendix B). The scales were organized into three constructs--SET Goal, Environmental Support, and Attitude--as shown in Appendix C.

## RESULTS

### Methodological Issues

The three major hypotheses were that the intervention would: (a) enhance student performance in college courses; (b) increase the percentage of students who completed their enrolled courses; and (c) enhance student opinions about SET fields and careers. As all students were enrolled in mathematics courses during the semester of the intervention, mathematics course grades and retention in the enrolled courses were used to test hypotheses (a) and (b).

Most participants had preintervention and postintervention measures of opinion and performance; the intervention was analyzed as a *nonequivalent control group* design. This type of quasi-experimental design has one major weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty may be addressed by analyzing the influence of preexisting characteristics on students' performance and opinion; the analysis

of covariance (ANCOVA), adjusting for preintervention performance or opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that existed prior to the intervention.

## Demographic Results

The comparability of the intervention and control groups was examined by testing for differences on the items of the College Student Protocol. The complete results are given in Appendix D. Of the 56 comparisons, the groups differed on only five: (a) fewer intervention-group students (17%) than control-group students (56%) were freshmen; (b) fewer intervention-group students were SET majors (25%) than were control-group students (78%); (c) more intervention-group students had work study support (58%) than did control-group students (11%); (d) more of the intervention-group students had parents who helped with homework (100%) than did the control-group students (56%); and (e) the intervention-group students reported more parental involvements ($\underline{M}$ = 5.08) than did the control-group students ($\underline{M}$ = 3.44). Two of the five differences favored the intervention-group students (more parental help), one difference favored the control-group students (more SET majors), and two were ambiguous (more control-group freshmen, more intervention-group students with work-study support). The five significant differences between the groups on preexisting characteristics were approximately the number of differences expected by chance at the 10-percent probability level. Based on these results, the groups were judged to be comparable on demographic characteristics prior to the intervention.

## Performance Measures

*Group differences in performance.* The five preintervention measures (SAT-Verbal, SAT-Math, ACT math percentile, prior college GPA, and prior Nelson-Denny Reading Test percentile) and the four postintervention measures of performance (semester GPA, final grade in mathematics course, Nelson-Denny percentile, and number of hours studied each week) were tested for group differences, and the results are given in Table 2. Note that the intervention and control groups did not differ on any of the five preintervention measures, nor did the groups differ on any of the four postintervention measures.

Because the mathematics grades were taken from students enrolled in several different courses, an additional analysis was made of a subsample of 11 students. The subsample consisted of 6 students enrolled in Calculus I (three taken from each group) and 5 students enrolled in Calculus II (two control-group and three intervention-group students). The groups did not differ significantly (due to the small subsample and the high variability of grades), but the control-group students' mean grade was almost one letter grade higher ($\underline{M}$ = 2.60, approximately "B-") than was the intervention-group students' grade ($\underline{M}$ = 1.67, approximately "C-").

A further analysis seemed necessary to provide a more sensitive test of the intervention's effects and to adjust for preintervention differences between the groups. ANCOVAs that adjusted for preintervention performance were completed for three postintervention performance measures: GPA, Nelson-Denny percentile, and mathematics course grade.

Table 2

GROUP COMPARISONS OF PERFORMANCE MEASURES

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | Sig. p |
|---|---|---|---|---|---|---|
| SAT-Verbal | Control<br>Intervention | 2<br>5 | 345.00<br>360.00 | 205.06<br>48.48 | 0.18<br>(5) | ns |
| SAT-Math | Control<br>Intervention | 2<br>5 | 335.00<br>336.00 | 91.92<br>70.92 | 0.02<br>(5) | ns |
| ACT-Math Percentile | Control<br>Intervention | 2<br>5 | 32.00<br>23.00 | 32.53<br>17.31 | -0.51<br>(5) | ns |
| Hours studied each week | Control<br>Intervention | 5<br>9 | 23.40<br>23.44 | 3.13<br>8.63 | 0.01<br>(12) | ns |
| Preintervention GPA | Control<br>Intervention | 8<br>12 | 2.28<br>2.40 | .39<br>.60 | 0.53<br>(18) | ns |
| Postintervention GPA | Control<br>Intervention | 8<br>12 | 2.03<br>2.32 | .42<br>.62 | 1.13<br>(18) | ns |
| Preintervention Nelson-Denny | Control<br>Intervention | 8<br>11 | 29.75<br>25.82 | 28.11<br>23.33 | -0.33<br>(17) | ns |
| Postintervention Nelson-Denny | Control<br>Intervention | 7<br>11 | 45.71<br>35.45 | 16.97<br>25.61 | -0.93<br>(16) | ns |
| Math Grade | Control<br>Intervention | 7<br>9 | 2.43<br>2.00 | 1.27<br>1.12 | -0.72<br>(14) | ns |
| Course Credit Hours in Math | Control<br>Intervention | 7<br>9 | 3.71<br>3.67 | .49<br>.50 | -0.19<br>(14) | ns |
| Calculus I/II Grade | Control<br>Intervention | 5<br>6 | 2.60<br>1.67 | 1.52<br>1.03 | -1.21<br>(9) | ns |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

*Group differences after adjusting for pretests.* A hierarchical ANCOVA adjusted for a pretest before comparing groups on three postintervention performance measures; the results are given in Table 3. This table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding the first and each subsequent measure to the multiple regression equation (one measure per row), and the significance test of each measure's contribution toward explaining the dependent measure. The columns of the table include the cumulative percentage of explained variance (cum $R^2$), added contribution in explained variance of the measure ($sR^2$), test of the contribution of the new measure ($F(sR^2)$), and the degrees of freedom (df) for the test.

Table 3

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| Postintervention GPA | PRE GPA | .85 | .85 | 99.44 | 1,17 | $\leq$.01 |
| | + GROUP | .85 | .00 | 0.02 | 1,16 | ns |
| | + PRE-x-GROUP | .87 | .01 | 1.34 | 1,15 | ns |
| Postintervention Nelson-Denny | PRE NELS-DENNY | .49 | .49 | 15.63 | 1,16 | $\leq$.01 |
| | + GROUP | .51 | .01 | 0.42 | 1,15 | ns |
| | + PRE-x-GROUP | .63 | .12 | 4.46 | 1,14 | $\leq$.10 |
| Math Grade | PRE GPA | .18 | .18 | 2.95 | 1,13 | ns |
| | + GROUP | .36 | .18 | 3.39 | 1,12 | $\leq$.10 |
| | + PRE-x-GROUP | .39 | .02 | 0.39 | 1,11 | ns |
| Calculus Grade | PRE GPA | .08 | .08 | 0.72 | 1,8 | ns |
| | + GROUP | .51 | .43 | 6.10 | 1,7 | $\leq$.05 |
| | + PRE-x-GROUP | .57 | .06 | 0.84 | 1,6 | ns |

All models were analyzed as two-tailed tests.

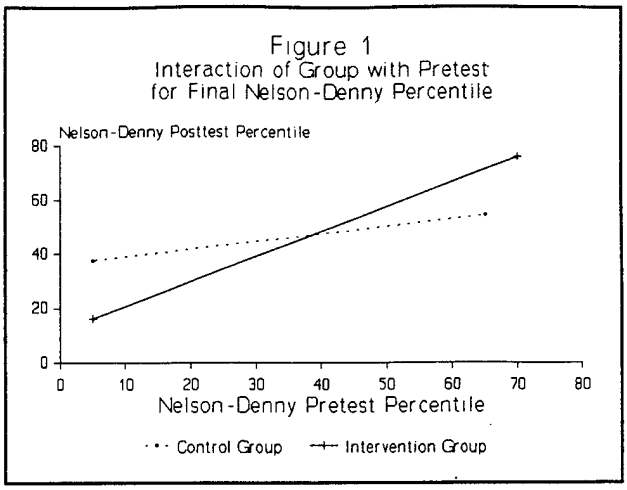
* Three models of independent variables were tested for each dependent variable, e.g.: (1) GPA alone; (2) GPA and ('+') GROUP; (3) GPA and GROUP and GPA-by-GROUP INTERACTION ('-x-').

The results in Table 3 demonstrated that the control-group and intervention-group students did not differ significantly for postintervention GPA, that preintervention Nelson-Denny percentile interacted significantly with group membership, and that the control-group students significantly outperformed the intervention-group students on the mathematics course grade whether all courses or only calculus courses were considered. The adjusted means for the mathematics grades were 2.88 (control group) and 1.87 (intervention group); the adjusted means for the calculus grades were 3.25 (control group) and 1.49 (intervention group).

The significant interaction indicated that the relationship between prior Nelson-Denny percentile and the final Nelson-Denny percentile was different in the two groups. The interaction was analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of preintervention scores for which the groups differed.

Figure 1 shows the nonparallel regression lines that indicate that for students with higher preintervention Nelson-Denny percentiles, the students in the intervention group outperformed those in the control group.

**Figure 1**




In Figure 1, for students with prior Nelson-Denny percentiles at or above 61, the intervention group outperformed the control group on the final Nelson-Denny test; the control group outperformed the intervention group only for students with prior Nelson-Denny percentiles at or below 15.

*Course completion.* An additional hypothesized benefit of the intervention for performance was that more of the students in the intervention group would complete their mathematics courses. Seventy-five percent (9 out of 12) of the intervention group and 78 percent (7 out of 9) of the control group finished their courses: this difference is not statistically significant in a sample of this size.

*Interrelationships among performance.* The interrelatedness of the performance measures was examined through intercorrelations, presented in Table 4. The preintervention and postintervention measures for GPA and the Nelson-Denny test were significantly correlated, preintervention GPA was more highly correlated with mathematics course grade than was preintervention Nelson-Denny percentile, and the average number of hours studied was not significantly correlated with either postintervention GPA or mathematics course grade.

**Table 4**

**INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a]**

| | **Pre GPA (n) Sig. p-Value** | **Post GPA (n) Sig. p-Value** | **Pre Nelson- Denny (n) Sig. p-Value** | **Post Nelson-Denny (n) Sig. p-Value** | **Math Grade (n) Sig. p-Value** |
|---|---|---|---|---|---|
| Post GPA | .92<br>(19)<br>≤.01 | 1.00 | | | |
| Pre Nelson-Denny | .08<br>(18)<br>ns | .14<br>(19)<br>ns | 1.00 | | |
| Post Nelson-Denny | .44<br>(17)<br>≤.05 | .45<br>(18)<br>≤.05 | .70<br>(18)<br>≤.01 | 1.00 | |
| Math Grade | .43<br>(15)<br>≤.10 | .56<br>(16)<br>≤.05 | .22<br>(15)<br>ns | .62<br>(15)<br>≤.01 | 1.00 |

| INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a] | | | | | |
|---|---|---|---|---|---|
| | Pre GPA (n) Sig. p-Value | Post GPA (n) Sig. p-Value | Pre Nelson- Denny (n) Sig. p-Value | Post Nelson-Denny (n) Sig. p-Value | Math Grade (n) Sig. p-Value |
| Number of Hours Studied | -.18 (13) ns | -.16 (14) ns | .51 (14) ≤.05 | .48 (13) ≤.05 | -.16 (10) ns |
| [a] All correlations were analyzed as two-tailed tests. | | | | | |

Opinion Measures

*Group differences on pre- and postintervention measures.* The means of the intervention- and control-group students were compared for the 13 opinion scales, three constructs, and total opinion score, before and after the intervention. These results are given in Table 5. Before the intervention began, the intervention and control groups did not differ significantly on any of the seventeen opinion measures; this strengthened the conclusion that the groups were comparable before the intervention. After the intervention ended, the intervention group had higher scores on one of the seventeen measures--Equal Opportunity; the control group had higher scores on four measures: SET Goal construct, Self-Concept, Aspiration, and Math/Science Attitude. However, the postintervention differences may have been due to the maturation of statistically significant preexisting differences and not due to the intervention. In order to adjust for preexisting differences, the final opinion measures were adjusted for preexisting differences via ANCOVA.

**Table 5**

| GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | | |
|---|---|---|---|---|---|---|---|
| CONSTRUCT/ Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
| | | Mean | SD | Mean | SD | | |
| OPINION, Total | Pretest<br>Posttest | 3.00<br>2.99 | .30<br>.28 | 2.90<br>2.84 | .24<br>.24 | -0.83<br>-1.23 | ns<br>ns |
| SET GOAL | Pretest<br>Posttest | 3.22<br>3.34 | .49<br>.38 | 3.14<br>3.02 | .25<br>.29 | -0.49<br>-2.12 | ns<br>≤.05 |
| Value | Pretest<br>Posttest | 3.42<br>3.50 | .50<br>.38 | 3.38<br>3.27 | .42<br>.46 | -0.21<br>-1.17 | ns<br>ns |
| Cultural Value | Pretest<br>Posttest | 3.69<br>3.56 | .32<br>.44 | 3.65<br>3.44 | .36<br>.32 | -0.32<br>-0.70 | ns<br>ns |

GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES

| CONSTRUCT/ Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| Self-Concept | Pretest | 2.85 | .64 | 2.69 | .37 | -0.75 | ns |
| | Posttest | 3.08 | .51 | 2.64 | .44 | -2.08 | ≤.05 |
| Aspiration | Pretest | 3.13 | .72 | 3.10 | .34 | -0.14 | ns |
| | Posttest | 3.32 | .56 | 2.93 | .47 | -1.70 | ≤.10 |
| ATTITUDE | Pretest | 2.80 | .32 | 2.73 | .33 | -0.46 | ns |
| | Posttest | 2.78 | .31 | 2.70 | .29 | -0.56 | ns |
| Math/Science Attitude | Pretest | 3.02 | .35 | 3.05 | .50 | 0.15 | ns |
| | Posttest | 3.23 | .46 | 2.92 | .40 | -1.64 | ≤.10 |
| Locus of Control | Pretest | 3.22 | .47 | 3.25 | .59 | 0.12 | ns |
| | Posttest | 3.04 | .49 | 3.15 | .47 | 0.51 | ns |
| Persistence | Pretest | 2.86 | .59 | 2.62 | .47 | -1.02 | ns |
| | Posttest | 2.47 | .39 | 2.68 | .58 | 0.91 | ns |
| Study Habits | Pretest | 2.58 | .40 | 2.65 | .38 | 0.37 | ns |
| | Posttest | 2.66 | .57 | 2.65 | .43 | -0.05 | ns |
| Anxiety | Pretest | 2.43 | .63 | 2.22 | .49 | -0.83 | ns |
| | Posttest | 2.40 | .46 | 2.26 | .54 | -0.59 | ns |
| ENVIRONMENTAL SUPPORT | Pretest | 3.05 | .38 | 2.86 | .20 | -1.46 | ns |
| | Posttest | 2.86 | .49 | 2.86 | .21 | -0.05 | ns |
| Academic Support | Pretest | 3.30 | .49 | 3.14 | .39 | -0.82 | ns |
| | Posttest | 3.21 | .64 | 3.00 | .40 | -0.90 | ns |
| Career Awareness | Pretest | 3.11 | .47 | 3.08 | .32 | -0.16 | ns |
| | Posttest | 3.04 | .60 | 3.08 | .35 | 0.20 | ns |
| Role Model | Pretest | 2.80 | .74 | 2.39 | .49 | -1.53 | ns |
| | Posttest | 2.50 | 1.10 | 2.39 | .37 | -0.33 | ns |
| Equal Opportunity | Pretest | 3.00 | .53 | 2.83 | .33 | -0.89 | ns |
| | Posttest | 2.71 | .45 | 2.97 | .33 | 1.51 | ≤.10 |

All pretests were analyzed as two-tailed tests.
All posttests were analyzed as one-tailed tests.
Pretest n's: Control = 9; Intervention = 12
Posttest n's: Control = 8; Intervention = 12

*Group differences on opinion adjusting for prior scores.* Table 6 reports the tests of the effects of group membership on opinion after adjusting for preintervention opinion scores. By this analysis, the groups differed overall on four opinion measures: the intervention group had significantly higher Persistence scores; and the control group had higher scores on three measures: SET Goal construct, Aspiration, and Math/Science Attitude. The ANCOVA results paralleled the t-test results for three measures; the Persistence result emerged because the control-group students' scores dropped from a preintervention mean of 2.86 to a postintervention mean of 2.47, and the intervention group changed very little.

**Table 6**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| OPINION, Total | PREINTERVENTION | .69 | .69 | 40.92 | 1,18 | $\leq$.01 |
| | +GROUP | .70 | .00 | 0.25 | 1,17 | ns |
| | +PRE-x-GROUP | .71 | .01 | 0.54 | 1,16 | ns |
| SET GOAL | PREINTERVENTION | .59 | .59 | 26.10 | 1,18 | $\leq$.01 |
| | +GROUP | .66 | .07 | 3.55 | 1,17 | $\leq$.10 |
| | +PRE-x-GROUP | .67 | .01 | 0.54 | 1,16 | ns |
| Value | PREINTERVENTION | .49 | .49 | 17.37 | 1,18 | $\leq$.01 |
| | +GROUP | .53 | .04 | 1.35 | 1,17 | ns |
| | +PRE-x-GROUP | .53 | .00 | 0.17 | 1,16 | ns |
| Cultural Value | PREINTERVENTION | .10 | .10 | 1.89 | 1,18 | ns |
| | +GROUP | .11 | .02 | 0.33 | 1,17 | ns |
| | +PRE-x-GROUP | .12 | .00 | 0.08 | 1,16 | ns |
| Self-Concept | PREINTERVENTION | .55 | .55 | 21.74 | 1,18 | $\leq$.01 |
| | +GROUP | .59 | .05 | 1.92 | 1,17 | ns |
| | +PRE-x-GROUP | .59 | .00 | 0.02 | 1,16 | ns |
| Aspiration | PREINTERVENTION | .56 | .56 | 22.90 | 1,18 | $\leq$.01 |
| | +GROUP | .63 | .07 | 3.08 | 1,17 | $\leq$.10 |
| | +PRE-x-GROUP | .67 | .04 | 2.00 | 1,16 | ns |
| ATTITUDE | PREINTERVENTION | .59 | .59 | 25.39 | 1,18 | $\leq$.01 |
| | +GROUP | .59 | .00 | 0.10 | 1,17 | ns |
| | +PRE-x-GROUP | .60 | .01 | 0.55 | 1,16 | ns |
| Math/Science Attitude | PREINTERVENTION | .49 | .49 | 17.01 | 1,18 | $\leq$.01 |
| | +GROUP | .59 | .10 | 4.35 | 1,17 | $\leq$.10 |
| | +PRE-x-GROUP | .65 | .06 | 2.69 | 1,16 | ns |

## HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Locus of Control | PREINTERVENTION | .36 | .36 | 10.18 | 1,18 | $\leq$.01 |
| | +GROUP | .37 | .01 | 0.25 | 1,17 | ns |
| | +PRE-x-GROUP | .37 | .00 | 0.00 | 1,16 | ns |
| Persistence | PREINTERVENTION | .35 | .35 | 9.68 | 1,18 | $\leq$.01 |
| | +GROUP | .48 | .13 | 4.16 | 1,17 | $\leq$.10 |
| | +PRE-x-GROUP | .52 | .05 | 1.56 | 1,16 | ns |
| Study Habits | PREINTERVENTION | .29 | .29 | 7.38 | 1,18 | $\leq$.05 |
| | +GROUP | .29 | .00 | 0.05 | 1,17 | ns |
| | +PRE-x-GROUP | .29 | .00 | 0.00 | 1,16 | ns |
| Anxiety | PREINTERVENTION | .62 | .62 | 28.91 | 1,18 | $\leq$.01 |
| | +GROUP | .62 | .00 | 0.08 | 1,17 | ns |
| | +PRE-x-GROUP | .65 | .04 | 1.68 | 1,16 | ns |
| Environmental Support | PREINTERVENTION | .25 | .25 | 5.95 | 1,18 | $\leq$.05 |
| | +GROUP | .28 | .03 | 0.73 | 1,17 | ns |
| | +PRE-x-GROUP | .28 | .00 | 0.00 | 1,16 | ns |
| Academic Support | PREINTERVENTION | .28 | .28 | 7.13 | 1,18 | $\leq$.05 |
| | +GROUP | .29 | .01 | 0.20 | 1,17 | ns |
| | +PRE-x-GROUP | .29 | .00 | 0.00 | 1,16 | ns |
| Career Awareness | PREINTERVENTION | .00 | .00 | 0.00 | 1,18 | ns |
| | +GROUP | .00 | .00 | 0.03 | 1,17 | ns |
| | +PRE-x-GROUP | .00 | .00 | 0.01 | 1,16 | ns |
| Role Model | PREINTERVENTION | .49 | .49 | 17.02 | 1,18 | $\leq$.01 |
| | +GROUP | .51 | .03 | 0.94 | 1,17 | ns |
| | +PRE-x-GROUP | .53 | .02 | 0.54 | 1,16 | ns |
| Equal Opportunity | PREINTERVENTION | .00 | .00 | 0.01 | 1,18 | ns |
| | +GROUP | .12 | .12 | 2.31 | 1,17 | ns |
| | +PRE-x-GROUP | .16 | .04 | 0.68 | 1,16 | ns |

All models were analyzed as two-tailed tests.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure): (1) PRETEST OPINION SCORE; (2) PRETEST OPINION SCORE and GROUP ('+'); (3) PRETEST OPINION SCORE, GROUP, and PRETEST OPINION SCORE-by-GROUP INTERACTION ('-x-').

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

*Alienation scale scores.* The CASET Participant Survey, a teacher-designed scale to measure student's alienation, was administered to students following the intervention. The survey consisted of 30 items that asked students how frequently they felt alienated; possible responses to the items were *at no time (0), some of the time* (1), and *most of the time* (2). Three of the items were worded in a reverse manner; these items were scored in reverse to produce a mean score that ranged from 0 (no alienation) to 2 (maximum alienation). Of the 30 items, 13 seemed ambiguous. Because of the ambiguity of these items, two alternative scores were derived: One alienation score was the mean of all 30 items, and a second score was the mean of the 17 unambiguous items.

The differences between the two groups' means on both alienation scales were tested for statistical significance via t-tests. The control-group students had significantly lower alienation on both scales (30-item $\underline{M}$ = .48, 17-item $\underline{M}$ = .37) than did the intervention-group students (30-item $\underline{M}$ = .66, 17-item $\underline{M}$ = .60),
30-item $\underline{t}$ (18) = 2.13, $\underline{p} \leq .05$, 17-item $\underline{t}$ (18) = 2.48, $\underline{p} \leq .05$.

To explore the validity of the alienation questionnaire, the two alienation scores were correlated with the postintervention opinion measures. The pairs of correlation coefficients for the 17 opinion measures are given in Table 7. The 30-item alienation score was correlated significantly with eight of the seventeen opinion measures, and the 17-item score was correlated significantly with nine of the seventeen opinion measures; the alienation measures seemed to correlate primarily with the scales of the Attitude and SET Goal constructs. The parallels between the alienation scores and the Attitude and SET Goal constructs also held for group differences: The control-group students had more positive scores on four opinion scales from the Attitude and SET Goal constructs, and the control-group students had lower scores on the two alienation scales.

**Table 7**

**CORRELATIONS BETWEEN POSTINTERVENTION OPINION MEASURES AND ALIENATION SCORES**

| OPINION CONSTRUCT/Scale | Alienation 30 Items $\underline{r}$ (Signif) | Alienation: 17 Items $\underline{r}$ (Signif) |
|---|---|---|
| OPINION, Total | -.47 (.05) | -.55 (.01) |
| SET GOAL | -.37 (.10) | -.47 (.05) |
| Value | -.09 (ns) | -.21 (ns) |
| Cultural Value | -.03 (ns) | -.16 (ns) |
| Self-Concept | -.46 (.05) | -.46 (.05) |
| Aspiration | -.34 (.10) | -.45 (.05) |
| ATTITUDE | -.48 (.05) | -.56 (.01) |
| Math/Science Attitude | -.27 (ns) | -.44 (.05) |
| Locus of Control | -.17 (ns) | -.27 (ns) |
| Persistence | -.35 (.10) | -.36 (.10) |

| CORRELATIONS BETWEEN POSTINTERVENTION OPINION MEASURES AND ALIENATION SCORES | | |
|---|---|---|
| OPINION CONSTRUCT/Scale | Alienation 30 Items r (Signif) | Alienation: 17 Items r (Signif) |
| Study Habits | -.15 (ns) | -.20 (ns) |
| Anxiety | -.44 (.05) | -.36 (.10) |
| ENVIRONMENTAL SUPPORT | -.23 (ns) | -.20 (ns) |
| Academic Support | -.39 (.10) | -.37 (.10) |
| Career Awareness | .03 (ns) | .02 (ns) |
| Role Model | -.20 (ns) | -.18 (ns) |
| Equal Opportunity | .07 (ns) | .10 (ns) |
| All were one-tailed tests. | | |
| NOTE: Each r, the Pearson correlation coefficient, was computed on 19 cases for both sets of measures. | | |

Summary of Results

Table 8 summarizes the findings as effect sizes. As the effect sizes indicate, the intervention had a small-to-moderate negative effect on performance and opinion. The hypotheses of enhanced performance and opinion were not supported by these results.

**Table 8**

| EFFECT SIZES | | | |
|---|---|---|---|
| **VARIABLE** | **Posttest** | **Adjusted Posttest** | **Group-by-Pre Interaction** |
| **PERFORMANCE** | | | |
| GPA | .52 | -.06 | .53 |
| Nelson-Denny | -.45 | -.31 | -1.02* |
| Math Grade | -.36 | -.93* | .31 |
| Calculus Grade | -.73 | -1.50** | .55 |

| EFFECT SIZES | | | |
|---|---|---|---|
| VARIABLE | Posttest | Adjusted Posttest | Group-by-Pre Interaction |
| **OPINION** | | | |
| **Total Opinion** | -.56 | -.23 | .34 |
| SET Goal | -.97** | -.86* | .34 |
| Attitude | -.26 | -.14 | .34 |
| Environmental Support | -.02 | .39 | .00 |

* $p \leq .10$, one-tailed
** $p \leq .05$, one-tailed

The measure of effect size is in pooled standard deviation units calculated according to B. T. Johnson (1989). A positive sign indicates that the intervention group outperformed the control group; a negative sign indicates that the control group had the higher score.

## DISCUSSION

The three hypotheses of enhanced performance, course completion, and enhanced opinions as a result of the intervention received no support. Unfortunately, the control-group students had significantly higher levels of performance, lower alienation scores, and significantly more positive opinions; the intervention and control groups did not differ in completion rate.

There were two positive effects of the intervention: (a) Students entering with high Nelson-Denny scores did better in the intervention group than in the control group; and (b) intervention-group students had higher adjusted Persistence scores than did the control-group students. There were five negative effects of the intervention: (a) Control-group students had higher adjusted mathematics grades (for all courses and for only calculus courses); (b) control-group students had more positive opinions about SET Goals; (c) control-group students had higher educational aspirations; (d) control-group students had more positive attitudes about math and science fields; and (e) control-group students had lower alienation scores on the scale developed by the college.

Though the intervention was analyzed as a quasi-experiment with the ensuing caution about causal conclusions, the groups appeared fairly well matched prior to the intervention. Comparisons on a total of 78 preintervention measures found significant differences on only six percent, which included a broad range of demographic (5 out of 56), performance (0 out of 5), and opinion measures (0 out of 17). However, some of the demographic differences may have accounted for the control-group students' greater success. For example, more control-group students were freshmen and more were SET majors; perhaps these freshman SET majors in the control group were more motivated to do well in mathematics. Some evidence for this can be inferred from Table 5; the control-group students showed several small-to-moderate gains from preintervention to postintervention opinion (on SET Goal, Self-Concept, Aspiration, and Math/Science Attitude), and the intervention-group students showed comparable gains on only one opinion measure

(Equal Opportunity). Unfortunately, the small sample size eliminates the possibility of analyzing only freshmen or only SET majors.

To understand better why the intervention activities were not successful, it would have been helpful to have quantitative measures of participation in the intervention activities. In addition, it was surprising that the number of hours studied per week did not correlate either with mathematics grade or with GPA; perhaps a more reliable measurement of study time might be correlated with performance.

Data from subsequent semesters of this intervention will include measures of participation in the intervention's components. This additional information will provide a stronger evaluation of the intervention's hypotheses.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# APPENDICES

# APPENDIX A

# COLLEGE STUDENT PROTOCOL

## College Student Protocol

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. Am. Indian (Please specify the tribe which best describes your heritage.) _____
   ___ e. Hispanic Which of the following best describes your heritage?
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

6. Class:
   ___ a. College freshman
   ___ b. College sophomore
   ___ c. College junior
   ___ d. College senior
   ___ e. Other (e.g., special or temporary student, etc.)
      Specify _____

7. Have you declared a college major?
   ___ a. No
   ___ b. Yes ..... Please specify your major. _____

8. Have you taken any advanced placement tests for college credit?
   ___ a. No
   ___ b. Yes ..... Please list tests taken. _____

9. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Two years of college
   ___ b. Four years of college
   ___ c. One or more years after college
   ___ d. Other Specify _____

10. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

11. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)

   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Work-study
   ___ d. Job other than work-study
   ___ e. Tuition or other scholarship
   ___ f. Loan
   ___ g. Previous personal earnings and savings
   ___ h. GI Bill, ROTC, or other governmental assistance (other than scholarship or loan)
   ___ i. Family trust fund, insurance plan, or other similar arrangement
   ___ j. Other Specify _____

12. You may want to receive help outside your regular college course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems
   ___ f. Increasing reading ability
   ___ g. Developing good study habits
   ___ h. Improving writing ability

13. What is or was the occupation of the person(s) with whom you lived during the years you were growing up? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

   _____ _____

14. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average

15. Are you:
___ a. An only child (skip to question 17)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

16. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

17. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

18. Indicate the extent of your mother's education. (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

19. What was the language spoken most often by adults in the household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe .... What is that language? _____
___ d. Other
Specify _____

20. Which of the following did your parent(s)/guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

21. Which of the following comes closest to describing your parent(s)/guardian(s)?
___ a. Do(es) not read at all
___ b. Sometimes read(s)
___ c. Read(s) a lot

22. Which of the following comes closest to describing you?
___ a. Do not read at all
___ b. Sometimes read
___ c. Read a lot

23. How many of these do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

24. From what kind of high school or secondary school did you graduate?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

25. Were you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes.....Please list the math and/or science clubs you belonged to.

_____

_____

_____

_____

26. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL WITH DIRECTIONALITY AND SCALES OF ITEMS

Legend:

| | |
|---|---|
| **SH Study Habits** | **PS Persistence** |
| **AT Attitude toward math/science** | **CV Cultural Value** |
| **SC Self-Concept** | **AS Academic Support** |
| **AX Anxiety** | **AP Aspiration** |
| **VL Value** | **EO Equal Opportunity** |
| **LC Locus of Control** | **RM Role Model** |
| **CA Career Awareness** | |

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of any ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |

| | | | |
|---|---|---|---|
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

i. _____

ii. _____

iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE COLLEGE STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 12 | CONTROL n = 9 |
| 1. Sex: | | |
| Women | 75% | 44% |
| Men | 25% | 56% |
| 2. Age | 19.77 | 19.61 |
| 6. Class: | | |
| .Freshmen | 17% | 56%[a] |
| .Sophomores | 75% | 33% |
| .Juniors | 8% | 0% |
| .Seniors | 0% | 0% |
| .Missing | 0% | 11% |
| 7. Declared SET majors | 25% | 78%[a] |
| .Missing or undeclared | 17% | 0% |
| 8. Students taken an advanced placement test | 17% | 0% |
| 9. Higher education expected: | | |
| .Two years of college | 8% | 0% |
| .Four years of college | 17% | 11% |
| .One or more years after college | 75% | 89% |
| 10. Studies most influenced by: | | |
| .Parents | 67% | 44% |
| .Another family member | 8% | 0% |
| .Teacher | 0% | 0% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 0% |
| .Friend | 17% | 33% |
| .Science professional | 8% | 0% |
| .Nonscience professional | 0% | 0% |
| .No one at all | 0% | 22% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 12 | CONTROL n = 9 |
| 11. Sources of income:[b] | | |
| .Parents/guardians | 83% | 56% |
| .Spouse | 0% | 0% |
| .Work study | 58% | 11% |
| .Job other than work study | 8% | 44% |
| .Tuition or scholarship | 17% | 22% |
| .Loan | 50% | 44% |
| .Grant | 50% | 67% |
| .Personal savings | 8% | 0% |
| .GI Bill, ROTC, etc. | 17% | 22% |
| .Family trust, etc. | 0% | 11% |
| .Other | 0% | 0% |
| Number of sources of income * | 2.92 | 2.78 |
| 12. Student needs help in:[b] | | |
| .Counseling on educational plans | 42% | 11% |
| .Counseling on career plans | 42% | 23% |
| .Improving math ability | 58% | 67% |
| .Finding part-time work | 50% | 22% |
| .Counseling on personal problems | 17% | 0% |
| .Increasing reading ability | 17% | 33% |
| .Developing good study habits | 58% | 44% |
| .Improving writing ability | 25% | 11% |
| Number of areas needing help * | 3.08 | 2.11 |
| 13. Sources of outside income: | | |
| .None | 8% | 11% |
| .One | 42% | 22% |
| .Two | 50% | 56% |
| .Missing | 0% | 11% |
| 14. Family income: | | |
| .Below U.S. average | 17% | 33% |
| .About average | 50% | 67% |
| .Above average | 8% | 0% |
| .Unknown | 25% | 0% |
| 15. Birth order of student: | | |
| .Only child | 0% | 11% |
| .Oldest child | 42% | 22% |
| .Youngest child | 25% | 56% |
| .In-between child | 25% | 11% |
| .Missing | 8% | 0% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 12 | CONTROL n = 9 |
| 16. Number of siblings: | | |
| .None | 0% | 11% |
| .One | 25% | 0% |
| .Two | 33% | 22% |
| .Three or more | 42% | 67% |
| 17. Father's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 17% | 0% |
| .High school graduate | 42% | 44% |
| .Some college | 0% | 11% |
| .College degree or more | 33% | 33% |
| .Missing | 8% | 11% |
| 18. Mother's education: | | |
| .Grade school or less | 8% | 0% |
| .Some high school | 0% | 0% |
| .High school graduate | 25% | 33% |
| .Some college | 25% | 33% |
| .College degree or more | 42% | 33% |
| 19. Language spoken most at home: | | |
| .English | 92% | 100% |
| .Spanish | 8% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| 20. Parents involvement during student's years in school: | | |
| .Attend PTA meetings | 83% | 67% |
| .Attend parent-teacher conferences | 83% | 67% |
| .Visit student's class | 58% | 22% |
| .Phone/visit if there's a problem | 67% | 44% |
| .Do volunteer work | 58% | 33% |
| .Assist student in course selection | 58% | 56% |
| .Assist in student's homework | 100% | 56%[a] |
| Number of parental involvements * | 5.08 | 3.44[a] |
| 21. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 8% | 33% |
| .A lot | 92% | 67% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 12 | CONTROL n = 9 |
| 22. Student reads: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 58% | 56% |
| .A lot | 42% | 44% |
| 23. Items in student's home:[b] | | |
| .Desk | 92% | 78% |
| .Daily newspaper | 92% | 78% |
| .Encyclopedia | 92% | 78% |
| .Typewriter | 67% | 67% |
| .Calculator | 100% | 100% |
| .Television | 100% | 100% |
| .Computer | 33% | 33% |
| .Video Cassette Recorder (VCR) | 75% | 100% |
| Number of support items * | 6.50 | 6.33 |
| 24. Type of high school attended: | | |
| .Public | 92% | 78% |
| .Private | 8% | 22% |
| .No formal high school | 0% | 0% |
| 25. Member math/science club in high school | 50% | 33% |
| 26. All activities student took part in:[b] | | |
| .Math/science club | 42% | 44% |
| .Field trip | 75% | 56% |
| .Watching science programs on TV | 67% | 44% |
| .Listen to talk by scientist | 42% | 22% |
| .Science/math fair | 75% | 56% |
| .Other science/math competition | 33% | 33% |
| .Play/work in computer lab | 83% | 89% |
| Number of activities * | 4.17 | 3.44 |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# TEXAS A & I UNIVERSITY

# INTERVENTIONS

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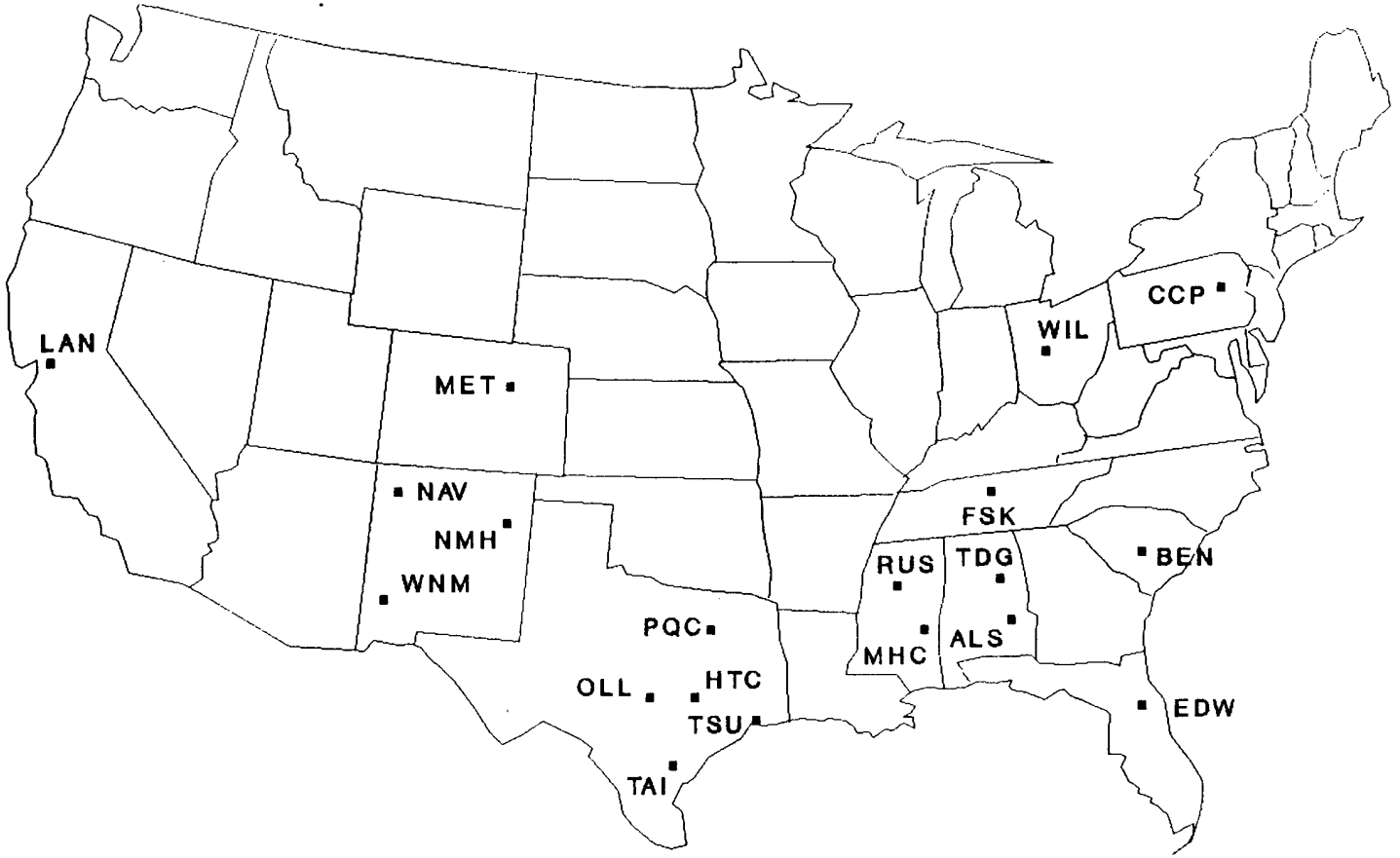
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# CASET Consortium Intervention Sites




LEGEND

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected came from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention- group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control- group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research will be described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF TEXAS A&I UNIVERSITY

Texas A&I University (formerly known as Texas College of Arts and Industries) is a four-year, public, coeducational institution located in Kingsville, Texas. Recently, Texas A&I University became a part of the Texas A&M University System, along with its sister institutions Corpus Christi State University and Laredo State University. The campus community consists of approximately 5400 students and 234 faculty members. The University, organized into the College of Arts and Sciences, College of Business Administration, College of Engineering, College of Education, and College of Graduate Studies, offers undergraduate and graduate degrees. The student body is approximately 51 percent female and 49 percent male. Approximately 4 percent of the students are Black, 53 percent are Hispanic, and the remaining 43 percent are of other ethnic origins, including Anglos (non-Hispanic Whites). The president of Texas A&I University is Dr. Manuel Ibanez.

Undergraduate degrees offered at Texas A&I University in quantitative subjects are Bachelor of Arts in chemistry, geology, mathematics, and physics, and Bachelor of Science in chemistry, geology, mathematics, physics, chemical engineering, civil engineering, computer science, electrical engineering, mechanical engineering, natural gas engineering, and industrial technology. Graduate degrees offered by the University in quantitative subjects are Master of Arts in chemistry and mathematics; Master of Science in chemistry, geology, mathematics, computer science, and engineering, including specialization in chemical, natural gas, civil, mechanical, and electrical engineering; and Master of Engineering, including specialization in chemical, natural gas, civil, mechanical, and electrical engineering.

Kingsville has a population of approximately 30,000. The state of Texas has a population of just over 17 million. According to U.S. Census Bureau estimates, the adult population of Texas is 66 percent Anglo, 11 percent Black, 21 percent Hispanic, and 2 percent other ethnic origins.

# PART II

# SUMMARY OF THE TEXAS A & I UNIVERSITY (TAIU)

# INTERVENTIONS

This report summarizes the three interventions conducted by Texas A&I University, a four-year, public institution located in Kingsville, Texas. Texas A&I University is a member of a consortium formed by The Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indian, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Texas A&I Intervention Activities:

In 1989 and 1990, Texas A&I University conducted three semesters of intervention for beginning college physics students featuring an alternative physics laboratory teaching method. The new method, based on the 4MAT approach to teaching, teaches to four distinct learning styles--imaginative, analytic, common sense, and dynamic--and integrates these with both right- and left-brain processing skills. Participants were beginning college physics students enrolled in certain laboratory sections; students in traditionally taught laboratory sections served as control-group members. Physics laboratory sections and physics lecture sections were taught independently. Based on the experience of the first two semesters, the last semester of intervention in 1990 also included remediation sessions in mathematics and high school physics to assist students who had deficient backgrounds in these areas.

Findings:

- Students who participated in the 4MAT-based physics labs generally showed stronger physics performance than students in traditionally taught physics labs.
- The intervention was most effective for students beginning the semester with lower GPAs (average of "C" to "C+") and less favorable opinions about SET fields and careers.
- The intervention also enhanced students' opinions about SET fields and careers.
- Looking at the remediation sessions in mathematics and high school physics, results showed that these sessions produced higher physics grades.

Recommendations:

- The 4MAT approach to teaching is promising and should be tried in other academic settings.
- This type of intervention demands high-quality lab instructors; lab instructors using an alternative teaching method, such as the 4MAT approach, need to be competent, well-trained, and very knowledgeable about the subject matter.
- Remediation sessions should be offered to students who exhibit deficiencies in mathematics or physics prior to participation in this type of intervention.

# PART III

# CASE STUDY OF THE TEXAS A & I UNIVERSITY

# 1989 FALL SEMESTER INTERVENTION

## ABSTRACT

In the fall of 1989 Texas A&I University, Kingsville, Texas, initiated and tested against a control group an alternative physics laboratory teaching method for beginning physics students. Participants were 52 undergraduate college students (23 women and 29 men) enrolled in two sections of a beginning physics lecture course; a majority of the participants were Hispanic. The intervention was repeated in the spring of 1990 and in the fall of 1990.

The Texas A&I University program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance in physics, and (b) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* The major component of the intervention was an alternative physics laboratory teaching method based on the 4MAT approach to teaching. This approach teaches to four distinct learning styles (imaginative, analytic, common-sense, and dynamic learning) and to both the right and left halves of the brain. A related intervention lab manual and lab instructor's guide were also developed, and intervention lab instructors received training in the 4MAT approach to teaching. The physics laboratory sections and the lecture course were taught independently; students in three lab sections served as the intervention group, and students in two lab sections served as the control group. Students in the control group attended traditionally taught physics labs and worked with the traditional lab manual.

*DATA:* All the participants furnished demographic data through the CASET College Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were SAT scores, high school class ranks, college GPAs, lecture quiz grades, lecture final exam grades, lab grades, course averages, and course grades.

The outcome measures of performance were lecture quiz grade, lecture final exam grade, lab grade, course average, and course grade. The preintervention measures of performance were SAT verbal and mathematics scores, high school class rank, and preintervention college GPA.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment because laboratory sections were designated as intervention or control. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design; through analyses of preintervention measures it appeared that the intervention and control groups were comparable.

*FINDINGS:* In general, the intervention had a positive effect on the participants and can be considered a successful intervention. The hypotheses of enhanced physics performance and enhanced opinions of SET fields and careers received substantial support. The intervention was particularly effective with those students beginning the semester with lower college GPAs and less favorable opinions about SET fields and careers. The intervention was associated with success in physics for students entering with a "C" level college GPA and was associated with a higher rate of students passing physics than has historically been the case at Texas A&I. There were significant positive effects for the intervention group as a whole on two environmental support opinion scales and beneficial effects on four additional opinion scales for students beginning with low opinion scores. Although the intervention was expected to benefit minority and women students, the performance benefits of the intervention generalized to Anglo males when they were added to the sample.

## DESCRIPTION OF THE INTERVENTION

Texas A & I University developed an intervention seeking to improve the performance and retention of physics students, especially minorities and women, who have indicated an interest in science, engineering and technology (SET) careers by majoring in science, mathematics, or engineering. The intervention consisted of a physics laboratory program based on an instructional system entitled 4MAT®, which teaches to four distinct learning styles and to both brain modes, that is, to both the right and left halves of the brain.

The work of David Kolb (1984) formed the theoretical base for the 4MAT® teaching approach. Kolb described differences in how people perceive and process information, leading to a system of four styles of learning: (a) imaginative learners, who perceive information concretely and process it reflectively; (b) analytic learners, who perceive information abstractly and process it reflectively; (c) common-sense learners, who perceive information abstractly and process it actively; and (d) dynamic learners, who perceive information concretely and process it actively. Bernice McCarthy (1987) suggested applying both left (analytic, systematic) and right (holistic, Gestalt) brain modality approaches (Springer & Deutsch, 1985) to each of the four learning styles; thus she developed the 4MAT® approach to teaching.

Texas A&I University proposed to implement and evaluate a 4MAT®-based approach in the beginning physics laboratory. A laboratory manual called *Fun d' Mental Physics*, and accompanying laboratory instructor's guide were developed by Lionel D. Hewett and Dale L. Schruben (1990). Every experiment in the manual includes the following eight elements: Experience, Analysis, Theory, Concepts, Practice, Design, Techniques, and Experiment. The Fun d'Mental laboratory approach is similar to the 4MAT® system, with one difference: the Fun d'Mental approach is designed specifically for a laboratory course accompanied by a lecture, while the 4MAT® system is designed for a fully integrated learning environment. In other words, the 4MAT® system emphasizes all learning styles and brain modes while the Fun d'Mental approach emphasizes those earning styles and brain modes not included in the regular lecture portion of the course. Thus the Theory, Concepts, and Practice portions of the learning cycle are usually de-emphasized in the Fun d'Mental experiment.

As a consequence of using multiple learning styles, students using the Fun d'Mental approach often design and conduct their own experiments, with guidance from the laboratory instructor, rather than following directions to carry out a specific experiment designed for them by someone else. Laboratory instructors were trained in the use of the new approach and manual, and were carefully supervised during its implementation. Revision and improvement of the manual through implementation was one goal of the project.

The institution reported that historically, about 40 percent of their beginning physics students had failed to pass physics. the underlying assumption of the project was that the traditional approach to physics laboratories is uncomfortable for a number of students whose learning style and preferred brain modality is not well addressed by the traditional approach; further this mismatch of teaching and learning style is more likely for women and minority students, who it is felt are more likely to have a right-brain dominance and a learning style other than analytic, favored by traditional school settings. The physics laboratories met once each week for 4 hours, beginning the third week of the semester, for a total of twelve meetings.

The intervention's two major hypotheses were that the intervention laboratory activities would: (a) enhance performance in the physics course, and (b) enhance opinion about SET fields and careers.

The Project Director for this CASET project at Texas A&I University was Dr. Lionel D. Hewett, Professor and Chairman, Department of Physics. The lecturer for Physics 104, intended primarily for non-physics science majors, was Dr. Paul H. Cox. The lecturer for Physics 231, intended primarily for physics and engineering majors, was Dr. Lionel D. Hewett. Laboratory instructors for the intervention laboratories, utilizing the Fun d'Mental approach and manual, were Michael Innes, Yuk Chan, and Paul Amirpour. Laboratory instructors for the control laboratories, taught in the traditional way with the traditional manual, were Prabhaker Aedla and Paul Amirpour.

The following excerpts from the chapters on "Force" in the two laboratory manuals illustrate the difference between the traditional approach and the 4MAT®-based approach tested in this project. The first excerpt is taken from the laboratory manual by Kruse, Dunn, and Hewitt (undated) used in the project reported here by the control group students, who participated in a traditionally-conducted physics laboratory.

EXCERPT FROM TECHNICAL PHYSICS LABORATORY MANUAL

*EXPERIMENT 4: FORCE*

*PURPOSE: To teach the student the two common methods for measuring forces. To demonstrate the vector nature of forces. To determine the conditions for translational equilibrium. To illustrate the distinction between accuracy and precision.*

*EQUIPMENT: Spring balances, weights, string, force table (or protractor).*

*EQUATIONS:*

$$w = mg$$

$$F_x = F\cos\theta$$

$$F_y = F\sin\theta$$

$$\sum F_x = 0$$

$$\sum F_y = 0$$

*INTRODUCTION:*

*There are two common methods of determining the value of a force used in an experiment. The first method consists of measuring the tension in a wire or string by inserting a force gauge (called a spring balance) in the position of the unknown force. The value of the force is read directly from the gauge without the necessity of making any conversions.*

(The manual goes on to describe the mass balance technique for measuring forces. A "PROCEDURE" section follows, through which the student is directed to measure forces and to determine the value of the conversion factor which converts from mass units to force units; the student then is instructed to measure concurrent forces, varying the angles of the forces and plotting curves to illustrate the equations above. The chapter ends with a "QUESTION" section having five questions for the student to answer.)

EXCERPT FROM FUN D' MENTAL PHYSICS LABORATORY MANUAL:

(Note: This excerpt is taken from edition 1.0, the Fun d' Mental Physics Manual, by Hewett and Schruben (1990). This edition was used in the Fall 1989 intervention which was used by the intervention group students who participated in the 4MAT based physics laboratory. The manual has since been revised.)

*Experiment 3: Force*

*INTRODUCTION*

(Here are some introductory remarks about the vector aspect of force and the purpose of the experiment.)

*EXPERIENCE*

*We are now going to do something like a group playground activity called loop tug of war. Please form a circle and grab a section of the loop of rope. Pull on the rope when the instructor gives you the signal. Do not pull so hard that there is any danger of injury. Please stop pulling when your instructor gives the signal.*

*ANALYSIS*

*How would you describe the feeling in your hands as you started to pull the rope? Force can be defined as an attempt to make a body move. Did you offer a force even when you were not moving? Did you pull along the direction of the rope or did you pull perpendicular to the rope? Did you notice that the rope assumed a polygon shape after you all started pulling? Did you plan what your feet did, or did it just sort of happen? Does the type of shoe a person has on make a difference? What connects your feet to your hands is your body. What you felt through your body was force, which will be further explored in a section to come called concepts. However for now you should be aware that force involved a magnitude which corresponds to roughly how hard you pulled, and a direction, which of course refers to the direction you pulled. Consider the aspects of magnitude and direction; is one more important?*

*THEORY*

*Through your interaction with the rope in the loop tug of war, you have experienced and observed what have come to be called forces. Like humankind before Galileo and Newton, you may be sure something exists here, but you may not be sure just what, yet. So we give it a name and begin to think about the observations and how to distinguish this force from other concepts sometimes called forces, such as freedom and justice. Force does not have color or shape, we do not construct it out of other materials. In that sense we could consider it a somewhat fundamental concept.*

*At present four distinct forces are recognized in nature: gravitational, electromagnetic, strong nuclear, and weak nuclear.*

*All forces act over distance. If the distance scale is on the order of the atomic nucleus, the nuclear forces are encountered. For molecular dimension length scales, electromagnetic forces dominate. Gravitational forces are important at longer lengths, especially those found in considering the cosmos. The forces that arise when materials are in contact are called contact forces. They are the result of the electrical interaction of molecules that make up the contacting materials. Contact forces and gravitational forces that give a body weight are the usual forces considered in mechanics. (Explanations of Newton's third and first laws complete this section.)*

*CONCEPTS*

(As a class, the students draw diagrams and solve for force and tension. The concept of stress over strain is introduced.)

*PRACTICE*

(There are three practice problems.)

*DESIGN*

*Design an experiment to test some aspect of the topic of this experiment. Before finalizing your design, explore techniques indicated in the section to follow. Obtain guidance from your instructor, and approval before you start to do your experiment.*

*TECHNIQUE*

*Return for a moment to the loop tug of war. If you had held on to a spring balance and hooked the other end over the rope, you could have measured the magnitude of force you were applying. Another way would have been to let strings and pulleys*

*transfer the unknown force to a known weight. The spring balance and the mass balance are the two ways force can be measured in this lab. Practice using them.*
*After obtaining the approval of your laboratory instructor to perform the experiment you designed, utilize the equipment available in the laboratory to set up the experiment.*

(A further explanation follows of setting up the experiment and taking preliminary data.)

*PERFORMANCE*

(Student sets up, performs, and reports experiment.)

## METHOD

Subjects

Subjects were college students, primarily freshmen, enrolled in either of the two introductory physics courses for science and engineering majors at Texas A & I University in the fall semester of 1989. Table 1 shows the sex and ethnic breakdown for the intervention and control groups.

**Table 1**

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | 0 | 0 | 0 | 0 | 0 | 0 |
| Anglo | 2 | - | 5 | - | 7 | - |
| Black | 1 | 0 | 0 | 0 | 1 | - |
| Hispanic | 8 | 12 | 7 | 17 | 15 | 29 |
| Unknown | 0 | - | 0 | - | 0 | - |
| **TOTAL** | **11** | **12** | **12** | **17** | **23** | **29** |

CASET Protocols and other Instruments

Demographic and descriptive data about the subjects were developed through the CASET College Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

Hypotheses tested were that the intervention would enhance the performance of participants in physics and that it would change opinions of participants in ways thought to be favorable to continuing in SET studies and careers. To assess opinion information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature

on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gives a scalar measurement for that variable. Thus the completed Opinion Protocol provides a scale measuring each of the thirteen variables. The Opinion Protocol items, together with the scales (attitudinal variables) they represent, are shown in Appendix B. This protocol was administered to intervention and control group students before and after the intervention.

To assess performance before, during, and after the intervention, a number of measures were used. SAT verbal and mathematics scores, high school class rank, and preintervention college GPA all provided baseline measurements of academic aptitude and achievement. The institution's own measures were used to assess performance in physics: grades on lecture quizzes, lecture final exam grade, laboratory grade, numeric course average, and course letter grade. The institution also administered a "Course Content Questionnaire" and a "Lab Attitude Questionnaire" for its own assessment and evaluation of the project: for CASET's test of the hypotheses, however, the performance measures listed above, such as the lecture final exam grades were selected.

The quizzes, examinations, and other assessments of performance were developed by, and scored by, the institution's physics faculty. Scores and grades were submitted to CASET, along with the CASET protocols, transcripts, and standardized test scores.

### Procedure

At the beginning of the intervention, intervention- and control- group members signed consent forms and transcript release forms. The CASET College Student Protocol and the preintervention Opinion Protocol were administered to intervention and control group students. The course was conducted as usual with periodic tests and regular laboratory sessions once a week. The laboratory sessions for the control group were conducted in the traditional way with the traditional laboratory manual written by Kruse, Dunn, and Hewett (undated). The intervention group laboratory sessions were conducted using the *Fun d'Mental Physics* laboratory manual by Hewett and Schruben (1990). The laboratory instructors for the intervention-group laboratories had received special training in conducting the Fun d' Mental laboratories; some of the demonstrations in the Fun d'Mental laboratories were conducted by full-time faculty with the laboratory instructors observing.

After the intervention, the postintervention Opinion Protocol was administered to intervention and control students, along with the institution's own tests of content mastery. Grades on the lecture quizzes and the lecture final exam, laboratory grades, course averages, and course grades were forwarded to CASET, along with the completed CASET instruments. The college also supplied college transcripts and standardized test scores for intervention and control students. The items of the Opinion Protocol were coded by CASET according to the thirteen scales they represent. Scoring of the positively worded items on the Opinion Protocol was reversed so that scores could be totaled meaningfully (see Appendix B). The scales were organized into three constructs -- SET Goal, Environmental Support, and Attitude-- as shown in Appendix C.

## RESULTS

### Methodological Issues

The intervention's two major hypotheses were that the intervention laboratory activities would: (a) enhance performance in the physics course, and (b) enhance opinion about SET fields and careers.

The intervention had preintervention and postintervention measures of opinion and performance for most participants, and was analyzed as a *nonequivalent control group design*. This type of quasi-experimental design has one major weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty may be addressed by analyzing the influence of preexisting characteristics on students' performance and opinion; the analysis of covariance (ANCOVA), adjusting for preintervention performance or opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that existed prior to the intervention.

Demographic Results

The comparability of the intervention and control groups was examined by testing for differences on the items of the College Student Protocol. The complete results are given in Appendix D. Of the 74 comparisons, the groups differed on only two, both of which favored the intervention group: (a) more students in the intervention group were majoring in a SET field (intervention = 79%, control = 39%); and (b) more intervention students' parents had visited their child's class in earlier schooling (55% vs. 22%). The difference in SET majors may not have been important because some non-SET majors may have been majoring in biomedical areas. (Biological science is not considered to be a SET field in CASET's research) The two differences between the groups on preexisting characteristics were significantly fewer than the number of differences expected by chance at the 10-percent probability level chi-square ($1,N=74$) = 2.96, $p < .10$. Based on these results, the groups were judged to be comparable on demographic characteristics prior to the intervention.

**Table 2**

**GROUP COMPARISONS OF PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | SIGP |
|---|---|---|---|---|---|---|
| SAT-Verbal | Control<br>Intervention | 5<br>7 | 390.00<br>395.71 | 112.03<br>52.87 | 0.12<br>(10) | ns |
| SAT-Math | Control<br>Intervention | 5<br>7 | 458.00<br>521.43 | 74.63<br>104.15 | 1.16<br>(10) | ns |
| High-School Rank | Control<br>Intervention | 8<br>11 | 84.14<br>76.08 | 19.24<br>16.00 | -1.00<br>(17) | ns |
| Prior College GPA | Control<br>Intervention | 23<br>27 | 2.79<br>2.57 | 0.50<br>0.53 | -1.52<br>(48) | ns |
| Lecture Quizzes | Control<br>Intervention | 18<br>25 | 46.94<br>53.56 | 17.71<br>18.71 | 1.17<br>(41) | ns |
| Lecture Final Exam | Control<br>Intervention | 18<br>25 | 48.00<br>47.12 | 27.56<br>17.77 | -0.13<br>(41) | ns |
| Lab Grade | Control<br>Intervention | 17<br>27 | 93.76<br>89.00 | 5.08<br>18.65 | -1.03<br>(42) | ns |

**GROUP COMPARISONS OF PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | SIG p |
|---|---|---|---|---|---|---|
| Numeric Course Grade | Control<br>Intervention | 18<br>25 | 58.44<br>62.80 | 19.02<br>15.76 | 0.82<br>(41) | ns |
| Final Grade | Control<br>Intervention | 16<br>23 | 2.00<br>1.83 | 1.21<br>1.15 | -0.45<br>(37) | ns |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

**Table 3**

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION - PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| LECTURE QUIZZES | PRIOR GPA | .0522 | .0522 | 2.09 | 1,38 | ≤.10 |
| | + GROUP | .1037 | .0515 | 2.13 | 1,37 | ≤.10 |
| | + GPA-x-GROUP | .1628 | .0592 | 2.54 | 1,36 | ≤.10 |
| LECTURE FINAL | PRIOR GPA | .0937 | .0937 | 3.93 | 1,38 | ≤.05 |
| | + GROUP | .0964 | .0027 | 0.11 | 1,37 | ns |
| | + GPA-x-GROUP | .1315 | .0351 | 1.45 | 1,36 | ns |
| LAB GRADE | PRIOR GPA | .0304 | .0304 | 1.22 | 1,39 | ns |
| | + GROUP | .0486 | .0182 | 0.73 | 1,38 | ns |
| | + GPA-x-GROUP | .0666 | .0180 | 0.40 | 1,37 | ns |
| COURSE AVERAGE | PRIOR GPA | .1277 | .1277 | 5.56 | 1,38 | ≤.05 |
| | + GROUP | .1595 | .0318 | 1.40 | 1,37 | ns |
| | + GPA-x-GROUP | .2208 | .0612 | 2.83 | 1,36 | ≤.10 |
| COURSE GRADE | PRIOR GPA | .2944 | .2944 | 14.19 | 1,34 | ≤.01 |
| | + GROUP | .2949 | .0005 | 0.02 | 1,33 | ns |
| | + GPA-x-GROUP | .4055 | .1106 | 5.95 | 1,32 | ≤.05 |

All models were analyzed as one-tailed tests.
* Three models of independent variables were tested for each dependent variable: (1) GPA alone; (2) GPA and ('+') GROUP; (3) GPA and GROUP and GPA-by-GROUP INTERACTION ('-x-').

Performance Measures

*Group differences in performance.* The four preintervention measures and the five postintervention measures of performance were tested for group differences, and the results are given in Table 2. Note that the intervention and control groups did not differ on any of the nine measures.
A further analysis--ANCOVA--adjusted for preintervention performance before testing for group differences.

*Group differences after adjusting for pretests.* A hierarchical ANCOVA adjusted for preintervention college GPA before comparing groups on postintervention performance measures; the results are given in Table 3. This table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding the first and each subsequent measure to the multiple regression equation (one measure per row), and the significance test of each measure's contribution toward explaining the dependent measure.

The columns of the table include the cumulative percentage of explained variance (cum $R^2$), added contribution in explained variance of the measure ($sR^2$), test of the contribution of the new measure ($F(sR^2)$), and the degrees of freedom (df) for the test. Because the hypothesis was directional--improvement for the intervention group--the test statistics were compared to one-tailed probability levels; for F statistics, this involved converting from the F to t statistic ($F = t^2$), and determining the corresponding one-tailed critical value.
The results in Table 3 demonstrated that the intervention group outperformed the control group on the lecture quizzes, and that there were significant interactions between prior college GPA and group membership for lecture quiz scores, course average, and course grade. These significant interactions indicated that the relationship between prior GPA and the posttest scores was different in the two groups. The interactions were analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of pretest scores for which the groups differed.

Figures 1, 2, and 3 show the nonparallel regression lines that indicate that for students with lower GPAs, the students in the intervention group outperformed those in the control group. In Figure 1, for students with prior GPAs at or below 2.6, the intervention group outperformed the control group on lecture quizzes; the control group outperformed the intervention group only for students with prior GPAs ranging from 3.6 to 3.7.

**Figure 1**

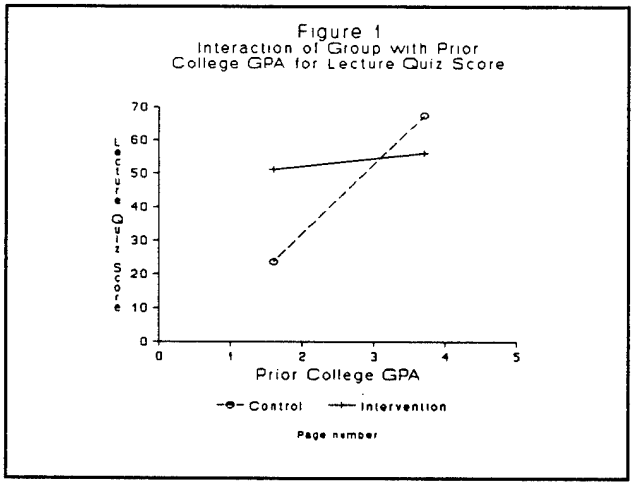



**Figure 2**

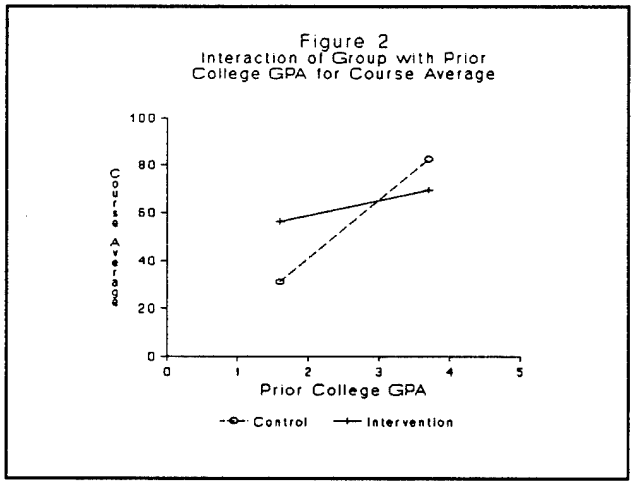



Figure 2 indicates that of those students with prior GPAs less than 2.6, the intervention group had higher course averages than did the control group; for students with prior GPAs ranging from 3.4 to 3.7, the control group had higher course averages.

**Figure 3**

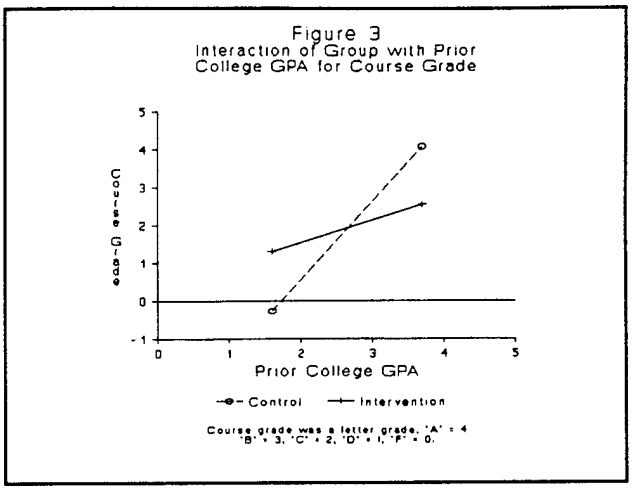



Figure 3 indicates that for students entering with a GPA less than 2.3, the intervention group students had higher course grades than did the control group students; for students entering with a GPA above 3.0, the control group had higher course grades. Specifically, twelve students entered the course with a "C" average or lower. Four of those students were in the control group; of those, only one passed the course (with a "D"). Eight of the twelve students were in the intervention laboratories: Five of these passed the course (2 "B's," 2 "C's," and 1 "D").

*Course completion and a prior calculus course.* An additional test of the hypothesized benefit of the intervention laboratories for performance was that more of the students in these laboratories would complete the physics course. Seventy-seven percent (23 out of 30) of the intervention group and 66 percent (16 out of 24) of the control group finished the course: this difference, while not statistically significant in a sample of this size, may be important for an educational institution. A related, exploratory hypothesis concerned was the value of having completed a calculus course prior to enrolling in physics; did having completed a prior calculus course predict success in physics? There was no significant difference between the mean final course grades of students who had or had not taken calculus. However, 86 percent of students who had taken calculus also successfully completed the physics course, compared to 61 percent of students without any calculus background. Though having completed calculus did not predict a student's grade, it did predict that the student was more likely to finish the physics course.

*Effects on performance including other students.* As described in the Method section, 22 Anglo male students (8 control and 14 intervention) were excluded from the preceding analyses of performance. One question concerning the generalizability of the performance findings could be answered by including their data: Did the intervention show benefits for the combined sample of target-group (minorities and women) and Anglo-male students?

When the 22 Anglo-male students were added to the sample and prior GPA controlled for in ANCOVAs, the intervention group outperformed the control group on three measures: lecture quiz scores (unadjusted intervention group $\underline{M}$ = 59.2, control group $\underline{M}$ = 50.2), $\underline{F}(1, 47) = 3.59$, $\underline{p} \leq .05$ (one-tailed test); lecture final exam scores (intervention group $\underline{M}$ = 56.2, control group $\underline{M}$ = 49.0), $\underline{F}(1, 47) = 1.91$, $\underline{p} \leq .10$; and course average (intervention group $\underline{M}$ = 69.2, control group $\underline{M}$ = 63.4), $\underline{F}(1, 47) = 3.11$, $\underline{p} \leq .05$. The intervention may have helped the Anglo males more than the minority and women group, as indicated by a significant interaction for scores on the lecture final exam--only for Anglo males did the intervention group outperform the control group, interaction $\underline{F}(1, 47) = 2.61$, $\underline{p} \leq .10$. In summary, analyses that included the Anglo-male students indicated that the intervention was successful in improving the lecture quiz scores and course averages for all students, but was especially effective in improving Anglo-male students' final exam scores and course averages.

*Interrelationships among performance.* The interrelatedness of the performance measures was examined through intercorrelations, presented in Table 4. The significant correlations indicated that the different measures were measuring overlapping constructs of physics performance.

Table 4

| INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a] | | | | | |
|---|---|---|---|---|---|
| | **Prior GPA Sig. p (n)** | **Lecture Quizzes Sig. p (n)** | **Lecture Exam Sig. p (n)** | **Lab Grade Sig. p (n)** | **Course Avg. Sig. p (n)** |
| Lecture Quizzes (n) | .23 p≤.10 (40) | 1.00 | | | |
| Lecture Exam (n) | .31 p≤.05 (40) | .58 p≤.01 (42) | 1.00 | | |
| Lab Grade (n) | .17 ns (41) | .35 p≤.05 (42) | .87 p≤.01 (42) | 1.00 | |
| Course Average (n) | .36 p≤.05 (40) | .82 p≤.01 (43) | .87 p≤.01 (42) | .66 p≤.01 (42) | 1.00 |
| Course Grade (n) | .54 p≤.01 (36) | .60 p≤.01 (39) | .67 p≤.01 (38) | .27 p≤.0 (38) | .73 p≤.01 (39) |

[a] All correlations were analyzed as two-tailed tests.

Opinion Measures

*Group differences on pre- and postintervention measures.* The means of the intervention- and control-group students were compared for the 13 opinion scales, three constructs, and total opinion score, before and after the intervention. These results are given in Table 5. Before the intervention began, the intervention and control groups did not differ significantly on any of the seventeen opinion measures; this strengthens the conclusion that the groups were comparable before the intervention. After the intervention ended, the intervention group had higher scores on two of the seventeen measures: Environmental Support and Equal Opportunity. The two postintervention differences may have been due to the maturation of preexisting differences and not due to the intervention. In order to adjust for preexisting differences, the final opinion measures were adjusted for preexisting differences via ANCOVA.

Table 5

| GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | | |
|---|---|---|---|---|---|---|---|
| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
| | | Mean | SD | Mean | SD | | |
| OPINION, Total | Pretest | 3.01 | 0.21 | 3.07 | 0.21 | 1.03 | ns |
| | Posttest | 3.02 | 0.20 | 3.07 | 0.20 | 0.87 | ns |
| SET GOAL | Pretest | 3.30 | 0.22 | 3.38 | 0.18 | 1.50 | ns |
| | Posttest | 3.30 | 0.30 | 3.33 | 0.22 | 0.38 | ns |
| Value | Pretest | 3.53 | 0.36 | 3.67 | 0.38 | 1.35 | ns |
| | Posttest | 3.62 | 0.40 | 3.60 | 0.33 | -0.12 | ns |
| Cultural Value | Pretest | 3.41 | 0.37 | 3.35 | 0.46 | -0.50 | ns |
| | Posttest | 3.38 | 0.61 | 3.29 | 0.46 | -0.54 | ns |
| Self-Concept | Pretest | 3.07 | 0.32 | 3.21 | 0.36 | 1.54 | ns |
| | Posttest | 3.14 | 0.28 | 3.19 | 0.29 | 0.63 | ns |
| Aspiration | Pretest | 3.29 | 0.30 | 3.37 | 0.27 | 0.99 | ns |
| | Posttest | 3.18 | 0.37 | 3.31 | 0.40 | 1.07 | ns |
| ATTITUDE | Pretest | 2.85 | 0.27 | 2.89 | 0.30 | 0.54 | ns |
| | Posttest | 2.89 | 0.23 | 2.90 | 0.24 | 0.16 | ns |
| Math/Science Attitude | Pretest | 3.12 | 0.28 | 3.25 | 0.33 | 1.48 | ns |
| | Posttest | 3.18 | 0.38 | 3.17 | 0.29 | -0.09 | ns |
| Locus of Control | Pretest | 3.32 | 0.26 | 3.22 | 0.45 | -0.96 | ns |
| | Posttest | 3.31 | 0.40 | 3.26 | 0.38 | -0.40 | ns |
| Persistence | Pretest | 2.79 | 0.50 | 2.75 | 0.50 | -0.31 | ns |
| | Posttest | 2.76 | 0.55 | 2.79 | 0.55 | 0.15 | ns |
| Study Habits | Pretest | 2.76 | 0.44 | 2.63 | 0.43 | -1.09 | ns |
| | Posttest | 2.68 | 0.48 | 2.66 | 0.37 | -0.15 | ns |
| Anxiety | Pretest | 2.38 | 0.59 | 2.57 | 0.46 | 1.31 | ns |
| | Posttest | 2.56 | 0.40 | 2.64 | 0.41 | 0.63 | ns |
| ENVIRONMENTAL SUPPORT | Pretest | 2.89 | 0.29 | 2.95 | 0.37 | 0.68 | ns |
| | Posttest | 2.83 | 0.27 | 3.01 | 0.23 | 2.31 | ≤.05 |
| Academic Support | Pretest | 2.70 | 0.61 | 2.75 | 0.66 | 0.32 | ns |
| | Posttest | 2.82 | 0.52 | 2.85 | 0.52 | 0.14 | ns |

| GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | | |
|---|---|---|---|---|---|---|---|
| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
| | | Mean | SD | Mean | SD | | |
| Career Awareness | Pretest | 3.04 | 0.34 | 3.22 | 0.46 | 1.51 | ns |
| | Posttest | 3.14 | 0.53 | 3.24 | 0.43 | 0.66 | ns |
| Role Model | Pretest | 2.75 | 0.56 | 2.70 | 0.56 | -0.34 | ns |
| | Posttest | 2.65 | 0.52 | 2.83 | 0.61 | 1.04 | ns |
| Equal Opportunity | Pretest | 3.07 | 0.42 | 3.14 | 0.45 | 0.60 | ns |
| | Posttest | 2.71 | 0.41 | 3.12 | 0.34 | 3.60 | ≤.01 |
| All pretests were analyzed as two-tailed tests. Nc=23, Ni=29<br>All posttests were analyzed as one tailed tests. Nc=17, Ni=24 | | | | | | | |

*Group differences on opinion adjusting for prior scores.* Table 6 reports the tests of the effects of group membership on opinion after adjusting for preintervention opinion scores. By this analysis, the groups differed overall on two opinion measures: the intervention group had significantly higher Environmental Support and Equal Opportunity scores, results that paralleled the t-test results. In addition, the pretest interacted with group membership for four opinion measures: SET Goal, Value, Cultural Value, and Math/Science Attitude.

**Table 6**

| HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION FINAL | | | | | | |
|---|---|---|---|---|---|---|
| OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
| OPINION, Overall | PREINTERVENTION | .3766 | .3766 | 23.560.43 | 1,39 | ≤.01 |
| | +GROUP | .3836 | .0069 | 0.35 | 1,38 | ns |
| | +PRE-x-GROUP | .3894 | .0058 | | 1,37 | ns |
| SET GOAL | PREINTERVENTION | .3474 | .3474 | 20.76 | 1,39 | ≤.01 |
| | +GROUP | .3488 | .0014 | 0.08 | 1,38 | ns |
| | +PRE-x-GROUP | .4056 | .0568 | 3.54 | 1,37 | ≤.05 |
| Value | PREINTERVENTION | .1494 | .1494 | 6.85 | 1,39 | ≤.01 |
| | +GROUP | .1517 | .0023 | 0.10 | 1,38 | ns |
| | +PRE-x-GROUP | .2225 | .0708 | 3.37 | 1,37 | ≤.05 |
| Cultural Value | PREINTERVENTION | .4452 | .4452 | 31.30 | 1,39 | ≤.01 |
| | +GROUP | .4455 | .0002 | 0.01 | 1,38 | ns |
| | +PRE-x-GROUP | .4951 | .0496 | 3.64 | 1,37 | ≤.05 |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION FINAL**

| OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Self-Concept | PREINTERVENTION | .3310 | .3310 | 19.29 | 1,39 | ≤.01 |
| | +GROUP | .3338 | .0028 | 0.16 | 1,38 | ns |
| | +PRE-x-GROUP | .3354 | .0017 | 0.09 | 1,37 | ns |
| Aspiration | PREINTERVENTION | .3311 | .3311 | 19.31 | 1,39 | ≤.01 |
| | +GROUP | .3382 | .0071 | 0.41 | 1,38 | ns |
| | +PRE-x-GROUP | .3506 | .0124 | 0.71 | 1,37 | ns |
| ATTITUDE | PREINTERVENTION | .4026 | .4026 | 26.29 | 1,39 | ≤.01 |
| | +GROUP | .4033 | .0006 | 0.04 | 1,38 | ns |
| | +PRE-x-GROUP | .4073 | .0041 | 0.25 | 1,37 | ns |
| Math/Science Attitude | PREINTERVENTION | .3481 | .3481 | 20.83 | 1,39 | ≤.01 |
| | +GROUP | .3654 | .0172 | 1.03 | 1,38 | ns |
| | +PRE-x-GROUP | .4145 | .0492 | 3.11 | 1,37 | ≤.05 |
| Locus of Control | PREINTERVENTION | .1845 | .1845 | 8.82 | 1,39 | ≤.01 |
| | +GROUP | .1898 | .0053 | 0.25 | 1,38 | ns |
| | +PRE-x-GROUP | .1905 | .0008 | 0.03 | 1,37 | ns |
| Persistence | PREINTERVENTION | .3808 | .3808 | 23.99 | 1,39 | ≤.01 |
| | +GROUP | .3979 | .0170 | 1.08 | 1,38 | ns |
| | +PRE-x-GROUP | .3984 | .0005 | 0.03 | 1,37 | ns |
| Study Habits | PREINTERVENTION | .2046 | .2046 | 10.03 | 1,39 | ≤.01 |
| | +GROUP | .2080 | .0035 | 0.17 | 1,38 | ns |
| | +PRE-x-GROUP | .2236 | .0156 | 0.74 | 1,37 | ns |
| Anxiety | PREINTERVENTION | .3787 | .3787 | 23.78 | 1,39 | ≤.01 |
| | +GROUP | .3792 | .0004 | 0.03 | 1,38 | ns |
| | +PRE-x-GROUP | .3793 | .0001 | 0.01 | 1,37 | ns |
| Environmental Support | PREINTERVENTION | .3493 | .3493 | 20.93 | 1,39 | ≤.01 |
| | +GROUP | .4324 | .0832 | 5.57 | 1,38 | ≤.05 |
| | +PRE-x-GROUP | .4331 | .0006 | 0.04 | 1,37 | ns |
| Academic Support | PREINTERVENTION | .2703 | .2703 | 14.45 | 1,39 | ≤.01 |
| | +GROUP | .2710 | .0007 | 0.04 | 1,38 | ns |
| | +PRE-x-GROUP | .2934 | .0223 | 1.17 | 1,37 | ns |
| Career Awareness | PREINTERVENTION | .2749 | .2749 | 14.79 | 1,39 | ≤.01 |
| | +GROUP | .2751 | .0001 | 0.01 | 1,38 | ns |
| | +PRE-x-GROUP | .2794 | .0044 | 0.22 | 1,37 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION FINAL**

| OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Role Model | PREINTERVENTION | .1444 | .1444 | 6.58 | 1,39 | ≤.01 |
| | +GROUP | .1776 | .0332 | 1.53 | 1,38 | ns |
| | +PRE-x-GROUP | .1785 | .0009 | 0.04 | 1,37 | ns |
| Equal Opportunity | PREINTERVENTION | .1139 | .1139 | 5.01 | 1,39 | ≤.05 |
| | +GROUP | .3153 | .2013.029 | 11.17 | 1,38 | ≤.01 |
| | +PRE-x-GROUP | .3447 | 5 | 1.66 | 1,37 | ns |

All models were analyzed as one-tailed tests.

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

As with the performance interactions, the nonparallel regression lines were graphed and the Johnson-Neyman technique used to determine the intersection point and range of values for which the groups differed. Figures 4 though 7 show the same pattern of differences--the intervention was most successful at enhancing the opinions of students who entered with low opinions of the value of SET fields and courses.

**Figure 4**

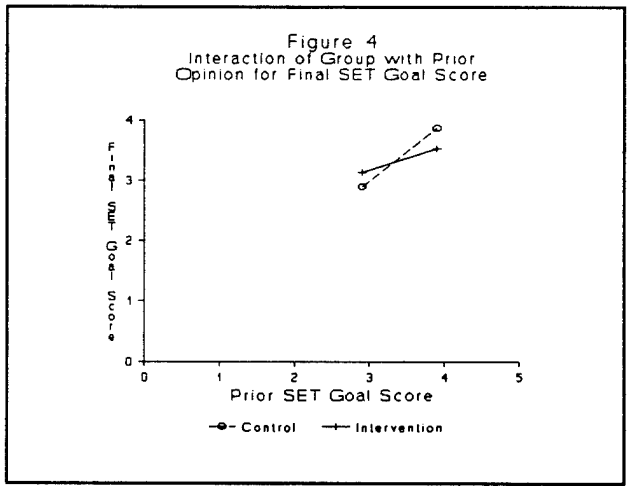



**Figure 5**

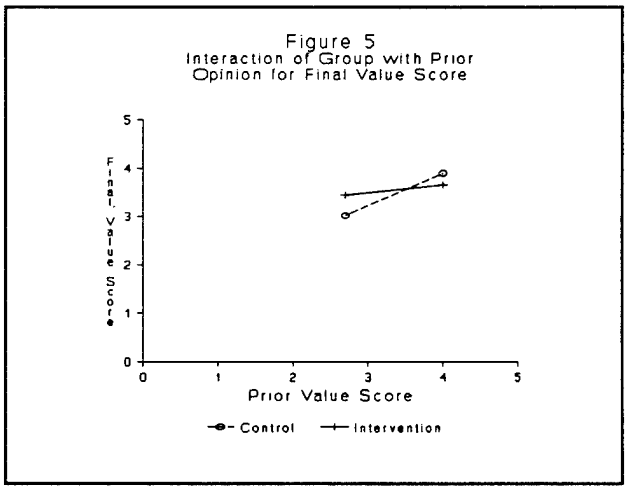



Figure 4 indicates the intervention raised the SET Goal opinion scores of students with lower prior opinions.

Figure 5 shows the intervention raised the Value opinion scores of students who entered with lower opinions.

**Figure 6**

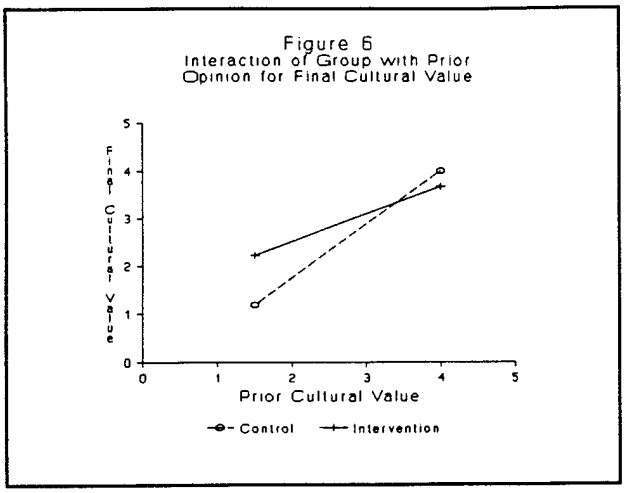



**Figure 7**

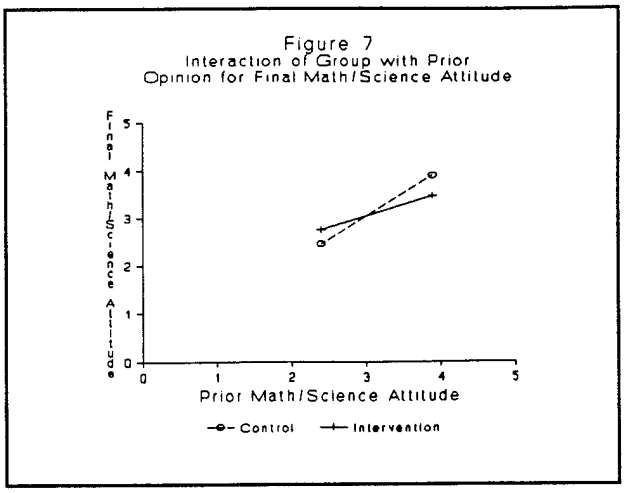



Figure 6 displays the interaction for Cultural Value scores; for students who had scores lower than average on the prior Cultural Value scale, the intervention group produced significantly higher scores on the final Cultural Value scale.

Figure 7 indicates that the intervention raised opinions of the students who had entered with the lowest scores for Math/Science Attitude.

In summary, the intervention had significant effects on Environmental Support and Equal Opportunity scores, and had beneficial effects on the opinions of students with low prior SET Goal, Value, Cultural Value, and Math/Science Attitude scores.

## DISCUSSION

The hypotheses of enhanced performance and opinion as a result of the intervention received substantial support, especially for students entering with lower GPAs and/or lower opinions about SET majors and careers. After adjusting for prior college GPA, the intervention group had higher scores on lecture quizzes for students as a whole, and had higher course averages and course grades for students who entered with GPAs of "C" or below. Most importantly, students entering with a "C" average could pass physics with the aid of the intervention laboratories. The advantages of the intervention were extended when Anglo male students were added to the minority and women students. Finally, the number of intervention students passing physics was higher than has been historically the case at this institution.

The major effects on opinion were two support advantages (Environmental Support and Equal Opportunity) for the intervention group as a whole; four selective advantages of the intervention were higher SET Goal, Value, and Cultural Value of SET majors and careers, and higher Math/Science Attitudes for students with low prior opinion scores.

The benefits of the intervention laboratories spilled over into performance differences for the lecture course and into opinion differences about SET fields. The benefits were most noticeable for students entering with lower GPAs and lower opinions about these fields. Although it was anticipated that the intervention would be of particular benefit to minority and women students, the benefits of the intervention laboratories generalized to Anglo males; including the Anglo males in the sample produced a larger overall performance advantage for the students in the intervention laboratories.

Though the intervention was analyzed as a quasi-experiment with the ensuing caution about causal conclusions, the groups appeared well matched prior to the intervention. Comparisons on 95 preintervention measures found significant differences on only two percent, which included a broad range of demographic (2 out of 74), performance (0 out of 4), and opinion measures (0 out of 17). As a result, confidence is greater in the causal effects of the intervention laboratories.

In interpreting why the intervention laboratories were successful, it should be noted that several variables differed between the intervention and control laboratories in addition to the content of the laboratory activities, according to a report by Dr. Hewett. First, the instructors for the intervention laboratories received three to four times as much training as did the control laboratory instructors. Second, physics department faculty supervised the intervention laboratories more thoroughly than they supervised the control laboratories; the amount of supervision differed by a factor of two or three. And third, several short lectures and/or demonstrations in the intervention laboratories were conducted by faculty. It seems that conclusions about the effectiveness of the intervention laboratories relative to the control laboratories must consider three elements other than the content of the laboratory activities: (a) the intervention laboratory instructors received more training, (b) the intervention laboratory instructors received more supervision, and (c) some of the intervention laboratories were taught by full-time faculty. Subsequent semesters of this intervention varied these additional elements, and this report's conclusions about the success of the intervention laboratory activities will be strengthened if the findings are replicated despite these variations.

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Documents supplied by CASET Consortium institutions: baseline reports, research proposals, college catalogs, and bulletins.

# APPENDICES

# APPENDIX A

# COLLEGE STUDENT PROTOCOL

## College Student Protocol

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. Am. Indian (Please specify the tribe which best describes your heritage.) _____
   ___ e. Hispanic Which of the following best describes your heritage?
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

6. Class:
   ___ a. College freshman
   ___ b. College sophomore
   ___ c. College junior
   ___ d. College senior
   ___ e. Other (e.g., special or temporary student, etc.)
      Specify _____

7. Have you declared a college major?
   ___ a. No
   ___ b. Yes ..... Please specify your major. _____

8. Have you taken any advanced placement tests for college credit?
   ___ a. No
   ___ b. Yes ..... Please list tests taken. _____

9. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Two years of college
   ___ b. Four years of college
   ___ c. One or more years after college
   ___ d. Other Specify _____

10. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

11. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)

   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Work-study
   ___ d. Job other than work-study
   ___ e. Tuition or other scholarship
   ___ f. Loan
   ___ g. Previous personal earnings and savings
   ___ h. GI Bill, ROTC, or other governmental assistance (other than scholarship or loan)
   ___ i. Family trust fund, insurance plan, or other similar arrangement
   ___ j. Other Specify _____

12. You may want to receive help outside your regular college course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems
   ___ f. Increasing reading ability
   ___ g. Developing good study habits
   ___ h. Improving writing ability

13. What is or was the occupation of the person(s) with whom you lived during the years you were growing up? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

   _____ _____

14. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average

15. Are you:
___ a. An only child (skip to question 17)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

16. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

17. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

18. Indicate the extent of your mother's education. (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

19. What was the language spoken most often by adults in the household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe .... What is that language? _____
___ d. Other
Specify _____

20. Which of the following did your parent(s)/guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

21. Which of the following comes closest to describing your parent(s)/guardian(s)?
___ a. Do(es) not read at all
___ b. Sometimes read(s)
___ c. Read(s) a lot

22. Which of the following comes closest to describing you?
___ a. Do not read at all
___ b. Sometimes read
___ c. Read a lot

23. How many of these do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

24. From what kind of high school or secondary school did you graduate?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

25. Were you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes.....Please list the math and/or science clubs you belonged to.

_____

_____

_____

_____

26. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL WITH DIRECTIONALITY AND SCALES OF ITEMS

**Legend:**

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of my ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |

| | | | |
|---|---|---|---|
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

    i. _____

    ii. _____

    iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF

# THE COLLEGE STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 29 | CONTROL n = 23 |
| 1. Sex | | |
| Women | 41% | 48% |
| Men | 59% | 52% |
| 2. Age | 22.49 | 23.10 |
| 6. Class | | |
| .Freshmen | 10% | 9% |
| .Sophomores | 45% | 35% |
| .Juniors | 28% | 26% |
| .Seniors | 17% | 30% |
| 7. Declared SET majors | 79% | 39%[a] |
| .Missing or undeclared | 7% | 9% |
| 8. Students taken an advanced placement test | 3% | 4% |
| 9. Higher education expected: | | |
| .Two years of college | 0% | 0% |
| .Four years of college | 66% | 39% |
| .One or more years after college | 34% | 56% |
| .Other | 0% | 4% |
| 10. Studies most influenced by | | |
| .Parents | 48% | 56% |
| .Another family member | 3% | 0% |
| .Teacher | 14% | 0% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 0% |
| .Friend | 7% | 13% |
| .Science professional | 3% | 4% |
| .Nonscience professional | 0% | 4% |
| .No one at all | 24% | 22% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 29 | CONTROL n = 23 |
| 11. Sources of income[b] | | |
| .Parents/guardians | 59% | 65% |
| .Spouse | 7% | 0% |
| .Work study | 21% | 17% |
| .Job other than work study | 38% | 30% |
| .Tuition or scholarship | 24% | 17% |
| .Loan | 45% | 56% |
| .Grant | 55% | 52% |
| .Personal savings | 17% | 13% |
| .GI Bill, ROTC, etc. | 3% | 4% |
| .Family trust, etc. | 3% | 9% |
| .Other | 3% | 0% |
| Number of sources of income * | 2.86 | 2.65 |
| 12. Student needs help in:[b] | | |
| .Counseling on educational plans | 24% | 39% |
| .Counseling on career plans | 62% | 56% |
| .Improving math ability | 41% | 48% |
| .Finding part-time work | 21% | 26% |
| .Counseling on personal problems | 7% | 13% |
| .Increasing reading ability | 24% | 17% |
| .Developing good study habits | 52% | 44% |
| .Improving writing ability | 24% | 22% |
| Number of areas needing help * | 2.55 | 2.65 |
| 13. Sources of outside income | | |
| .None | 7% | 0% |
| .One | 52% | 39% |
| .Two | 41% | 69% |
| 14. Family income: | | |
| .Below U.S. average | 24% | 39% |
| .About average | 59% | 35% |
| .Above average | 17% | 17% |
| .Unknown | 0% | 9% |
| 15. Birth order of student: | | |
| .Only child | 3% | 4% |
| .Oldest child | 28% | 57% |
| .Youngest child | 34% | 17% |
| .In-between child | 34% | 22% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 29 | CONTROL n = 23 |
| 16. Number of siblings: | | |
| .None | 3% | 4% |
| .One | 10% | 13% |
| .Two | 24% | 30% |
| .Three or more | 62% | 52% |
| 17. Father's education: | | |
| .Grade school or less | 24% | 9% |
| .Some high school | 10% | 26% |
| .High school graduate | 14% | 30% |
| .Some college | 28% | 9% |
| .College degree or more | 24% | 26% |
| 18. Mother's education: | | |
| .Grade school or less | 31% | 17% |
| .Some high school | 0% | 13% |
| .High school graduate | 31% | 17% |
| .Some college | 24% | 35% |
| .College degree or more | 14% | 17% |
| 19. Language spoken most at home: | | |
| .English | 52% | 56% |
| .Spanish | 48% | 35% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 9% |
| 20. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 38% | 52% |
| .Attend parent-teacher conferences | 55% | 35% |
| .Visit student's class | 55% | 22%[a] |
| .Phone/visit if there's a problem | 48% | 35% |
| .Do volunteer work | 45% | 44% |
| .Assist student in course selection | 24% | 26% |
| .Assist in student's homework | 31% | 56% |
| Number of parental involvements * | 2.96 | 2.70 |
| 21. Parent(s) read: | | |
| .Not at all | 3% | 4% |
| .Sometimes | 52% | 44% |
| .A lot | 45% | 52% |
| 22. Student reads: | | |
| .Not at all | 7% | 0% |
| .Sometimes | 55% | 52% |
| .A lot | 38% | 48% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 29 | CONTROL n = 23 |
| 23. Items in student's home:[b] | | |
| .Desk | 72% | 83% |
| .Daily newspaper | 76% | 70% |
| .Encyclopedia | 90% | 87% |
| .Typewriter | 66% | 70% |
| .Calculator | 100% | 100% |
| .Television | 100% | 100% |
| .Computer | 38% | 52% |
| .Video Cassette Recorder (VCR) | 83% | 78% |
| Number of support items * | 6.24 | 6.39 |
| 24. Type of high school attended | | |
| .Public | 97% | 96% |
| .Private | 3% | 0% |
| .No formal high school | 0% | 0% |
| .Missing | 0% | 4% |
| 25. Member math/science club in high school | 48% | 48% |
| 26. All activities student took part in:[b] | | |
| .Math/science club | 38% | 35% |
| .Field trip | 79% | 83% |
| .Watching science programs on TV | 86% | 91% |
| .Listen to talk by scientist | 48% | 44% |
| .Science/math fair | 45% | 26% |
| .Other science/math competition | 31% | 39% |
| .Play/work in computer lab | 69% | 78% |
| Number of activities * | 3.97 | 3.96 |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# WESTERN NEW MEXICO UNIVERSITY

# MATH ANXIETY INTERVENTION

Prepared by:

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# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected come from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention-group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention activities tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields -- American Indian, Black, Hispanic, and women students -- were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields. Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF WESTERN NEW MEXICO UNIVERSITY

Western New Mexico University is a four-year, public, coeducational institution located in Silver City, New Mexico. The University community consists of approximately 1700 students and 90 faculty members. The University, organized into the Department of Business and Public Administration, Department of Education and Psychology, Department of Expressive Arts, Department of Humanities, Department of Mathematics and Computer Science, Department of Natural Sciences, Department of Physical Education and Health, Department of Social Sciences, and Department of Vocational Education, offers undergraduate and graduate degrees. The student body is approximately 60 percent female and 40 percent male. Approximately 2 percent of the students are American Indian, 2 percent are Black, 40 percent are Hispanic, and the remaining 56 percent are of other ethnic origins, including Anglos (non-Hispanic Whites).

Western New Mexico University offers Bachelor of Arts and Bachelor of Science degrees in a variety of quantitative subjects including mathematics, computer science, chemistry, general science, and geology. A preprofessional program is also offered for students interested in careers in engineering.

Silver City has a population of about 12,000. The state of New Mexico has a population of approximately 1.6 million. According to U.S. Census Bureau estimates, the adult population of New Mexico is 53 percent Anglo, 2 percent Black, 36 percent Hispanic, and 9 percent other ethnic origins, including American Indian. Silver City is adjacent to three metropolitan areas: Las Cruces, New Mexico; El Paso, Texas; and Juarez, Mexico. Institutions of higher education located near Western New Mexico University are University of Texas at El Paso and New Mexico State University in Las Cruces.

# PART II

# CASE STUDY OF THE WESTERN NEW MEXICO UNIVERSITY

# 1989 FALL SEMESTER INTERVENTION

## ABSTRACT

In the fall of 1989 Western New Mexico University, Silver City, New Mexico, conducted and tested against a control group a math anxiety reduction program for college students taking developmental mathematics courses. Participants were 72 undergraduate students (50 women and 22 men), primarily Hispanic and Anglo, enrolled in three sections of Fundamentals of Mathematics. The intervention section and one of the control sections were taught by one instructor, and the other control section was taught by a different instructor.

The Western New Mexico University program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) reduce math anxiety, (b) enhance mathematics performance, and (c) create more favorable attitudes toward math/science fields.

*COMPONENTS:* The major component of the eight-week program was math anxiety treatment provided during regularly scheduled classes. Treatment sessions, conducted weekly by graduate students in counseling, included a video presentation about math anxiety, small group discussions, and relaxation exercises.

*DATA:* All the participants furnished demographic data through the CASET College Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were scores on the Mathematics Anxiety Ratings Scale (MARS), preintervention scores on an institution-specific test of mathematics ability, midterm and final course grades, national standardized test scores, and high school GPAS.

The outcome measures of performance were the midterm course grade, final course grade, and posttest score on the MARS. The preintervention measures of performance were the pretest score on the MARS, pretest score on a test of math ability, ACT composite standard score, and high school GPA.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. The hypotheses of reduced math anxiety, enhanced mathematics performance, and more favorable attitudes toward math/science fields were tested by analyzing demographic, performance, and opinion data in the context of a nonequivalent control group design.

*FINDINGS:* The intervention had little positive effect on the participants, but can be considered a successful intervention in that the opinions of students with the lower scores on certain opinion scales were enhanced. Analyses of the data revealed some unexpected results: there was no significant difference in performance between the intervention and control groups, and the control group reported less math anxiety than did the intervention group. The intervention was associated with more favorable opinions about math/science fields and careers, enhancing scores on five out of seventeen opinion measures. In general, the intervention was most successful at enhancing the opinion scores of students who began the program with the most negative opinions about math and science.

## DESCRIPTION OF THE INTERVENTION

Faculty at Western New Mexico University expressed the belief that at least one reason for the lower proportions of minorities and women in mathematics and science courses was "widespread Math Anxiety." Accordingly, a math anxiety intervention program was developed within the departmental mathematics program, for implementation during the Fall 1989 semester. This intervention proposed to improve mathematics performance by treating math anxiety in college students taking lower-level mathematics courses. One section of the developmental skills course in mathematics was designated as an intervention group, and two sections as control groups. One control group had the same instructor as the intervention group; the second control group had a different instructor.

The developmental skills course met for three hours per week. The intervention design called for one of those hours to be given over to math anxiety treatment for the intervention section of the class; in practice, this time was shortened after a few weeks to thirty minutes per week. The remaining class meeting time (two hours per week at first; later two and one-half hours per week) was regular instructional time. The two control classes did not participate in any intervention activity, but met for their three hours of instruction every week.

The math anxiety treatment sessions included watching a video program about math anxiety, a lecture about math anxiety, relaxation exercises, and small group discussions of students' feelings about math classes, math myths, math successes, and career goals.

There were eight weekly treatment sessions, beginning September 27, 1989 (the sixth week of the semester) and ending November 29, 1989. The sessions were conducted by a graduate student in counseling, under the supervision of a member of the mathematics faculty with experience in math anxiety treatment. The first graduate student counselor was replaced after the first four sessions with another graduate student counselor; the supervising faculty member reported that there had been cooperation problems on the part of the first graduate student and that cooperation improved with the second graduate student.

The supervising faculty member reported several problems with the execution of the project: the staffing change just mentioned, "anxiety" on the part of the class instructor about the time that the intervention took from the class; a "negative attitude" on the part of the students. The faculty member attributed the reported "negative attitude" to students' view that the intervention program was "being forced upon them," and to the several class periods spent filling out the measures of performance, anxiety, and opinion related to the research.

The project director for this intervention was Dr. Alfred Milligan, Chair, Department of Mathematics and Computer Science, Western New Mexico University. The project coordinator and math anxiety specialist was Dr. Adrienne Dare, Assistant Professor, Mathematics and Computer Science. The intervention class and one control class were taught by Sherry Lee Lane; the second control class was taught by Farzin Heidari.

## METHOD

### Subjects

Subjects for this study were university students enrolled in developmental mathematics courses at Western New Mexico University in the fall of 1989. Data from 19 intervention and 53 control students were analyzed. The ethnic/race and

sex distribution of both groups are presented in Table 1. The majority of the students were Hispanic, and 69 percent were women. Additional demographic information about the sample can be found in the Results section.

**Table 1**

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | 0 | 0 | 3 | 0 | 3 | 0 |
| Anglo | 10 | - | 5 | - | 15 | - |
| Black | 0 | 0 | 1 | 0 | 1 | 0 |
| Hispanic | 22 | 20 | 7 | 2 | 29 | 22 |
| Unknown | 1 | 0 | 1 | 0 | 2 | 0 |
| **TOTAL** | **33** | **20** | **17** | **2** | **50** | **22** |

CASET Protocols and Other Instruments

Demographic and descriptive data about the students were developed through the College Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support (see Appendix A).

To assess attitudinal information relative to Science, Engineering, and Technology (SET) careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. These variables provided the framework for the Opinion Protocol. Opinion Protocol items, together with the scales they represent, are listed in Appendix B. The Opinion Protocol was administered before and after intervention activity to monitor any changes.

A measure of math anxiety, the Math Anxiety Rating Scale or MARS (Suinn, 1972), was given to students prior to and following the intervention. The MARS was administered and scored by WNMU project staff, and the scores were submitted to CASET. The MARS is a measure consisting of 98 items on a five-point scale that provides a score indicating an individual's degree of math anxiety. The range of possible scores is 98 to 490, with a higher score indicating higher math anxiety.

In addition, faculty provided three measures of mathematics performance for each student: (a) a pretest measure of math ability, (b) a midterm grade, and (c) a final grade. Two other preintervention measures of academic performance were submitted: ACT score and high school GPA.

Procedure

At the beginning of the semester, intervention and control students signed consent forms. The MARS, and the faculty-generated pretest of mathematical ability were administered to intervention and control students. Next, all the students completed the CASET Student Protocol and Pre-Opinion Protocol. In the last week of the semester, students completed the CASET Post Opinion Protocol and were again administered the MARS. Regular course content tests including midterm and final examinations were administered as usual to intervention and control students.

Faculty scored the test of mathematical ability and the MARS, as well as midterm and final examinations, and forwarded scores and grades to CASET, along with the CASET instruments. University project staff also forwarded to CASET the students' standardized test scores and college and high school transcripts.

CASET received Protocols from 21 intervention and 55 control students. CASET staff evaluated the demographic information on each student and eliminated from the sample those students who were not U. S. citizens or who were not members of the minority groups, targeted in this study. One intervention participant and one control group member were eliminated because they indicated that they were not U.S. citizens; one intervention participant and one control group member were eliminated because they indicated they were Anglo males. Data for the remaining students were analyzed: 19 intervention participants and 53 control-group students.

The items of the Opinion Protocol were coded according to the thirteen scales they represent. Scoring of the positively worded items on the Opinion Protocol was reversed so that scores could be totaled meaningfully (see Appendix B). The scales were organized into three constructs -- SET Goal, Environmental Support, and Attitude -- as shown in Appendix C.

## RESULTS

Methodological Issues

The three hypotheses were that the intervention activities would reduce math anxiety, enhance mathematics performance, and create more favorable attitudes toward math/science fields; the hypotheses were tested in a *nonequivalent control group design* (Cook & Campbell, 1979). This quasi-experimental design describes a study with preintervention and postintervention measures on groups formed through nonrandom assignment.

The major weakness of the nonequivalent control group design is that differences between the control and intervention groups may have been due either to the intervention or to the interaction between maturation and preexisting differences between the groups. Analysis of covariance (ANCOVA) methods that adjust postintervention scores for preintervention levels can statistically control for some nonequivalency and provide a more sensitive test of the intervention's effects. Hierarchical ANCOVA tests also can investigate the possible interaction of group membership with pretest score, a finding that might occur if an intervention is successful with a particular type of student.

Because large numbers of students had no scores, the missing data were an important concern in interpreting the results of this intervention. For the demographic measures, 11 percent of the control group and 16 percent of the intervention group had no Student Protocol. For the performance measures, between 8 percent and 55 percent of the control group had no scores for a particular variable, and between 37 percent and 63 percent of the intervention group had missing data. For the opinion measures, 2 percent of the control group and 21 percent of the intervention group were missing preintervention Opinion Protocols; 72 percent of the control group and 58 percent of the intervention group were missing post- intervention Opinion Protocols.

## Demographic Results

The comparability of the intervention and control groups was examined by testing for differences on the items of the College Student Protocol. The complete results are given in Appendix D. Of the 74 comparisons, the groups differed on eight: (a) a greater percentage of the students in the intervention group were women (intervention = 89 percent, control = 62 percent); (b) fewer intervention students were in their first year (75 percent vs. 96 percent); (c) fewer intervention students wanted help in increasing their reading ability (0 percent vs. 26 percent); (d) intervention students reported needing help in fewer areas (intervention M = 1.50, control M = 2.53); (e) fewer intervention students had been on a math/science field trip (12 percent vs. 40 percent); (f) fewer intervention students had heard a scientist's lecture (0 percent vs. 23 percent); (g) fewer intervention students had worked in a computer lab (31 percent vs. 64 percent); and (h) intervention students had participated in fewer math/science activities (intervention M = 1.00, control M = 2.06).

Of the eight demographic differences, two seemed ambiguous in their influence (higher percentage of women and lower percentage of first-year students in the intervention group), two favored the intervention group (intervention students needed less help with reading and needed less help in general), and four differences favored the control group (more of whom had been on field trips, heard scientist's lectures, worked in computer labs, and participated in more math/science activities). The six unambiguous differences between the groups on preexisting characteristics could be reduced to two: intervention students reported needing less help, and control students reported prior participation in more math/science activities.

The potential importance of four preexisting characteristics that differed between the groups--sex, help needed, number of prior math/science activities, and year in school--were evaluated by testing for the significance of relationships with two postintervention performance measures: (a) final exam score, and (b) final MARS score. The only preexisting demographic difference related to either final score was between sex and final MARS score ($r$ = -.26, $n$ = 31): women had higher scores, i.e., women were more anxious about math, a finding that had been reported previously for the MARS (Brush, 1978). The other variables--needing help, math/science activities, and first-year status--were not related to either of the postintervention performance measures. The one demographic difference that was related to performance--sex--was used as a final demographic adjustment to verify the interpretation of group differences for performance.

## Performance Measures

In this intervention, two sections of a "Fundamentals of Math" class were designated as control sections and a third section was selected as the intervention section. The intervention section and one of the control sections were both taught by one instructor, and the other control section was taught by a second instructor. The two instructors used different grading schemes and, consequently, assigned scores that were not comparable. A standardized score was devised for each of the two pairs of tests, resulting in midterm and final scores on the same scale for all of the sections.

The standardization process used each control group's mean and standard deviation to create $z$-scores from the exam scores for each instructor ($z = (X - M)/s$). This standardization converted the exam scores for the two control groups into a new scale with a mean of zero and a standard deviation of one; this assumed that the control groups did not differ. The intervention group's standardized mean and standard deviation would differ from the control group only if the raw scores differed, which is the assumption made in testing whether the intervention group outperformed the control groups. Finally, the $z$-scores were transformed into a scale having a mean of 50, a standard deviation of 10, and a range of possible scores from 0 to 100 ($10(z) + 50$); this produced a scale that was similar to a T-score scale (Allen & Yen, 1979).

*Group differences in performance.* The four preintervention measures and the three postintervention measures of performance were tested for group differences, and the results are given in Table 2. Note that the control group outperformed the intervention group on the math pretest and on the MARS posttest. A further analysis was conducted to control for possible preintervention differences between the groups, and because of the small number of students with

both pre- and postintervention measures of performance (42 percent to 50 percent of the 72 students); the next section presents analyses of covariance, ANCOVAs, that adjusted for pretest scores for all students.

**Table 2**

GROUP COMPARISONS OF PERFORMANCE MEASURES

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | SIG P |
|---|---|---|---|---|---|---|
| ACT Composite Standard Score | Control<br>Intervention | 32<br>12 | 10.06<br>11.17 | 3.50<br>4.63 | 0.85<br>(42) | ns |
| High School GPA | Control<br>Intervention | 33<br>11 | 2.40<br>2.48 | 0.46<br>0.43 | 0.47<br>(42) | ns |
| Math Pretest | Control<br>Intervention | 45<br>7 | 20.80<br>13.43 | 7.66<br>7.46 | 2.38<br>(50) | ≤.05 |
| Midterm Grade | Control<br>Intervention | 52<br>8 | 50.38<br>52.37 | 9.61<br>11.16 | 0.54<br>(58) | ns |
| Final Grade | Control<br>Intervention | 49<br>8 | 50.00<br>47.45 | 9.90<br>13.50 | -0.64<br>(55) | ns |
| MARS Pretest | Control<br>Intervention | 47<br>7 | 239.23<br>274.00 | 62.27<br>78.14 | -1.33<br>(52) | ns |
| MARS Posttest | Control<br>Intervention | 24<br>7 | 233.88<br>293.00 | 79.60<br>111.03 | -1.58<br>(29 | ≤.01 |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences.
For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

*Group differences after adjusting for pretests.* A hierarchical ANCOVA adjusted for pretest scores before comparing groups on postintervention final grade and MARS measures, and the results are given in Table 3. The table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding the first and each subsequent variable to the multiple regression equation and the significance test of the variable's contribution to explaining the dependent variable. The columns of the table are the cumulative percentage of explained variance (cum $R^2$), added contribution in explained variance of the variable ($sR^2$), F-test of the contribution of the new variable [$F(sR^2)$], and the degrees of freedom (df) for the test. Because the hypothesis was directional--improvement for the intervention group--the test statistics were compared to one-tailed probability levels; for F statistics, this involved converting from the F to t statistic ($F = t^2$) and determining the corresponding one-tailed critical value.

Table 3

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig. p |
|---|---|---|---|---|---|---|
| FINAL GRADE | ACT | .1608 | .1608 | 6.52 | 1,34 | ≤.01 |
| | + GROUP | .1744 | .0136 | 0.54 | 1,33 | ns |
| | + ACT-x-GROUP | .1840 | .0096 | 0.38 | 1,32 | ns |
| FINAL GRADE | HS GPA | .1143 | .1143 | 4.39 | 1,34 | ≤.05 |
| | + GROUP | .1146 | .0003 | 0.01 | 1,33 | ns |
| | + GPA-x-GROUP | .1158 | .0012 | 0.04 | 1,32 | ns |
| FINAL GRADE | MATH PRETEST | .0392 | .0392 | 1.92 | 1,47 | ns |
| | + GROUP | .0417 | .0026 | 0.12 | 1,46 | ns |
| | + PRE-x-GROUP | .0432 | .0014 | 0.07 | 1,45 | ns |
| MARS | MARS PRETEST | .6260 | .6260 | 46.86 | 1,28 | ≤.01 |
| | + GROUP | .6614 | .0354 | 2.82 | 1,27 | ≤.10 |
| | + PRE-x-GROUP | .6627 | .0013 | 0.10 | 1,26 | ns |

All models were analyzed as one-tailed tests.

* Three models of independent variables were tested for each dependent variable: (1) ACT alone; (2) ACT and ('+') GROUP; (3) ACT and GROUP with ACT-by-GROUP INTERACTION ('-x-').

The results of these analyses indicated that the control group demonstrated lower anxiety as measured by the MARS after the intervention than did the intervention group. This finding supported the *t-test* result of Table 2.

*Performance adjusting for sex differences.* Three findings suggested an additional analysis controlling for sex: (a) the intervention groups had a higher percentage of women; (b) sex had correlated significantly with final MARS score; and (c) due to missing data, the intervention students who had both prior and final MARS scores were all women. When only women were examined, the same pattern of findings emerged from the ANCOVAs: the women in the control showed lower postintervention math anxiety as measured by the MARS than did the women in the intervention group, and the two groups did not differ on the final exam. Thus, the finding of lower math anxiety scores by the control group was verified after controlling for the sex of students.

*Interrelationships among performance measures.* Table 4 presents the correlations among all of the performance measures. From an examination of the table, one sees both expected and unexpected relationships. It was expected that the ACT score and high school GPA would be correlated significantly, that both would be related to midterm and final exam grades, and that the MARS taken prior to the intervention would be correlated with the MARS taken after the intervention. However, it was not expected that the math pretest would be correlated negatively with the midterm and final grades.

Table 4

INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a]

| Performance Measure | ACT (n) Sig. p | HS GPA (n) Sig. p | Math Pretest (n) Sig. p | Midterm (n) Sig. p | Final (n) Sig. p | MARS Pretest (n) Sig. p |
|---|---|---|---|---|---|---|
| HS GPA | .36<br>≤.05<br>(35) | 1.00 | | | | |
| Math Pretest | .11<br>ns<br>(33) | -.03<br>ns<br>(33) | 1.00 | | | |
| Midterm | .55<br>≤.01<br>(38) | .33<br>≤.05<br>(38) | -.39<br>≤.01<br>(52) | 1.00 | | |
| Final | .40<br>≤.01<br>(36) | .34<br>≤.05<br>(36) | -.20<br>≤.10<br>(49) | .68<br>≤.01<br>(56) | 1.00 | |
| MARS Pretest | -.04<br>ns<br>(33) | .09<br>ns<br>(33) | -.15<br>ns<br>(52) | .02<br>ns<br>(54) | -.17<br>ns<br>(51) | 1.00 |
| MARS Posttest | .17<br>ns<br>(17) | .15<br>ns<br>(16) | .20<br>ns<br>(29) | -.04<br>ns<br>(30) | -.22<br>ns<br>(30) | .79<br>≤.01<br>(30) |

[a] All correlations were analyzed as two-tailed tests.

This surprising finding indicated that the ACT score would be a better choice as a preintervention measure of performance. Also of note were the expected negative correlations between the MARS scores and final grade; these correlations were nearly significant at the 10 percent probability level.

Opinion Measures

The means of the intervention and control students were compared for the 13 opinion scales, three constructs, and total opinion score, before and after the intervention. These results are given in Table 5. Before the intervention began, the control group had significantly higher scores on one of the seventeen measures: Role Model. After the intervention ended, the intervention group had significantly higher scores on one measure--Study Habits--and the control group had significantly higher scores on one measure--Locus of Control.

Table 5

GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES

| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| OPINION, Total | Pretest | 2.76 | 0.23 | 2.68 | 0.26 | -1.10 | ns |
| | Posttest | 2.73 | 0.26 | 2.70 | 0.21 | -0.29 | ns |
| SET GOAL | Pretest | 2.84 | 0.33 | 2.80 | 0.34 | -0.36 | ns |
| | Posttest | 2.75 | 0.33 | 2.78 | 0.24 | 0.18 | ns |
| Value | Pretest | 3.36 | 0.45 | 3.22 | 0.41 | -1.11 | ns |
| | Posttest | 3.25 | 0.48 | 3.12 | 0.35 | -0.64 | ns |
| Cultural Value | Pretest | 3.23 | 0.43 | 3.29 | 0.43 | 0.50 | ns |
| | Posttest | 3.15 | 0.46 | 3.22 | 0.25 | 0.39 | ns |
| Self-Concept | Pretest | 2.38 | 0.42 | 2.24 | 0.52 | -1.07 | ns |
| | Posttest | 2.46 | 0.43 | 2.44 | 0.49 | -0.09 | ns |
| Aspiration | Pretest | 2.65 | 0.50 | 2.75 | 0.54 | 0.67 | ns |
| | Posttest | 2.40 | 0.45 | 2.55 | 0.28 | 0.85 | ns |
| ATTITUDE | Pretest | 2.46 | 0.24 | 2.37 | 0.30 | -1.32 | ns |
| | Posttest | 2.49 | 0.23 | 2.46 | 0.15 | -0.30 | ns |
| Math/Science Attitude | Pretest | 2.81 | 0.31 | 2.76 | 0.33 | -0.48 | ns |
| | Posttest | 2.79 | 0.32 | 2.81 | 0.38 | 0.14 | ns |
| Locus of Control | Pretest | 3.09 | 0.46 | 3.13 | 0.33 | 0.32 | ns |
| | Posttest | 3.24 | 0.48 | 3.00 | 0.18 | -1.38 | ≤.10 |
| Persistence | Pretest | 2.72 | 0.46 | 2.54 | 0.60 | -1.27 | ns |
| | Posttest | 2.85 | 0.42 | 2.81 | 0.64 | -0.17 | ns |
| Study Habits | Pretest | 2.61 | 0.34 | 2.58 | 0.26 | -0.34 | ns |
| | Posttest | 2.47 | 0.34 | 2.75 | 0.40 | 1.79 | ≤.05 |
| Anxiety | Pretest | 2.24 | 0.44 | 2.08 | 0.57 | -1.18 | ns |
| | Posttest | 2.34 | 0.41 | 2.23 | 0.58 | -0.56 | ns |
| ENVIRONMENTAL SUPPORT | Pretest | 2.85 | 0.25 | 2.73 | 0.30 | -1.46 | ns |
| | Posttest | 2.76 | 0.41 | 2.61 | 0.33 | -0.86 | ns |
| Academic Support | Pretest | 2.97 | 0.47 | 2.93 | 0.44 | -0.26 | ns |
| | Posttest | 2.96 | 0.59 | 2.83 | 0.59 | -0.47 | ns |
| Career Awareness | Pretest | 2.80 | 0.36 | 2.71 | 0.33 | -0.86 | ns |
| | Posttest | 2.67 | 0.42 | 2.50 | 0.40 | -0.93 | ns |

| GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES | | | | | | | |
|---|---|---|---|---|---|---|---|
| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
| | | Mean | SD | Mean | SD | | |
| Role Model | Pretest | 2.52 | 0.46 | 2.21 | 0.66 | -2.04 | ≤.05 |
| | Posttest | 2.33 | 0.72 | 2.33 | 0.56 | 0.00 | ns |
| Equal Opportunity | Pretest | 3.09 | 0.51 | 3.08 | 0.47 | -0.08 | ns |
| | Posttest | 3.09 | 0.56 | 2.79 | 0.50 | -1.26 | ns |
| All pretests were analyzed as two-tailed tests. | | | | All posttests were analyzed as one-tailed tests. | | | |
| Pretest n's: Control = 52; Intervention = 15. | | | | Posttest n's: Control = 15; Intervention = 8. | | | |

All of the postintervention differences may have resulted from the persistence of preexisting differences and not due to the intervention; this is especially likely because so few students, only 28 percent completed both pre- and postintervention Opinion Protocols. In order to adjust for possible preexisting differences, the final opinion variables were adjusted for preexisting differences via ANCOVA.

*Group differences on opinion adjusting for prior scores.* Table 6 reports the results of the effects of group membership after adjusting for preintervention opinion scores.
By this analysis, the intervention group had significantly higher scores on five measures: total Opinion, SET Goal, Self-Concept, Study Habits, and Environmental Support. In addition, the pretest and group membership interacted for seven opinion measures: SET Goal, Cultural Value, Aspiration, Locus of Control, Study Habits, Environmental Support, and Academic Support.

**Table 6**

| HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION | | | | | | |
|---|---|---|---|---|---|---|
| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLE MODELS* | Cumul.$R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
| OPINION, Total | PRETEST SCORE | .6508 | .6508 | 33.55 | 1,18 | ≤.01 |
| | + GROUP | .7377 | .0868 | 5.63 | 1,17 | ≤.05 |
| | + PRE-x-GROUP | .7420 | .0043 | 0.27 | 1,16 | ns |
| SET GOAL | PRETEST SCORE | .8193 | .8193 | 81.61 | 1,18 | ≤.01 |
| | + GROUP | .8984 | .0791 | 13.25 | 1,17 | ≤.01 |
| | + PRE-x-GROUP | .9114 | .0130 | 2.36 | 1,16 | ≤.10 |
| Value | PRETEST SCORE | .0951 | .0951 | 1.89 | 1,18 | ≤.10 |
| | + GROUP | .0953 | .0002 | 0.00 | 1,17 | ns |
| | + PRE-x-GROUP | .1149 | .0196 | 0.35 | 1,16 | ns |
| Cultural Value | PRETEST SCORE | .4547 | .4547 | 15.01 | 1,18 | ≤.01 |
| | + GROUP | .4844 | .0297 | 0.98 | 1,17 | ns |
| | + PRE-x-GROUP | .6131 | .1287 | 5.32 | 1,16 | ≤.05 |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLE MODELS* | Cumul.$R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Self-Concept | PRETEST SCORE | .6582 | .6582 | 34.67 | 1,18 | ≤.01 |
| | + GROUP | .7172 | .0590 | 3.55 | 1,17 | ≤.05 |
| | + PRE-x-GROUP | .7238 | .0066 | 0.38 | 1,16 | ns |
| Aspiration | PRETEST SCORE | .5388 | .5388 | 21.03 | 1,18 | ≤.01 |
| | + GROUP | .5682 | .0294 | 1.16 | 1,17 | ns |
| | + PRE-x-GROUP | .6471 | .0789 | 3.58 | 1,16 | ≤.05 |
| ATTITUDE | PRETEST SCORE | .3919 | .3919 | 11.60 | 1,18 | ≤.01 |
| | + GROUP | .4375 | .0456 | 1.38 | 1,17 | ns |
| | + PRE-x-GROUP | .4553 | .0178 | 0.52 | 1,16 | ns |
| Math/Science Attitude | PRETEST SCORE | .7251 | .7251 | 47.47 | 1,18 | ≤.01 |
| | + GROUP | .7394 | .0144 | 0.94 | 1,17 | ns |
| | + PRE-x-GROUP | .7395 | .0001 | 0.00 | 1,16 | ns |
| Locus of Control | PRETEST SCORE | .5145 | .5145 | 19.08 | 1,18 | ≤.01 |
| | + GROUP | .5584 | .0439 | 1.69 | 1,17 | ns |
| | + PRE-x-GROUP | .6198 | .0614 | 2.58 | 1,16 | ≤.10 |
| Persistence | PRETEST SCORE | .3209 | .3209 | 8.50 | 1,18 | ≤.01 |
| | + GROUP | .3220 | .0011 | 0.03 | 1,17 | ns |
| | + PRE-x-GROUP | .3221 | .0001 | 0.00 | 1,16 | ns |
| Study Habits | PRETEST SCORE | .0248 | .0248 | 0.46 | 1,18 | ns |
| | + GROUP | .1880 | .1631 | 3.41 | 1,17 | ≤.05 |
| | + PRE-x-GROUP | .2954 | .1074 | 2.44 | 1,16 | ≤.01 |
| Anxiety | PRETEST SCORE | .1731 | .1731 | 3.77 | 1,18 | ≤.05 |
| | + GROUP | .1797 | .0066 | 0.14 | 1,17 | ns |
| | + PRE-x-GROUP | .1808 | .0011 | 0.02 | 1,16 | ns |
| ENVIRONMENTAL SUPPORT | PRETEST SCORE | .5585 | .5585 | 22.77 | 1,18 | ≤.01 |
| | + GROUP | .6093 | .0507 | 2.21 | 1,17 | ≤.10 |
| | + PRE-x-GROUP | .6671 | .0578 | 2.78 | 1,16 | ≤.10 |
| Academic Support | PRETEST SCORE | .4878 | .4878 | 17.14 | 1,18 | ≤.01 |
| | + GROUP | .5267 | .0389 | 1.40 | 1,17 | ns |
| | + PRE-x-GROUP | .7146 | .1879 | 10.54 | 1,16 | ≤.01 |
| Career Awareness | PRETEST SCORE | .1594 | .1594 | 3.41 | 1,18 | ≤.05 |
| | + GROUP | .1597 | .0003 | 0.01 | 1,17 | ns |
| | + PRE-x-GROUP | .1755 | .0158 | 0.31 | 1,16 | ns |
| Role Model | PRETEST SCORE | .1716 | .1716 | 3.73 | 1,18 | ≤.05 |
| | + GROUP | .2085 | .0369 | 0.79 | 1,17 | ns |
| | + PRE-x-GROUP | .2584 | .0499 | 1.08 | 1,16 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLE MODELS* | Cumul.$R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Equal Opportunity | PRETEST SCORE | .1785 | .1785 | 3.91 | 1,18 | ≤.05 |
| | + GROUP | .1889 | .0104 | 0.22 | 1,17 | ns |
| | + PRE-x-GROUP | .2008 | .1020 | 0.24 | 1,16 | ns |

All models were analyzed as one-tailed tests.

**Note:** $sR^2$ is the proportion of variance attributed to the last entered independent variable; $F(sR^2)$ is the value for the test of significance for that proportion of variance.

These seven significant interactions between the preintervention opinion score and group membership indicated that the relationship between the prior and final opinion scores was different in the two groups. The interactions were analyzed using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of pretest scores for which the groups differed. The group-by-preintervention opinion interactions were graphed in Figures 1 - 7.

Figure 1 shows the interaction for group with prior scores for SET Goal scores: for students who had higher scores (3 or higher) on the prior SET Goal scale, the intervention group produced sig- nificantly higher scores on the final SET Goal scale.

**Figure 1**

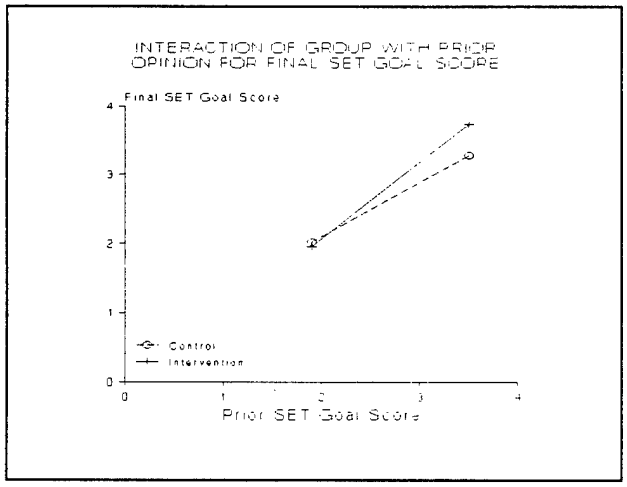
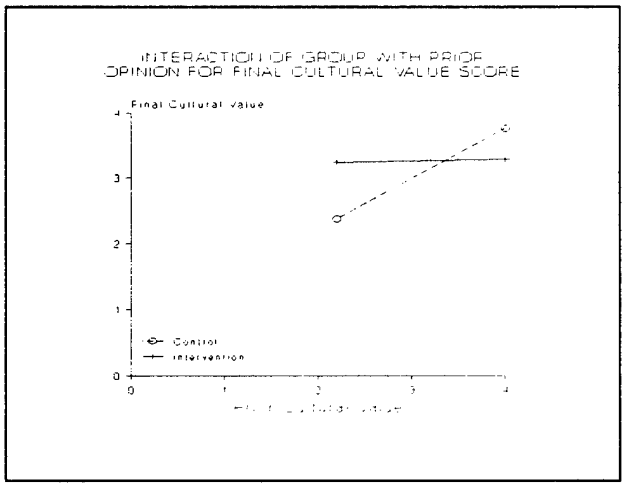



**Figure 2**




The interactions between preintervention score and group membership for the Cultural Value, Aspiration, Locus of Control, Study Habits, Environmental Support, and Academic Support opinion measures are graphed in Figures 2 through 7. The interactions for these six measures took a similar form such that the intervention was related to higher opinion scores for students who entered the intervention with relatively low opinions (approximately 2.5 or lower), and the intervention had negative effects on opinion relative to the control group only for students with the very highest preintervention scores on these measures.

**Figure 3**

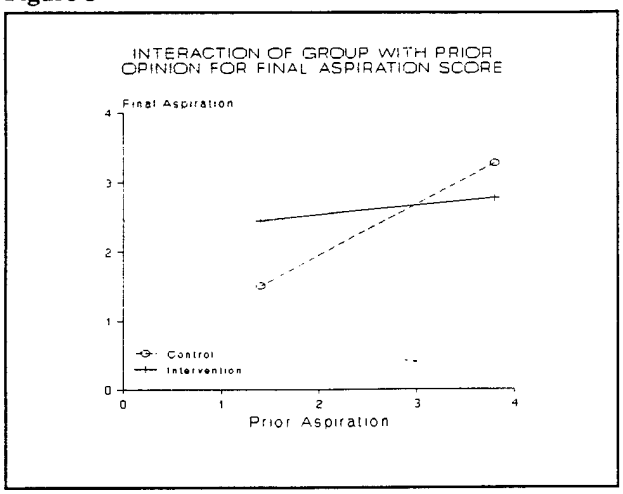



**Figure 4**

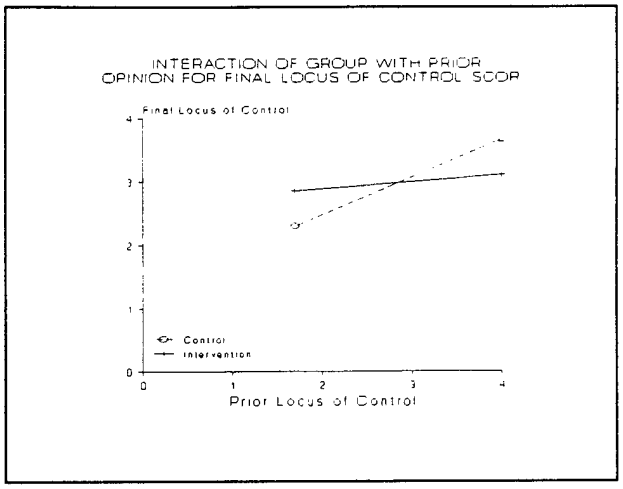



**Figure 5**

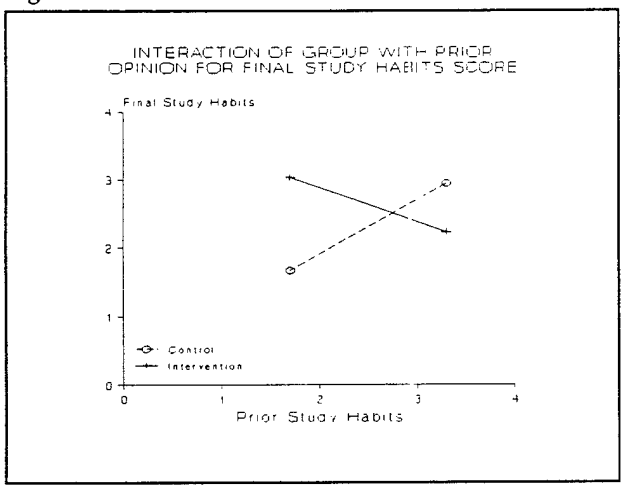



**Figure 6**

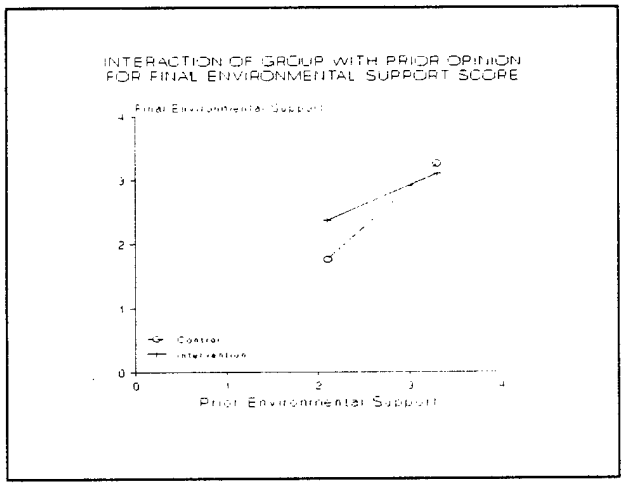
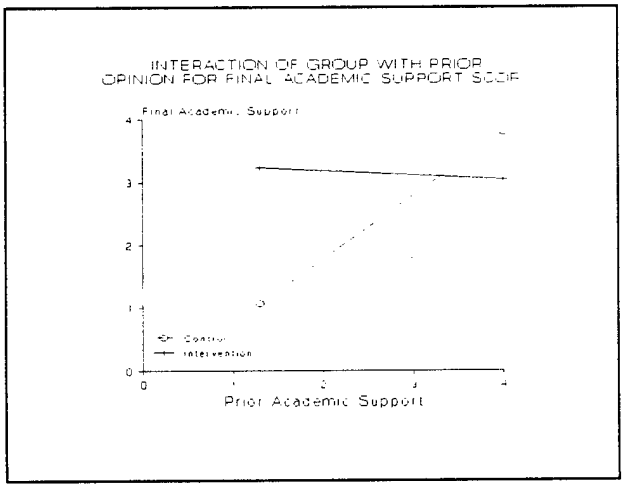



**Figure 7**




In summary, the intervention had significant, positive effects for the entire group on five measures: total Opinion, SET Goal, Self Concept, Study Habits, and Environmental Support. In addition, the pretest and group membership interacted for seven opinion measures: SET Goal, Cultural Value, Aspiration, Locus of Control, Study Habits, Environmental Support, and Academic Support; for all but SET Goal, the interaction indicated that the intervention was most successful at increasing the opinion scores of students who began with the most negative opinions about math, science, and engineering courses and careers.

*Relationships between MARS and opinion measures.* It was expected that the MARS scores would correlate with some of the scales that were derived from the Opinion Protocol's 55 items. Correlations between prior and final MARS scores and opinion scores are presented in Table 7.

Table 7

CORRELATION BETWEEN OPINION MEASURES AND MARS SCORES

| OPINION CONSTRUCT/Scale | Pre-MARS & Pre-Opinion | | Post-MARS & Post-Opinion | |
|---|---|---|---|---|
| | r | Sig. p[a] | r | Sig. p[a] |
| OPINION, Total | -.12 | ns | .04 | ns |
| SET GOAL | -.16 | ns | -.14 | ns |
| Value | -.05 | ns | -.29 | ns |
| Cultural Value | -.02 | ns | -.03 | ns |
| Self-Concept | -.18 | ns | -.20 | ns |
| Aspiration | -.15 | ns | .16 | ns |
| ATTITUDE | -.09 | ns | -.03 | ns |
| Math/Science Attitude | .15 | ns | .45 | ≤.05 |
| Locus of Control | -.01 | ns | -.32 | ≤.10 |
| Persistence | -.12 | ns | -.17 | ns |
| Study Habits | -.06 | ns | -.03 | ns |
| Anxiety | -.12 | ns | .08 | ns |
| ENVIRONMENTAL SUPPORT | -.06 | ns | .20 | ns |
| Academic Support | .05 | ns | .39 | ≤.05 |
| Career Awareness | -.17 | ns | -.19 | ns |
| Role Model | -.13 | ns | .40 | ≤.05 |
| Equal Opportunity | .11 | ns | -.18 | ns |

[a] All two-tailed significance tests.

NOTE: r, the Pearson correlation coefficients, were computed on 53 cases for preintervention measures and 19 cases for postintervention measures.

The preintervention MARS was not significantly related to any of the 17 preintervention opinion measures, but the postintervention MARS was correlated significantly with four opinion measures: MARS scores were negatively correlated with Locus of Control scores, and positively correlated with Math/science Attitude, Academic Support, and Role Model scores. Because the MARS scores are scaled in direction opposite to the opinion measures, i.e., a larger score indicates more anxiety, the negative correlation with Locus of Control was expected, but the other three positive correlations were in the opposite direction to what was expected. Although the findings were unexpected, the correlations were computed on only 19 of the original 72 students; this reduction of the beginning sample by almost three-quarters may have produced anomalous findings.

## DISCUSSION

Of the three hypotheses about the intervention's effects--enhanced mathematics performance, lowered math test anxiety, and more favorable opinions--only the more favorable opinion hypothesis received some support. The intervention and control groups did not differ on performance (final exam grade), and the control group had less anxiety than did the intervention group, contrary to expectations.

The major effects on opinion were advantages for all or most of the intervention group on nine of 17 measures: (a) positive advantages for the whole intervention group for five measures (total Opinion, SET Goal, Self-Concept, Study Habits, and Environmental Support); and (b) positive advantages for some students on seven measures (a higher SET Goal score for students with high prior scores, and higher scores for Cultural Value, Aspiration, Locus of Control, Study Habits, Environmental Support, and Academic Support, for students with lower prior scores). The students who finished in the intervention group had more favorable opinions about math/science fields and careers.

It is necessary to point out that this finding of more favorable opinions in the intervention group is not necessarily due to the intervention. The postintervention opinion results favoring the intervention group compared intervention students who had one instructor with control students who had a different instructor. Therefore, any differences between the opinion scores of the intervention and control groups may also be interpreted as differences between the two instructors. Only a replication that used the same instructor in both classes would control this rival interpretation of these results.

The MARS results justify some further discussion. The preintervention MARS scores were nearly significantly different (to the control group's advantage), and the postintervention MARS scores, whether tested by $t$-test or by ANCOVA, were higher in the control group. The MARS scores for the control group did decline significantly from preintervention to postintervention (from 248 to 234, $t$ (23) = 1.69, $p < .10$), but the MARS scores increased nonsignificantly for the intervention group (from 260 to 287). Several aspects of this outcome should be noted: (a) due to the large percentage of students for whom the project director did not provide postintervention measures (presumably because in most cases the students did not finish the course), the resulting, small sample may have been atypical; and (b) the MARS scores for these students (overall pretest mean = 244) was significantly higher than the mean of the two samples (171) studied by Brush (1978), and was as high as the mean of students accepted for individual counseling for math anxiety in other studies (Richardson & Suinn, 1972; Suinn, Edie, Nicoletti, & Spinelli, 1972). (The mean MARS score for the intervention group was approximately 100 points higher than Brush's samples' mean, which was based on students at a private, northeastern college.) The group intervention may have been successful for students with lower levels of anxiety. However, the findings suggest that with highly math anxious students, such as the students of this sample who were enrolled in "Fundamentals of Math," a more intensive, individualized program might be effective, whereas the group approach attempted here may have exacerbated their condition.

Another possibility is that the MARS may not be uniformly measuring math anxiety at the higher levels of anxiety; this would help explain why the intervention group demonstrated positive opinion changes from pre- to postintervention despite indicating greater anxiety on the MARS. Also, the unusual, positive correlations between the MARS and some of the opinion scales might be due to some unusual measurement properties of the MARS at the higher range of math

anxiety. Validity studies of the MARS relating math anxiety to math performance (Richardson & Suinn, 1972; Suinn et al., 1972) have been based on a performance score from an unusual, accelerated administration of the math form of the Differential Aptitude Test; these studies' results may not generalize to natural math testing situations in which students have adequate time to prepare for an anticipated test on which they are motivated to perform at their best.

The substantial loss of students from the intervention group (only 8 of 19 had final exam grades) suggests that reducing withdrawals from mathematics intervention classes should be a major goal for the future. Unavailability of data from a large number of students weakens confidence in the already tentative conclusions that the results suggest.

For these reasons, and in light of the difficulties described in the *Description* of the intervention section above, it is difficult to interpret the findings from this study. It would appear that participation in a normal mathematics course uninterrupted by a special program for math anxiety may in fact be more effective in diminishing math anxiety than giving up one session per week of instruction for a special program. However, since the program was modified somewhat during the semester, it would seem that only a partial test of the approach took place.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# APPENDICES

# APPENDIX A

# COLLEGE STUDENT PROTOCOL

## College Student Protocol

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. Am. Indian (Please specify the tribe which best describes your heritage.) _____
   ___ e. Hispanic Which of the following best describes your heritage?
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

6. Class:
   ___ a. College freshman
   ___ b. College sophomore
   ___ c. College junior
   ___ d. College senior
   ___ e. Other (e.g., special or temporary student, etc.)
      Specify _____

7. Have you declared a college major?
   ___ a. No
   ___ b. Yes ..... Please specify your major. _____

8. Have you taken any advanced placement tests for college credit?
   ___ a. No
   ___ b. Yes ..... Please list tests taken. _____

9. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Two years of college
   ___ b. Four years of college
   ___ c. One or more years after college
   ___ d. Other Specify _____

10. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

11. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)
   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Work-study
   ___ d. Job other than work-study
   ___ e. Tuition or other scholarship
   ___ f. Loan
   ___ g. Previous personal earnings and savings
   ___ h. GI Bill, ROTC, or other governmental assistance (other than scholarship or loan)
   ___ i. Family trust fund, insurance plan, or other similar arrangement
   ___ j. Other Specify _____

12. You may want to receive help outside your regular college course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems
   ___ f. Increasing reading ability
   ___ g. Developing good study habits
   ___ h. Improving writing ability

13. What is or was the occupation of the person(s) with whom you lived during the years you were growing up? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

   _____ _____

14. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average

15. Are you:
___ a. An only child (skip to question 17)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

16. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

17. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

18. Indicate the extent of your mother's education. (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

19. What was the language spoken most often by adults in the household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe .... What is that language? _____
___ d. Other
Specify _____

20. Which of the following did your parent(s)/guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

21. Which of the following comes closest to describing your parent(s)/guardian(s)?
___ a. Do(es) not read at all
___ b. Sometimes read(s)
___ c. Read(s) a lot

22. Which of the following comes closest to describing you?
___ a. Do not read at all
___ b. Sometimes read
___ c. Read a lot

23. How many of these do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

24. From what kind of high school or secondary school did you graduate?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

25. Were you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes.....Please list the math and/or science clubs you belonged to.

_____

_____

_____

_____

26. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL WITH DIRECTIONALITY AND SCALES OF ITEMS

Legend:

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of any ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |

| | | | |
|---|---|---|---|
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

    i. _____

    ii. _____

    iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE COLLEGE STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE* | |
|---|---|---|
| | INTERVENTION n = 16 | CONTROL n = 47 |
| 1. Sex | | |
| • Women | 89% | 62%[a] |
| • Men | 11% | 38% |
| 2. Age * | 24.97 | 22.86 |
| 6. Class | | |
| • Freshmen | 75% | 96%[a] |
| • Sophomores | 6% | 2% |
| • Juniors | 0% | 2% |
| • Seniors | 0% | 0% |
| • Other | 12% | 0% |
| • Missing | 6% | 0% |
| 7. Declared SET majors | 6% | 4% |
| • Missing or undeclared | 50% | 45% |
| 8. Students taking an advanced placement test | 19% | 6% |
| • Missing | 0% | 4% |
| 9. Higher education expected | | |
| • Two years of college | 31% | 17% |
| • Four years of college | 44% | 66% |
| • One or more years after college | 19% | 17% |
| 10. Studies most influenced by | | |
| • Parents | 38% | 47% |
| • Another family member | 12% | 15% |
| • Teacher | 0% | 4% |
| • Counselor | 0% | 6% |
| • Minister | 0% | 0% |
| • Friend | 6% | 8% |
| • Science professional | 0% | 2% |
| • Nonscience professional | 6% | 0% |
| • No one at all | 38% | 17% |

| PROTOCOL ITEM | PERCENT RESPONSE* | |
|---|---|---|
| | INTERVENTION n = 16 | CONTROL n = 47 |
| 11. Sources of income[b] | | |
| • Parents/guardians | 19% | 30% |
| • Spouse | 6% | 0% |
| • Work study | 25% | 19% |
| • Job other than work study | 19% | 21% |
| • Tuition or scholarship | 12% | 6% |
| • Loan | 6% | 13% |
| • Grant | 50% | 66% |
| • Personal savings | 6% | 0% |
| • GI Bill, ROTC, etc. | 0% | 4% |
| • Family trust, etc. | 0% | 2% |
| • Other | 19% | 11% |
| Number of income sources * | 1.62 | 1.72 |
| 12. Student needs help in[b] | | |
| • Counseling on educational plans | 19% | 30% |
| • Counseling on career plans | 31% | 38% |
| • Improving math ability | 19% | 32% |
| • Finding part-time work | 38% | 34% |
| • Counseling on personal problems | 6% | 8% |
| • Increasing reading ability | 0% | 26%[a] |
| • Developing good study habits | 31% | 55% |
| • Improving writing ability | 6% | 30% |
| Number areas needing help[c] * | 1.50 | 2.53[a] |
| 13. Sources of outside income | | |
| • None | 6% | 11% |
| • One | 56% | 49% |
| • Two | 19% | 30% |
| • Missing | 19% | 11% |
| 14. Family income | | |
| • Below U.S. average | 50% | 36% |
| • About average | 25% | 32% |
| • Average | 0% | 8% |
| • Unknown | 19% | 23% |
| 15. Birth order of student | | |
| • Only child | 19% | 4% |
| • Oldest child | 12% | 30% |
| • Youngest child | 19% | 19% |
| • In-between child | 50% | 43% |
| • Missing | 4% | 0% |

| PROTOCOL ITEM | PERCENT RESPONSE* | |
|---|---|---|
| | INTERVENTION n = 16 | CONTROL n = 47 |
| 16. Number of siblings | | |
| • None | 19% | 4% |
| • One | 12% | 15% |
| • Two | 6% | 21% |
| • Three or more | 62% | 55% |
| • Missing | 0% | 4% |
| 17. Father's education | | |
| • Grade school or less | 25% | 19% |
| • Some high school | 6% | 30% |
| • High school graduate | 12% | 15% |
| • Some college | 31% | 19% |
| • College degree or more | 0% | 8% |
| • Missing | 25% | 8% |
| 18. Mother's education | | |
| • Grade school or less | 12% | 28% |
| • Some high school | 25% | 30% |
| • High school graduate | 12% | 23% |
| • Some college | 25% | 6% |
| • College degree or more | 6% | 8% |
| • Missing | 19% | 4% |
| 19. Language spoken most at home | | |
| • English | 62% | 53% |
| • Spanish | 19% | 43% |
| • Language of tribe | 6% | 0% |
| • Other | 0% | 4% |
| • Missing | 12% | 0% |
| 20. Parents involvement during student's years in school[b] | | |
| • Attend PTA meetings | 12% | 15% |
| • Attend parent-teacher conferences | 44% | 36% |
| • Visit student's class | 31% | 23% |
| • Phone/visit if there's a problem | 31% | 43% |
| • Do volunteer work | 19% | 17% |
| • Assist student in course selection | 31% | 21% |
| • Assist in student's homework | 62% | 68% |
| Number of parental involvements * | 2.31 | 2.23 |
| 21. Parent(s) read | | |
| • Not at all | 0% | 4% |
| • Sometimes | 31% | 28% |
| • A lot | 69% | 66% |

| PROTOCOL ITEM | PERCENT RESPONSE* | |
|---|---|---|
| | INTERVENTION n = 16 | CONTROL n = 47 |
| 22. Student reads | | |
| • Not at all | 6% | 2% |
| • Sometimes | 56% | 68% |
| • a lot | 38% | 28% |
| 23. Items in student's home[b] | | |
| • Desk | 63% | 47% |
| • Daily newspaper | 81% | 74% |
| • Encyclopedia | 81% | 66% |
| • Typewriter | 50% | 51% |
| • Calculator | 94% | 74% |
| • Television | 100% | 98% |
| • Computer | 12% | 15% |
| • VCR | 56% | 60% |
| Number of support items * | 5.38 | 4.85 |
| 24. Type of high school attended | | |
| • Public | 69% | 83% |
| • Private | 0% | 0% |
| • No formal high school | 31% | 13% |
| 25. Member of math/science club in high school | 12% | 19% |
| 26. Activities student took part in[b] | | |
| • Math/science club | 0% | 0% |
| • Field trip | 12% | 40%[a] |
| • Watching science programs on TV | 31% | 47% |
| • Listening to talk by scientist | 0% | 23% |
| • Science/math fair | 25% | 26% |
| • Other science/math competition | 0% | 6% |
| • Play/work in computer lab | 31% | 64%[a] |
| Number of activities[d]* | 1.00 | 2.06 |

* Mean value reported in lieu of percent response.
[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.
[c] $t$ (61 df) = 2.61. Intervention SD = 1.21. Control SD = 1.41
[d] $t$ (61 df) = 2.44. Intervention SD = 0.89, Control SD = 1.66

# CASET RESEARCH REPORT:

# TEXAS SOUTHERN UNIVERSITY

# INTERVENTIONS

Prepared by:

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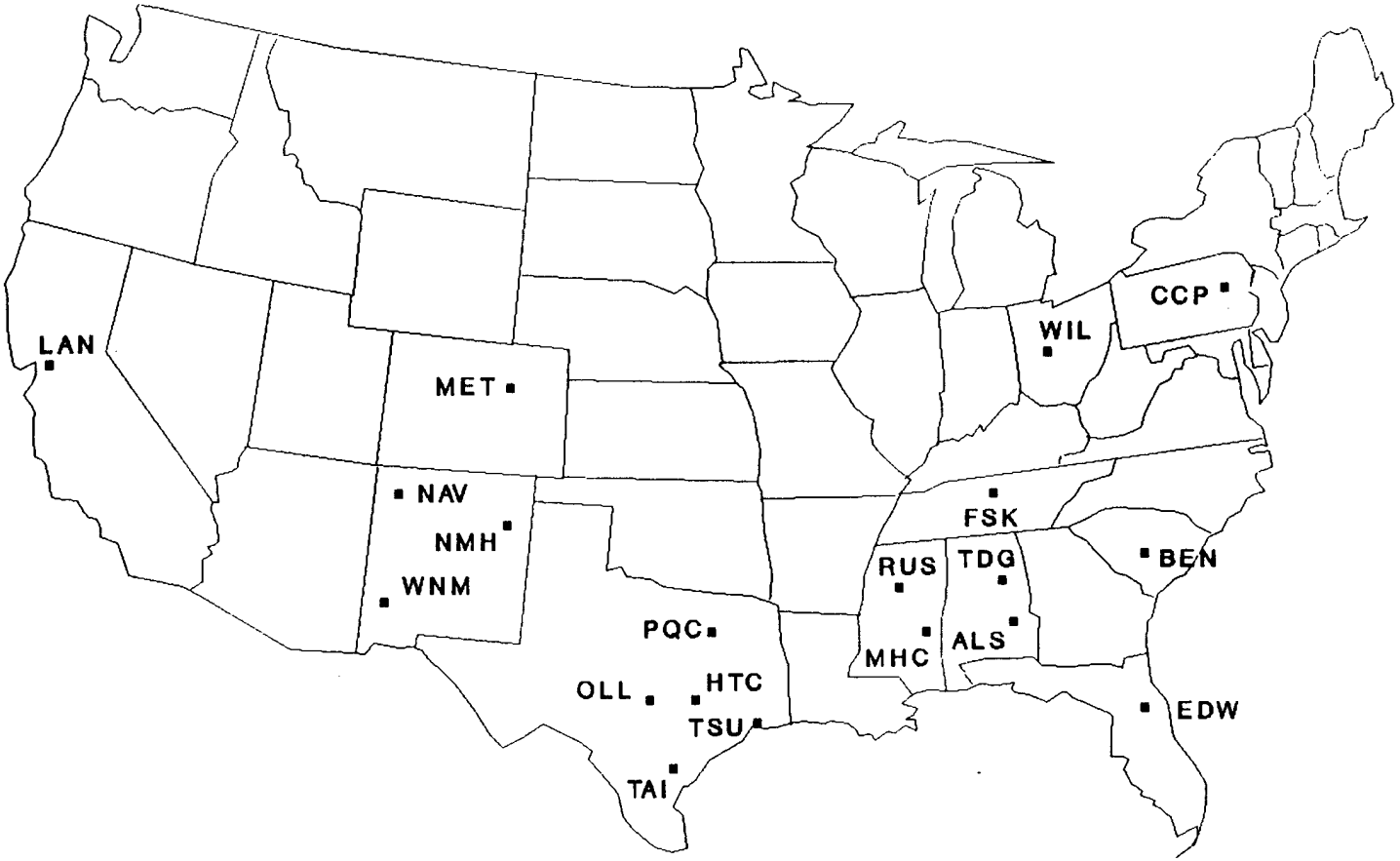
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected came from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention- group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF TEXAS SOUTHERN UNIVERSITY

Texas Southern University (TSU) is a historically Black, four-year, public, coeducational institution located in Houston, Texas. The campus community consists of approximately 8700 students and 450 faculty members. The University, organized into the College of Arts and Sciences, School of Business, College of Education, College of Pharmacy and Health Sciences, and the School of Technology, offers undergraduate and graduate degrees. The student body is approximately 53 percent female and 47 percent male. Although the student population is predominantly Black, there is a large number of non-Black and international students from over 55 countries attending TSU. The president of TSU is Dr. William O. Harris.

Degrees offered at TSU in quantitative subjects are Bachelor of Science in chemistry, computer science, physics, mathematics, and engineering technology, and Master of Science in chemistry and mathematics. The University also offers a dual degree program in chemistry, mathematics, or physics, and engineering in cooperation with Rice University also located in Houston.

Houston has a population of approximately 1.7 million in its metropolitan area. The state of Texas has a population of just over 17 million. According to U.S. Census Bureau estimates, the adult population of Texas is 66 percent Anglo, 11 percent Black, 21 percent Hispanic, and 2 percent other ethnic origins. Houston has twenty-six other institutions of higher education, including the campuses of the Houston Community College System, Rice University, the various campuses of the University of Houston, University of St. Thomas, and the University of Texas Health Science Center.

# PART II

# SUMMARY OF THE TEXAS SOUTHERN UNIVERSITY (TSU) INTERVENTIONS

This report summarizes two interventions conducted by Texas Southern University, a historically Black, four-year public institution located in Houston, Texas. The college is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Texas Southern University Intervention Activities:

In Fall of 1989 and in Spring of 1990, Texas Southern University conducted two intervention programs for college students with an expressed interest in science or technical fields. The major components of the intervention were study skills seminars, mentoring, tutoring, and counseling. Field trips were conducted to afford students an opportunity to observe role models in action. Participants were college students, primarily freshmen and sophomores, majoring or with an expressed interest in science and technical fields; most participants were Black.

Findings:

- The intervention produced positive effects in mathematics performance for intervention participants.
- Intervention participants were more likely to complete the college science courses in which they were enrolled than were control-group students.
- The intervention semester associated with stronger performance effects was associated also with less positive opinion effects.

Recommendations:

- These findings suggest that intervention planners may have to choose whether they want to positively impact performance or opinion. There are some indications that it is difficult to do both at the same time.
- These findings also suggest that this intervention's academic components--study skills seminars, mentoring and tutoring--were more effective than its attitudinal components--counseling, field trips, and observing role models.
- Study skills seminars should be offered at the beginning of the semester, so that students have the opportunity to practice those skills throughout the semester.

# PART III

# CASE STUDY OF THE TEXAS SOUTHERN UNIVERSITY

# 1990 SPRING SEMESTER INTERVENTION

## ABSTRACT

In the spring of 1990 Texas Southern University (TSU), Houston, Texas, conducted and tested against a control group an intervention program designed to provide college students academic reinforcement and enrichment in the areas of science and mathematics. Participants were 73 Black undergraduates attending TSU (51 women and 22 men) who were enrolled in introductory biology, chemistry, or mathematics. For each of the three courses, one section served as the intervention group, and another section of the same course taught by the same instructor served as the control group. The intervention was initially conducted in the fall of 1989.

The TSU program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance in science and mathematics courses, and (b) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* Major components of the intervention were lunchtime study skills seminars covering a variety of topics such as test-taking and time-scheduling (conducted early in the program), tutoring; weekly counseling sessions with instructors serving as mentors; field trips to local science and research facilities and a biomedical symposium. In addition, a Science Enrichment Center was established at the university to house supplementary materials such as videotapes, computer software, and reading materials; these materials were available to the intervention-group students as needed.

*DATA:* All the participants furnished demographic data through the CASET College Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were high school and college GPAs, national and state standardized test scores, and final course grades in the biology, chemistry, and mathematics courses in which the students were enrolled.

The outcome measures of performance were the course grade in biology, chemistry, or mathematics and postintervention college GPA. The preintervention measures of performance were SAT mathematics and verbal scores, Texas Educational Assessment of Minimal Skills (TEAMS) mathematics score, preintervention college GPA, and high school GPA.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment because course sections were designated as intervention or control. Demographic, performance, and opinion data were analyzed in the context of a nonequivalent control group design; through analyses of preintervention demographic measures it appeared that the intervention and control groups were comparable.

*FINDINGS:* The intervention had some positive effect on the participants and can be considered a successful intervention based on its effects on course completion. The hypothesis that the intervention would enhance student performance was partially supported: The two groups did not differ on course grades or postintervention GPAs, but more students in the intervention group than in the control group successfully completed the science or mathematics courses they were taking. The hypothesis that the intervention would enhance opinions about SET fields and careers was not supported, although there were limited benefits for intervention-group students who began with low Math/Science Attitudes and Persistence opinion scores. The method of student recruitment for the program may have resulted in preexisting differences between the intervention group (made up of volunteers in course sections) and the control group (made up of all students in comparable course sections) in characteristics related to academic success; these preexisting differences between the groups make conclusions about the intervention's effects tentative.

## DESCRIPTION OF THE INTERVENTION

Texas Southern University developed an intervention to provide academic reinforcement and enrichment primarily for college freshmen who have indicated an interest in science, mathematics, computer science, engineering or other science-based field. During the Spring 1990 semester, freshmen taking introductory courses in biology, chemistry, or mathematics were offered the opportunity to participate in the intervention program. The program offered study skills seminars in the early part of the intervention so that students would have those skills available for their course work and study during the semester. At the conclusion of the study skills seminars, the students went on three field trips in Houston so that they could meet professional role models and watch scientists and technical workers in action; students visited Uncle Ben's rice processing plant, NASA/Johnson Space Center, and the positron laboratory at the University of Texas Medical School.

Mentoring and tutoring were key parts of the program. Tutorial assistance was available to the intervention-group students as needed. Instructors for the three introductory courses served as mentors for the students, attending activities with them, suggesting tutoring or supplementary reading, and advising them about course selections and other decisions. Once a week, each mentor scheduled time to meet with his or her own intervention-group students to provide help and counseling. Intervention-group students were invited to attend a biomedical symposium held at the Hyatt Regency Hotel in Houston during the semester of the intervention to meet internationally known minority scientists. A Science Enrichment Center was established at TSU to house supplementary materials, such as videotapes, computer software, and reading materials, for intervention-group students to use as needed or as their mentors recommended.

The study skills seminars included the following topics:

- preparing for examinations
- taking objective examinations
- taking essay examinations
- listening and note-taking
- concentration
- time-scheduling
- vocabulary-building
- learning about the library

Of about 85 students invited to participate, 35 did so on a regular basis. The project coordinator, Dr. Yvonne Hogan, saw a conflict for many students between the program and work and other commitments. She addressed the problem of students' limited time for participation in a novel way: The study skills seminars were held at lunchtime, with lunch served to participants. At the lunchtime meetings, a "team spirit" was fostered, with interactions among students and between students and their faculty mentors. For example, students had an opportunity to recognize and applaud specific academic successes of their fellow students.

The two hypotheses were that the intervention would: (a) enhance performance in science and mathematics courses, and (b) enhance opinions about SET fields and careers.

The Project Director for this CASET project at Texas Southern University was Dr. Joseph Jones, Dean for Research and Graduate Studies, Texas Southern University. The Project Coordinator was Dr. Yvonne H. Hogan, Professor, Department of Biology. Faculty mentors were Dr. Dinah Colbert (biology), Dr. Paul Thurston (chemistry), and Mr. John Wiley (mathematics).

## METHOD

### Subjects

Subjects were Black freshmen and sophomore college students enrolled in introductory courses in chemistry, mathematics, or biology. For each of these three courses, one section was designated as the intervention-group section, and another section of the same course taught by the same instructor was designated as the control-group section. Students enrolled in the intervention-group section were invited to participate in the intervention activities, and those who did so on a regular basis (about 35 of the 85 invited) were designated as the intervention group. Control-group students filled out the same protocols and provided the same information as the intervention-group students, but did not participate in any intervention activities.

A total of 83 sets of data were submitted from 29 intervention-group students and 54 control-group students. Ten of these data sets -- three from the intervention group and seven from the control group -- were eliminated from the analysis because the students were not U. S. citizens, and thus did not represent the populations that are the subject of this research. A total of 26 data sets from intervention-group students and 47 data sets from control-group students were analyzed; the data from these students are presented in this report. Table 1 shows the distribution of men and women in the intervention and control groups.

**Table 1**

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | | | | | | |
| Anglo | | | | | | |
| Black | 32 | 15 | 19 | 7 | 51 | 22 |
| Hispanic | | | | | | |
| Unknown | | | | | | |
| TOTAL | 32 | 15 | 19 | 7 | 51 | 22 |

### CASET Protocols and Other Instruments

The two hypotheses were that the intervention would: (a) enhance performance in science and mathematics courses, and (b) enhance opinions about SET fields and careers.

Demographic and descriptive data about the subjects were developed through the CASET College Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gave a scalar measurement for that variable. Thus the completed Opinion Protocol provided a scale measuring each of the thirteen variables. The Opinion Protocol was administered to intervention- and control-group students before and after the intervention. The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B.

The preintervention measures of performance for intervention- and control-group students were Scholastic Aptitude Test (SAT) mathematics and verbal scores, Texas Educational Assessment of Minimal Skills (TEAMS) mathematics score, preintervention college grade point average (GPA), and high school GPA.

Postintervention measures of performance were postintervention college GPA and final grade in the chemistry, biology or mathematics course in which a given student was enrolled.

### Procedure

At the beginning of the intervention, intervention- and control-group members signed consent forms and transcript release forms. The first measures of opinion and the measures of demographic information were taken on February 21, 1990. Intervention activities were conducted, with students' participation monitored and documented for purposes of analysis. After the intervention, the CASET Opinion Protocol was administered a second time to all students on May 3, 1990. Intervention-group and control-group students took final examinations and received course grades, which were forwarded to CASET as an outcome measure of the performance effects of the intervention. High school and college transcripts, as well as TEAMS and SAT scores for intervention-group and control-group students were forwarded to CASET for analysis, along with the CASET Student Protocols and the preintervention and postintervention Opinion Protocols.

The items of the Opinion Protocol were coded by CASET according to the thirteen scales they represent. Items on the Opinion Protocol were scored in such a way that a larger number reflected a positive outcome (see Appendix B). The scales were organized into three constructs--SET Goal, Environmental Support, and Attitude--as shown in Appendix C.

## RESULTS

### Methodological Issues

The two hypotheses were that the intervention would: (a) enhance performance in science and mathematics courses, and (b) enhance opinions about SET fields and careers. Most participants had preintervention and postintervention measures of performance, and the intervention was analyzed as a *nonequivalent control group* design. This type of quasi-experimental design has one common weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty may be addressed by analyzing the influence of preexisting

characteristics on students' performance and opinion; the analysis of covariance (ANCOVA), adjusting for preintervention performance or opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that existed before the intervention.

## Demographic Results

The comparability of the intervention and control groups was examined by testing for differences on the items of the College Student Protocol. The complete results are given in Appendix D. Of the 54 comparisons, the groups differed on nine: (a) the intervention-group students were older ($M$ = 21.8 years) than the control-group students ($M$ = 19.7 years); (b) more intervention- group students wanted career counseling (54%) than did control-group students (24%); (c) more intervention-group students wanted to increase their reading ability (39%) than did control-group students (15%); (d) more mothers of intervention-group students had a college degree (46%) than did mothers of control-group students (20%); (e) parents of control-group students attended more conferences with teachers (67%) than did the parents of intervention-group students (42%); (f) more intervention-group students had been members of a math/science club in high school (58%) than had control-group students (33%); (g) more intervention-group students had taken part in math/science club activities in high school (46%) than had control-group students (9%); (h) more control-group students had been on a science-related field trip (80%) than had intervention-group students (58%); and (i) more control-group students had heard a lecture by a scientist (37%) than had intervention-group students (12%). Four of the nine differences favored the intervention-group students (older, more mothers had college degrees, greater membership in math/science clubs), three differences favored the control-group students (more parents had met with teachers, students had attended more science-related field trips and science lectures), and two were ambiguous (more intervention-group students wanted career counseling and help to improve reading ability). The nine significant differences between the groups on preexisting characteristics were not significantly different from the number of differences expected by chance at the 10-percent probability level. Based on these results, the groups were judged to be comparable on demographic characteristics before the intervention.

## Performance Measures

*Group differences in performance.* The five preintervention measures (SAT-Verbal, SAT-Mathematics, TEAMS Mathematics score, high school GPA, and prior college GPA) and the two postintervention measures of performance (semester GPA and final grade in science/mathematics course) were tested for group differences, and the results are given in Table 2. Note that the intervention and control groups differed on one preintervention measure: The intervention-group students had higher preintervention college GPAs ($M$ = 2.57) than did the control-group students ($M$ = 2.20), $t$ (59) = 1.82, $p \leq .10$, two-tailed. The combined groups differed on one postintervention measure: The intervention-group students had higher postintervention college GPAs ($M$ = 2.57) than did the control-group students ($M$ = 2.14), $t$ (62) = 2.35, $p \leq .05$, one-tailed. The groups did not differ in their mean course grades.

Because the GPAs and course grades were collected from students enrolled in several different courses, i.e., biology, chemistry, and mathematics, additional analyses were made of subsamples of students in each class. Because of the small number of students in mathematics (five control-group and three intervention-group students), separate analyses were made only for biology and chemistry students. The results of group comparisons for preintervention GPA, postintervention GPA, and course grade are given in Table 2. The intervention-group students enrolled in biology had significantly higher preintervention GPAs, higher postintervention GPAs, and higher mean grades in biology than did the control-group students. The intervention- and control-group students enrolled in chemistry did not differ significantly on any of the three measures.

The advantage of the intervention-group students before and after the intervention was confined to the biology course; because these students began with a GPA advantage, a further analysis seemed necessary to provide a more sensitive test of the intervention's effects and to adjust for preintervention differences between the groups. ANCOVAs that

adjusted for preintervention college GPA were completed for four postintervention performance measures: GPA (for all classes), course grade (for all classes), biology grade, and chemistry grade.

**Table 2**

**GROUP COMPARISONS OF PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | Sig. p |
|---|---|---|---|---|---|---|
| SAT-Verbal | Control<br>Intervention | 4<br>10 | 332.50<br>337.00 | 117.58<br>75.58 | 0.09<br>(12) | ns |
| SAT-Math | Control<br>Intervention | 4<br>10 | 335.00<br>383.00 | 75.94<br>82.06 | 1.01<br>(12) | ns |
| TEAMS-Math | Control<br>Intervention | 5<br>6 | 794.40<br>805.00 | 47.02<br>97.28 | 0.22<br>(9) | ns |
| High school GPA | Control<br>Intervention | 10<br>10 | 2.20<br>2.86 | 0.60<br>1.08 | 1.69<br>(18) | ns |
| Preintervention College GPA | Control<br>Intervention | 40<br>21 | 2.20<br>2.57 | 0.76<br>0.70 | 1.82<br>(59) | $\leq$.10 |
| Postintervention College GPA | Control<br>Intervention | 41<br>23 | 2.14<br>2.57 | 0.71<br>0.66 | 2.35<br>(62) | $\leq$.05 |
| Course Grade-All | Control<br>Intervention | 42<br>25 | 1.93<br>2.28 | 1.11<br>1.10 | 1.26<br>(65) | ns |
| Biology: Pre College GPA | Control<br>Intervention | 17<br>13 | 2.35<br>2.82 | .64<br>.61 | 2.00<br>(28) | $\leq$.10 |
| Biology: Post College GPA | Control<br>Intervention | 17<br>13 | 2.30<br>2.82 | .60<br>.57 | 2.36<br>(28) | $\leq$.05 |
| Biology Course Grade | Control<br>Intervention | 17<br>15 | 1.65<br>2.13 | 1.00<br>0.92 | 1.43<br>(30) | $\leq$.10 |
| Chemistry: Pre College GPA | Control<br>Intervention | 18<br>5 | 2.32<br>2.40 | 0.68<br>0.69 | 0.23<br>(21) | ns |
| Chemistry:Post College GPA | Control<br>Intervention | 19<br>6 | 2.22<br>2.33 | 0.72<br>0.59 | 0.34<br>(23) | ns |
| Chemistry Course Grade | Control<br>Intervention | 21<br>7 | 2.24<br>2.86 | 1.18<br>1.22 | 1.19<br>(26) | ns |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

*Group differences after adjusting for pretests.* A hierarchical ANCOVA adjusted for preintervention college GPA before comparing groups on four postintervention performance measures; the results are given in Table 3. This table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding the first and each later variable to the multiple regression equation (one variable per row), and the significance test of each variable's contribution toward explaining the dependent measure. The columns of the table include the cumulative percentage of explained variance (cum $R^2$), added contribution in explained variance of the variable ($sR^2$), test of the contribution of the new variable ($F(sR^2)$), and the degrees of freedom (df) for the test.

**Table 3**

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON POSTINTERVENTION PERFORMANCE COVARYING PREINTERVENTION PERFORMANCE**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | F ($sR^2$) | df | Sig.p |
|---|---|---|---|---|---|---|
| Postintervention College GPA | PRE COLL GPA | .76 | .76 | 191.04 | 1,59 | ≤.01 |
| | + GROUP | .77 | .00 | 0.42 | 1,58 | ns |
| | + PRE-x-GROUP | .77 | .00 | 0.26 | 1,57 | ns |
| Course Grade (Combined) | PRE COLL GPA | .20 | .20 | 13.79 | 1,54 | ≤.01 |
| | + GROUP | .20 | .00 | 0.00 | 1,53 | ns |
| | + PRE-x-GROUP | .22 | .01 | 0.97 | 1,52 | ns |
| Biology Course Grade | PRE COLL GPA | .56 | .56 | 32.77 | 1,26 | ≤.01 |
| | + GROUP | .57 | .01 | 0.45 | 1,25 | ns |
| | + PRE-x-GROUP | .57 | .01 | 0.38 | 1,24 | ns |
| Chemistry Course Grade | PRE COLL GPA | .18 | .18 | 4.37 | 1,20 | ≤.05 |
| | + GROUP | .18 | .00 | 0.01 | 1,19 | ns |
| | + PRE-x-GROUP | .18 | .00 | 0.01 | 1,18 | ns |

All models were analyzed as two-tailed tests.

* Three models of independent variables were tested for each dependent variable: (1) GPA alone; (2) GPA and ('+') GROUP; (3) GPA and GROUP and GPA-by-GROUP INTERACTION ('-x-').

The results in Table 3 demonstrated that the control-group and intervention-group students did not differ significantly for postintervention GPA, combined course grade, biology course grade, or chemistry course grade. The findings from Table 2 had indicated that intervention-group students enrolled in biology had higher postintervention GPAs and course grades; the ANCOVA findings indicated that adjusting for preintervention GPA eliminated the intervention group's advantage on postintervention GPA and course grade.

*Course completion.* An additional benefit of the intervention related to the hypothesis of enhanced performance was that more of the students in the intervention group successfully completed their science or mathematics course. Ninety-two percent (24 of 26 students) of the intervention group and 79 percent (37 of 47 students) of the control group earned a passing grade in the course: This difference was significantly different, Fisher's exact test, $z = 1.44$, $p \leq .10$, one-tailed. Based on these analyses, the first hypothesis was partially supported: The intervention had no effect on grade in science or mathematics classes, as measured by semester GPA and course grade, but based on the criterion of completing the course with a passing grade, the intervention was successful.

*Interrelationships among performance.* The interrelatedness of the performance measures was examined through intercorrelations, presented in Table 4. As expected, the preintervention and postintervention measures for GPA were correlated significantly, and course grade was correlated significantly with preintervention GPA.

**Table 4**

| INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a] | | |
|---|---|---|
| | **Preintervention College GPA (n) Sig. p-Value** | **Postintervention College GPA (n) Sig. p-Value** |
| Post College GPA | .87<br>(61)<br>≤.01 | 1.00 |
| Course Grade | .45<br>(56)<br>≤.01 | .68<br>(59)<br>≤.01 |

[a] All correlations were analyzed as two-tailed tests.

*Interrelationships among performance and participation.* The interrelatedness of the postintervention performance and participation measures was examined through intercorrelations, presented in Table 5. The postintervention measures of GPA and course grade were correlated significantly with attendance at weekly meetings, tutorials, and meetings with mentors. Seminar attendance was significantly related to course grade, but not related to GPA. Going on the three field trips was not significantly related to either postintervention measure of performance.

**Table 5**

| CORRELATIONS BETWEEN PERFORMANCE MEASURES AND PARTICIPATION | | | | | | |
|---|---|---|---|---|---|---|
| | **Weekly Meetings** | **Seminars** | **Tutoring** | **Field Trips** | **Meetings w/Mentors** | **N** |
| Post GPA | .32* | .19 | .35* | .21 | .35* | 23 |
| Course Grade | .43** | .31* | .40* | .21 | .63** | 25 |

* $p \leq .05$, one-tailed
** $p \leq .01$, one-tailed

Opinion Measures

*Group differences on pre- and postintervention measures.* The means of the intervention- and control-group students were compared for the 13 opinion scales, three constructs, and total opinion score, before and after the intervention. These results are given in Table 6. Before the intervention began, the students in the intervention and control groups did not differ significantly on any of the seventeen opinion measures; this strengthened the conclusion that the groups were comparable before the intervention. After the intervention ended, the intervention-group and control-group students did not differ on any of the seventeen measures. However, the absence of any postintervention differences may have been partly due to the less sensitive test of group differences (t-test). To adjust for preexisting differences and provide a more sensitive test of the intervention's effects on opinion, the final opinion measures were adjusted for preexisting opinion scores via ANCOVA.

**Table 6**

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| OPINION,Total | Pretest | 3.05 | .22 | 3.05 | .21 | -0.11 | ns |
| | Posttest | 2.99 | .26 | 3.01 | .22 | 0.15 | ns |
| SET GOAL | Pretest | 3.30 | .26 | 3.34 | .28 | 0.50 | ns |
| | Posttest | 3.22 | .28 | 3.24 | .31 | 0.28 | ns |
| Value | Pretest | 3.46 | .33 | 3.55 | .47 | 0.98 | ns |
| | Posttest | 3.38 | .42 | 3.47 | .45 | 0.74 | ns |
| Cultural Value | Pretest | 3.52 | .35 | 3.59 | .30 | 0.83 | ns |
| | Posttest | 3.54 | .37 | 3.52 | .31 | -0.22 | ns |
| Self-Concept | Pretest | 3.09 | .36 | 3.01 | .51 | -0.84 | ns |
| | Posttest | 2.99 | .37 | 2.99 | .41 | -0.03 | ns |
| Aspiration | Pretest | 3.24 | .39 | 3.35 | .39 | 1.05 | ns |
| | Posttest | 3.09 | .46 | 3.14 | .43 | 0.40 | ns |
| ATTITUDE | Pretest | 2.66 | .27 | 2.66 | .23 | 0.01 | ns |
| | Posttest | 2.56 | .33 | 2.59 | .17 | 0.50 | ns |
| Math/Science Attitude | Pretest | 2.85 | .26 | 2.94 | .28 | 1.29 | ns |
| | Posttest | 2.75 | .38 | 2.77 | .24 | 0.23 | ns |
| Locus of Control | Pretest | 3.18 | .46 | 3.20 | .35 | 0.21 | ns |
| | Posttest | 3.15 | .45 | 3.05 | .27 | -0.95 | ns |

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| Persistence | Pretest | 3.00 | .49 | 2.92 | .44 | -0.71 | ns |
| | Posttest | 2.93 | .54 | 2.82 | .33 | -0.92 | ns |
| Study Habits | Pretest | 2.77 | .37 | 2.70 | .41 | -0.75 | ns |
| | Posttest | 2.68 | .46 | 2.81 | .28 | 1.20 | ns |
| Anxiety | Pretest | 2.64 | .53 | 2.54 | .58 | 0.72 | ns |
| | Posttest | 2.52 | .56 | 2.60 | .45 | -0.54 | ns |
| ENVIRONMENTAL SUPPORT | Pretest | 3.07 | .26 | 3.04 | .29 | -0.38 | ns |
| | Posttest | 3.12 | .34 | 3.09 | .36 | -0.37 | ns |
| Academic Support | Pretest | 3.05 | .44 | 2.98 | .62 | -0.53 | ns |
| | Posttest | 3.14 | .46 | 3.07 | .53 | -0.57 | ns |
| Career Awareness | Pretest | 3.24 | .43 | 3.23 | .38 | -0.09 | ns |
| | Posttest | 3.29 | .38 | 3.25 | .42 | -0.36 | ns |
| Role Model | Pretest | 2.86 | .65 | 2.84 | .65 | -0.09 | ns |
| | Posttest | 2.85 | .66 | 2.95 | .62 | 0.55 | ns |
| Equal Opportunity | Pretest | 3.11 | .46 | 3.13 | .46 | 0.19 | ns |
| | Posttest | 3.18 | .48 | 3.08 | .38 | -0.88 | ns |

All pretests were analyzed as two-tailed tests. All posttests were analyzed as one-tailed tests.
Pretest n's: Control = 46; Intervention = 25 Posttest n's: Control = 30; Intervention = 25

*Group differences on opinion adjusting for prior scores.* Table 7 reports the tests of the effects of group membership on opinion after adjusting for preintervention opinion scores. By this analysis, the groups did not differ generally on any opinion measures. However, group membership interacted with preintervention opinion score for two measures: Math/Science Attitude and Persistence. The significant interaction indicated that the relationship between prior opinion score and the final opinion score was different in the two groups. The interaction was analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of preintervention scores for which the groups differed.

Figure 1 shows the nonparallel regression lines that indicate that for students with lower preintervention Math/Science Attitude scores, the students in the intervention group had more positive opinions than the students in the control group.

In Figure 1, for students with prior opinion scores at or below 2.8, the intervention group had more positive opinions than the control group on the final opinion scale; the control group had more positive opinions than the intervention group only for students with prior Math/Science Attitude scores at or above 3.

Figure 2 shows a similar relationship between group membership and prior Persistence scores: Intervention group students with preintervention scores at or below 2.6 had higher postintervention Persistence scores than did comparable

control- group students. Students with higher preintervention Persistence scores (3.1 or higher) did better in the control group than in the intervention group.

**Figure 1**

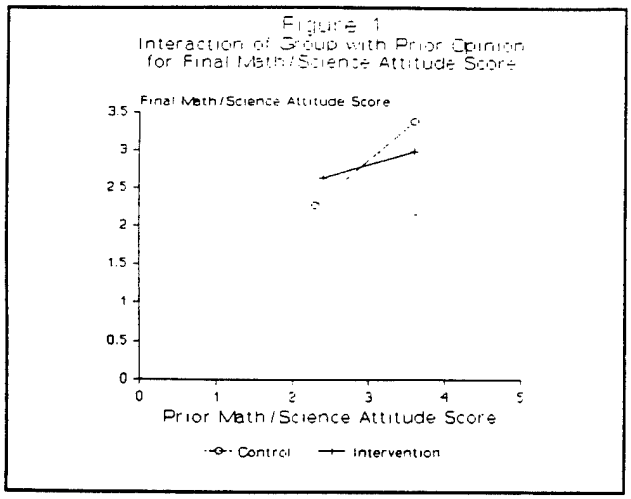
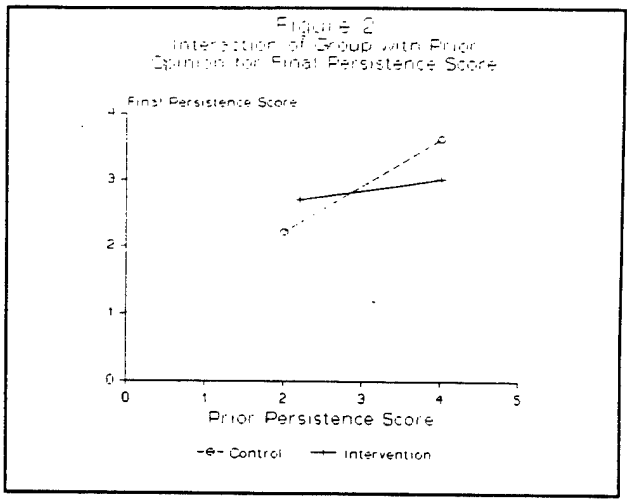



**Figure 2**




Tests of the second hypothesis lead to the conclusion that the intervention had little or no effect on students' opinions about SET fields and careers.

**Table 7**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| OPINION,Total | PREINTERVENTION | .32 | .32 | 23.91 | 1,52 | $\leq$.01 |
| | +GROUP | .32 | .00 | 0.12 | 1,51 | ns |
| | +PRE-x-GROUP | .34 | .02 | 1.82 | 1,50 | ns |
| SET GOAL | PREINTERVENTION | .44 | .44 | 40.61 | 1,52 | $\leq$.01 |
| | +GROUP | .44 | .00 | 0.00 | 1,51 | ns |
| | +PRE-x-GROUP | .44 | .00 | 0.00 | 1,50 | ns |
| Value | PREINTERVENTION | .15 | .15 | 8.88 | 1,52 | $\leq$.01 |
| | +GROUP | .15 | .01 | 0.45 | 1,51 | ns |
| | +PRE-x-GROUP | .17 | .01 | 0.81 | 1,50 | ns |
| Cultural Value | PREINTERVENTION | .41 | .41 | 35.21 | 1,51 | $\leq$.01 |
| | +GROUP | .41 | .00 | 0.21 | 1,50 | ns |
| | +PRE-x-GROUP | .41 | .00 | 0.08 | 1,49 | ns |
| Self-Concept | PREINTERVENTION | .43 | .43 | 30.48 | 1,52 | $\leq$.01 |
| | +GROUP | .43 | .00 | 0.18 | 1,51 | ns |
| | +PRE-x-GROUP | .43 | .00 | 0.04 | 1,50 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Aspiration | PREINTERVENTION | .36 | .36 | 28.15 | 1,51 | ≤.01 |
| | +GROUP | .36 | .00 | 0.05 | 1,50 | ns |
| | +PRE-x-GROUP | .36 | .00 | 0.00 | 1,49 | ns |
| ATTITUDE | PREINTERVENTION | .19 | .19 | 12.58 | 1,52 | ≤.01 |
| | +GROUP | .20 | .00 | 0.23 | 1,51 | ns |
| | +PRE-x-GROUP | .23 | .03 | 2.25 | 1,50 | ns |
| Math/Science Attitude | PREINTERVENTION | .23 | .23 | 15.93 | 1,52 | ≤.01 |
| | +GROUP | .23 | .00 | 0.02 | 1,51 | ns |
| | +PRE-x-GROUP | .29 | .05 | 3.70 | 1,50 | ≤.10 |
| Locus of Control | PREINTERVENTION | .09 | .09 | 5.28 | 1,52 | ≤.05 |
| | +GROUP | .12 | .03 | 1.49 | 1,51 | ns |
| | +PRE-x-GROUP | .12 | .00 | 0.00 | 1,50 | ns |
| Persistence | PREINTERVENTION | .32 | .32 | 24.31 | 1,51 | ≤.01 |
| | +GROUP | .33 | .01 | 0.39 | 1,50 | ns |
| | +PRE-x-GROUP | .40 | .08 | 6.31 | 1,49 | ≤.05 |
| Study Habits | PREINTERVENTION | .10 | .10 | 5.87 | 1,52 | ≤.05 |
| | +GROUP | .14 | .03 | 2.06 | 1,51 | ns |
| | +PRE-x-GROUP | .14 | .00 | 0.11 | 1,50 | ns |
| Anxiety | PREINTERVENTION | .27 | .27 | 19.59 | 1,52 | ≤.01 |
| | +GROUP | .28 | .01 | 0.54 | 1,51 | ns |
| | +PRE-x-GROUP | .28 | .00 | 0.06 | 1,50 | ns |
| ENVIRONMENTAL SUPPORT | PREINTERVENTION | .24 | .24 | 16.36 | 1,51 | ≤.01 |
| | +GROUP | .24 | .00 | 0.07 | 1,50 | ns |
| | +PRE-x-GROUP | .26 | .02 | 1.19 | 1,49 | ns |
| Academic Support | PREINTERVENTION | .06 | .06 | 3.20 | 1,51 | ≤.10 |
| | +GROUP | .06 | .00 | 0.04 | 1,50 | ns |
| | +PRE-x-GROUP | .08 | .02 | 1.22 | 1,49 | ns |
| Career Awareness | PREINTERVENTION | .22 | .22 | 14.38 | 1,51 | ≤.01 |
| | +GROUP | .22 | .00 | 0.00 | 1,50 | ns |
| | +PRE-x-GROUP | .22 | .00 | 0.14 | 1,49 | ns |
| Role Model | PREINTERVENTION | .38 | .38 | 30.61 | 1,51 | ns |
| | +GROUP | .39 | .01 | 1.15 | 1,50 | ns |
| | +PRE-x-GROUP | .40 | .01 | 1.19 | 1,49 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Equal Opportunity | PREINTERVENTION | .08 | .08 | 4.67 | 1,51 | $\leq$.05 |
| | +GROUP | .10 | .01 | 0.74 | 1,50 | ns |
| | +PRE-x-GROUP | .10 | .00 | 0.11 | 1,49 | ns |

All models were analyzed as two-tailed tests.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure): (1) PRETEST OPINION SCORE: (2) PRETEST OPINION SCORE and GROUP ('+'); (3) PRETEST OPINION SCORE, GROUP, and PRETEST OPINION SCORE-by-GROUP INTERACTION ('-x-').

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

*Correlations between opinions and participation.* The seventeen opinion measures were tested for their relationship to the level of participation in each of the five intervention components. The correlation coefficients are given in Table 8. Of the 85 tested relationships between participation and postintervention opinion, eight were significant at the $p \leq .10$ level (two-tailed); of these, six were positive correlations, and two were negative. Of the five components, attendance at the tutorials was significantly positively correlated with two postintervention opinion scales: Value and Study Habits. Of the 17 opinion measures, Aspiration was significantly positively correlated with attendance at three components of the intervention: weekly meetings, seminars, and meetings with mentors. On the negative side, Persistence was significantly negatively correlated with attendance at two components: seminars and meetings with mentors. Given that there were few significant findings and that some were negative correlations, the general conclusion is that there was little or no relationship between attendance and final opinions.

**Table 8**

**CORRELATIONS BETWEEN POSTINTERVENTION OPINION MEASURES AND PARTICIPATION**

| CONSTRUCT/Scale | Weekly Meetings | Seminars | Tutoring | Field Trips | Meetings w/ Mentors |
|---|---|---|---|---|---|
| OPINION | -.04 | -.05 | .26 | .05 | .07 |
| SET GOAL | .22 | .18 | .31 | .07 | .16 |
| Value | .12 | .05 | .43** | .17 | -.08 |
| Cultural Value | .06 | -.02 | -.02 | .30 | -.25 |
| Self-Concept | .09 | .11 | .16 | -.21 | .26 |
| Aspiration | .36* | .34* | .31 | .09 | .35* |
| ATTITUDE | -.24 | -.30 | .19 | -.09 | .05 |

**CORRELATIONS BETWEEN POSTINTERVENTION OPINION MEASURES AND PARTICIPATION**

| CONSTRUCT/Scale | Weekly Meetings | Seminars | Tutoring | Field Trips | Meetings w/ Mentors |
|---|---|---|---|---|---|
| Math/Science Attitude | .00 | .03 | .21 | .00 | .23 |
| Locus of Control | .17 | -.06 | .06 | .34* | -.13 |
| Persistence | -.26 | -.35* | -.23 | -.12 | -.36* |
| Study Habits | -.05 | -.16 | .34* | .15 | .13 |
| Anxiety | -.28 | -.27 | .07 | -.28 | .08 |
| ENVIRONMENTAL SUPPORT | -.17 | -.06 | .14 | .17 | -.08 |
| Academic Support | -.11 | -.01 | .11 | .11 | -.06 |
| Career Awareness | .06 | .02 | .20 | .24 | .07 |
| Role Model | -.15 | .03 | .03 | .11 | -.06 |
| Equal Opportunity | -.30 | -.26 | .10 | .01 | -.15 |

* $p \leq .10$ All were two-tailed tests.
** $p \leq .05$

NOTE: Each $r$, the Pearson correlation coefficient, was computed on 25 cases.

Summary of Results

Table 9 summarizes the findings as effect sizes. As the effect sizes indicate, the intervention had small positive effects on performance and negligible effects on opinion. The hypothesis of enhanced performance received partial support from these results. The hypothesis of enhanced opinion was not supported.

Table 9

| EFFECT SIZES | | | |
|---|---|---|---|
| **VARIABLE** | **Posttest** | **Adjusted Posttest** | **Group-by-Pre Interaction** |
| **PERFORMANCE** | | | |
| GPA | .61 | .17 | .14 |
| Grade in Course (All) | .32 | .00 | .28 |
| Grade in Biology | .51 | .25 | .23 |
| Grade in Chemistry | .52 | .05 | .05 |
| **OPINION** | | | |
| **Total Opinion** | .04 | .09 | .37 |
| SET Goal | .08 | .00 | .00 |
| Attitude | .14 | .13 | .41 |
| Environmental Support | -.10 | .07 | .30 |

The measure of effect size is in pooled standard deviation units calculated according to B. T. Johnson (1989). A positive sign indicates that the intervention group outperformed the control group; a negative sign indicates that the control group had the higher score.

## DISCUSSION

The hypothesis of enhanced performance as a result of the intervention received partial support: The intervention-group and control-group students did not differ on course grades or post-intervention GPAs, but more of the intervention-group students successfully completed their course. The groups did not differ on any opinion measure; two significant interactions between group membership and prior opinions had limited benefits for intervention-group students who began with low Math/Science Attitude and Persistence opinion scores.

Though the intervention was analyzed as a quasi-experiment with the ensuing caution about causal conclusions, the groups appeared comparable before the intervention. Comparisons on a total of 76 preintervention measures found significant differences on only 13 percent, which included a broad range of demographic (9 of 54 measures), performance (1 of 5 measures), and opinion measures (0 of 17 measures).

The intervention's success in enabling students to finish a course with a passing grade may have been due to preexisting differences between the groups. These possible differences were likely created by the method used to recruit students

for the intervention group. Selecting volunteers from one section of a course as the intervention group, and comparing the volunteers to all students in another section of the same course creates potential disparities in motivation and other characteristics possibly related to academic success. Students who are motivated enough to attend extra sessions may have done better than other students without the intervention activities.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# APPENDICES

# APPENDIX A

# COLLEGE STUDENT PROTOCOL

## College Student Protocol

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. Am. Indian (Please specify the tribe which best describes your heritage.) _____
   ___ e. Hispanic Which of the following best describes your heritage?
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

6. Class:
   ___ a. College freshman
   ___ b. College sophomore
   ___ c. College junior
   ___ d. College senior
   ___ e. Other (e.g., special or temporary student, etc.)
      Specify _____

7. Have you declared a college major?
   ___ a. No
   ___ b. Yes ..... Please specify your major. _____

8. Have you taken any advanced placement tests for college credit?
   ___ a. No
   ___ b. Yes ..... Please list tests taken. _____

9. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Two years of college
   ___ b. Four years of college
   ___ c. One or more years after college
   ___ d. Other Specify _____

10. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

11. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)

   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Work-study
   ___ d. Job other than work-study
   ___ e. Tuition or other scholarship
   ___ f. Loan
   ___ g. Previous personal earnings and savings
   ___ h. GI Bill, ROTC, or other governmental assistance (other than scholarship or loan)
   ___ i. Family trust fund, insurance plan, or other similar arrangement
   ___ j. Other Specify _____

12. You may want to receive help outside your regular college course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems
   ___ f. Increasing reading ability
   ___ g. Developing good study habits
   ___ h. Improving writing ability

13. What is or was the occupation of the person(s) with whom you lived during the years you were growing up? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

   _____ _____

14. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average

15. Are you:
___ a. An only child (skip to question 17)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

16. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

17. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

18. Indicate the extent of your mother's education. (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

19. What was the language spoken most often by adults in the household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe .... What is that language? _____
___ d. Other
Specify _____

20. Which of the following did your parent(s)/guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

21. Which of the following comes closest to describing your parent(s)/guardian(s)?
___ a. Do(es) not read at all
___ b. Sometimes read(s)
___ c. Read(s) a lot

22. Which of the following comes closest to describing you?
___ a. Do not read at all
___ b. Sometimes read
___ c. Read a lot

23. How many of these do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

24. From what kind of high school or secondary school did you graduate?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

25. Were you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes.....Please list the math and/or science clubs you belonged to.

_____

_____

_____

_____

26. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL WITH DIRECTIONALITY AND SCALES OF ITEMS

Legend:

| | |
|---|---|
| **SH Study Habits** | **PS Persistence** |
| **AT Attitude toward math/science** | **CV Cultural Value** |
| **SC Self-Concept** | **AS Academic Support** |
| **AX Anxiety** | **AP Aspiration** |
| **VL Value** | **EO Equal Opportunity** |
| **LC Locus of Control** | **RM Role Model** |
| **CA Career Awareness** | |

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of any ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |

| | | | |
|---|---|---|---|
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

i. _____

ii. _____

iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF

# THE COLLEGE STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 26 | CONTROL n = 47 |
| 1. Sex: | | |
| Women | 73% | 68% |
| Men | 27% | 32% |
| 2. Age | 21.78 | 19.72[a] |
| 6. Class: | | |
| .Freshmen | 73% | 76% |
| .Sophomores | 19% | 15% |
| .Juniors | 0% | 6% |
| .Seniors | 4% | 0% |
| .Other | 4% | 0% |
| .Missing | 0% | 2% |
| 7. Declared SET majors | 8% | 11% |
| .Missing or undeclared | 4% | 0% |
| 8. Students taken an advanced placement test | 8% | 25% |
| .Missing | 4% | 4% |
| 9. Higher education expected: | | |
| .Two years of college | 0% | 6% |
| .Four years of college | 27% | 37% |
| .One or more years after college | 54% | 56% |
| .Missing | 4% | 0% |
| 10. Studies most influenced by: | | |
| .Parents | 54% | 67% |
| .Another family member | 12% | 6% |
| .Teacher | 0% | 0% |
| .Counselor | 0% | 0% |
| .Minister | 0% | 0% |
| .Friend | 8% | 6% |
| .Science professional | 12% | 6% |
| .Nonscience professional | 0% | 2% |
| .No one at all | 15% | 11% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 26 | CONTROL n = 47 |
| 11. Sources of income:[b] | | |
| .Parents/guardians | 46% | 59% |
| .Spouse | 8% | 2% |
| .Work study | 4% | 11% |
| .Job other than work study | 35% | 33% |
| .Tuition or scholarship | 23% | 13% |
| .Loan | 31% | 22% |
| .Grant | 46% | 59% |
| .Personal savings | 8% | 15% |
| .GI Bill, ROTC, etc. | 0% | 4% |
| .Family trust, etc. | 0% | 0% |
| .Other | 0% | 0% |
| Number of sources of income * | 2.00 | 2.17 |
| 12. Student needs help in:[b] | | |
| .Counseling on educational plans | 35% | 22% |
| .Counseling on career plans | 54% | 24%[a] |
| .Improving math ability | 50% | 59% |
| .Finding part-time work | 27% | 33% |
| .Counseling on personal problems | 8% | 4% |
| .Increasing reading ability | 39% | 15%[a] |
| .Developing good study habits | 62% | 63% |
| .Improving writing ability | 42% | 41% |
| Number of areas needing help * | 3.15 | 2.65 |
| 13. Sources of outside income: | | |
| .None | 12% | 2% |
| .One | 38% | 39% |
| .Two | 50% | 50% |
| .Missing | 0% | 9% |
| 14. Family income: | | |
| .Below U.S. average | 27% | 11% |
| .About average | 46% | 61% |
| .Above average | 12% | 11% |
| .Unknown | 15% | 17% |
| 15. Birth order of student: | | |
| .Only child | 0% | 4% |
| .Oldest child | 42% | 28% |
| .Youngest child | 38% | 37% |
| .In-between child | 19% | 30% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 26 | CONTROL n = 47 |
| 16. Number of siblings: | | |
| .None | 0% | 6% |
| .One | 27% | 22% |
| .Two | 35% | 22% |
| .Three or more | 35% | 50% |
| .Missing | 4% | 0% |
| 17. Father's education: | | |
| .Grade school or less | 4% | 4% |
| .Some high school | 8% | 9% |
| .High school graduate | 38% | 46% |
| .Some college | 15% | 20% |
| .College degree or more | 35% | 17% |
| .Missing | 0% | 4% |
| 18. Mother's education: | | |
| .Grade school or less | 4% | 0% |
| .Some high school | 8% | 6% |
| .High school graduate | 15% | 26% |
| .Some college | 27% | 48% |
| .College degree or more | 46% | 20%[a] |
| 19. Language spoken most at home: | | |
| .English | 100% | 98% |
| .Spanish | 0% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| .Missing | 0% | 2% |
| 20. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 31% | 44% |
| .Attend parent-teacher conferences .Visit student's class | 42% | 67%[a] |
| .Phone/visit if there's a problem | 54% | 48% |
| .Do volunteer work | 58% | 63% |
| .Assist student in course selection | 19% | 15% |
| .Assist in student's homework | 31% | 41% |
| Number of parental involvements * | 50% | 65% |
| | 2.85 | 3.48 |
| 21. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 35% | 26% |
| .A lot | 65% | 74% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 26 | CONTROL n = 47 |
| 22. Student reads: | | |
| .Not at all | 4% | 2% |
| .Sometimes | 50% | 59% |
| .A lot | 46% | 39% |
| 23. Items in student's home:[b] | | |
| .Desk | 58% | 65% |
| .Daily newspaper | 73% | 65% |
| .Encyclopedia | 81% | 89% |
| .Typewriter | 73% | 72% |
| .Calculator | 96% | 91% |
| .Television | 96% | 96% |
| .Computer | 23% | 28% |
| .Video Cassette Recorder (VCR) | 88% | 80% |
| Number of support items * | 5.88 | 5.87 |
| 24. Type of high school attended: | | |
| .Public | 100% | 94% |
| .Private | 0% | 4% |
| .No formal high school | 0% | 2% |
| 25. Member math/science club in high school | 58% | 33%[a] |
| 26. All activities student took part in:[b] | | |
| .Math/science club | 46% | 9%[a] |
| .Field trip | 58% | 80%[a] |
| .Watching science programs on TV | 50% | 65% |
| .Listen to talk by scientist | 12% | 37%[a] |
| .Science/math fair | 50% | 50% |
| .Other science/math competition | 31% | 17% |
| .Play/work in computer lab | 62% | 67% |
| Number of activities * | 3.08 | 3.26 |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# WESTERN NEW MEXICO UNIVERSITY

# "NATURAL NEW MEXICO" INTERVENTION

Prepared by:

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# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected came from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention-group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all members (by parent or guardian when the student was below the age of consent in his or her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF WESTERN NEW MEXICO UNIVERSITY

Western New Mexico University (WNMU) is a four-year, public, coeducational institution located in Silver City, New Mexico. The University community consists of approximately 1700 students and 90 faculty members. The University, organized into the Department of Business and Public Administration, Department of Education and Psychology, Department of Expressive Arts, Department of Humanities, Department of Mathematics and Computer Science, Department of Natural Sciences, Department of Physical Education and Health, Department of Social Sciences, and Department of Vocational Education, offers undergraduate and graduate degrees. The student body is approximately 60 percent female and 40 percent male. Approximately 2 percent of the students are American Indian, 2 percent are Black, 40 percent are Hispanic, and the remaining 56 percent are of other ethnic origins, including Anglos (non-Hispanic Whites).

Western New Mexico University offers Bachelor of Arts and Bachelor of Science degrees in a variety of quantitative subjects including mathematics, computer science, chemistry, general science, and geology. A pre-professional program is also offered for students interested in careers in engineering.

Silver City has a population of around 12,000. The state of New Mexico has a population of approximately 1.6 million. According to U.S. Census Bureau estimates, the adult population of New Mexico is 53 percent Anglo, 2 percent Black, 36 percent Hispanic, and 9 percent other ethnic origins, including American Indian. Silver City is adjacent to the metropolitan areas of Las Cruces, New Mexico; El Paso, Texas; and Juarez, Mexico. Institutions of higher education located near Western New Mexico University are University of Texas at El Paso and New Mexico State University in Las Cruces.

# PART II

# SUMMARY OF THE WESTERN NEW MEXICO UNIVERSITY (WMNU) INTERVENTIONS

This report summarizes the two summer interventions conducted by Western New Mexico University, a four-year, public institution located in Silver City, New Mexico. Western New Mexico University is a member of a consortium formed by The Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Western New Mexico University Intervention Activities:

During the summers of 1989 and 1990, Western New Mexico University conducted a residential, in-the-field science program entitled "Natural New Mexico." This one-week program was designed to increase high school students' interest in geology, biology, and astronomy through demonstrations, lectures, and hands-on science activities. This intervention dealt with enhancing students' opinions; students' academic performance was not analyzed. Participants were recruited from nearby high schools; recruitment for the program was initiated through high school science teachers. In 1989, Western New Mexico University conducted a one-week session of the "Natural New Mexico" program; in 1990, there were two one-week sessions.

Findings:

- The intervention enhanced opinions about SET fields and careers in both summers.
- Although the project director reported some difficulty in recruiting students for the program, the retention rate for those students who began the program was 100%; all students who began the program finished the program, due in part to the program's short duration and residential character.
- Just one week of intensive exposure to science and the actual work of scientists provides students with a valuable, high-impact experience.

Recommendations:

- Transfer the model to other similar programs studying the natural phenomena of almost any region or geographic location: desert, wetlands, forests, coastal regions, etc.
- Organize at least one residential evening to introduce students to the campus, university science students, and science faculty.

# PART III

# CASE STUDY OF THE WESTERN NEW MEXICO UNIVERSITY

# 1989 SUMMER SEMESTER INTERVENTION

## ABSTRACT

In the summer of 1989 Western New Mexico University, Silver City, New Mexico, conducted and tested against a control group a one-week, residential, in-the-field science program entitled "Natural New Mexico" for high school students. Participants were 16 high school students (12 women and 4 men), primarily Hispanic and Anglo, who were preparing to enter 10th and 11th grades from two high schools in the Silver City area and who were recruited by their high school science teachers to participate in the program. The intervention was repeated in the summer of 1990.

The Western New Mexico University program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESIS:* Hypothesis was that the intervention would enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* The major components of the intervention were hands-on science activities in the mountains and fields of southern New Mexico, including examining rocks and minerals, observing different life zones, banding bats, participating in an astronomy demonstration, and attending outdoor lectures on biology and geology; at night they stayed in the college dormitories.

*DATA:* All the participants furnished demographic data through the CASET High School Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were preintervention high school GPAs and national standardized test scores.

As the intervention was designed primarily to enhance opinions, the measures of interest were opinion measures; no postintervention measures of performance were taken. The preintervention measures of performance were preintervention high school GPA, PSAT verbal and mathematics percentiles, and California Test of Basic Skills (CTBS) percentile.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Demographic, performance (preintervention only), and opinion data were analyzed in the context of a nonequivalent control group design; through analyses of preintervention measures it appeared that the control-group students had advantages over the intervention-group students in the areas of performance and opinion before the intervention.

*FINDINGS:* The intervention had some positive effect on the participants and can be considered a successful intervention in that the opinions of students with lower scores on certain opinion scales were enhanced. The hypothesis that the intervention would enhance opinions about SET fields and careers was partially supported; students in the intervention group who had lower Total Opinion, lower Attitude construct, and lower Attitudes toward Math/Science scores had more positive postintervention opinions about SET fields and careers. Because of the small sample size, other effects of the intervention did not reach statistical significance. The changes in opinion may be important, however, considering that the control-group students had preexisting advantages over the intervention-group students before the intervention.

## DESCRIPTION OF THE INTERVENTION

Western New Mexico University developed a one-week residential program for high school students entitled "Natural New Mexico." The program was planned to stir students' interest in geology, biology, and astronomy through a week of hands-on, in-the-field science. The program was intended to enable students to experience the work scientists actually do, as distinct from the study of science in the classroom. The project objectives centered on recruitment rather than performance; participation was not limited to high-ability students. The focus of "Natural New Mexico" was on showing students a variety of biological, geological, and astronomical phenomena, and letting them see that scientists can really enjoy what they do.

The first implementation of this intervention at WNMU was conducted during the summer of 1989. Students were recruited from two high schools in the Silver City area: Silver High School and Cobre High School. Recruitment was initiated through high school science teachers, who were introduced to the program at an open house for local science teachers in January of 1989 at WNMU, eight months before the intervention began.

The intervention took place from Monday through Friday, the week of August 14 - 18, 1989. Students stayed in the WNMU dormitories at night and spent days out in the field. Students were transported on the field trips in the Geology Department van. The schedule for the week was as follows:

Day 1 - Lectures on plate tectonics, geologic history, rocks and minerals, fossils, ecology, and life zones. A barbecue supper at Little Walnut Picnic Area also was scheduled for this day, but rain forced the group inside to eat in the Student Union building.

Day 2 - Tour Inner City Loop to see different life zones and rock types, collect fossils at Georgetown. Cook out, band bats in evening.

Day 3 - Drive out to Gila River near Cliff to see riparian environment and volcanic rocks. Supper in cafeteria. Astronomy demonstration in evening.

Day 4 - Trip through Big Burro Mountains to Red Rock to see several life zones and a variety of rocks.

Day 5 - Trip to Adan volcanic field, via Mimbres, to see desert life zone and Basin and Range volcanics. On return, stop at City of Rocks for cook-out.

The text used for the program was *Mosaic of New Mexico's Scenery, Rocks, and History*, available from the New Mexico Bureau of Mines and Mineral Resources. Students had the option of writing a paper at the end of the program and receiving one hour of college credit.
All the staff for this CASET project were WNMU faculty members. The project director was Dr. John Cunningham, Chairman of the Department of Natural Sciences. Dr. Cunningham developed and directed the project, and also served as one of the two primary faculty members who instructed the students participating in the intervention. The other primary faculty member was Mr. Robert F. Miller, Associate Professor of Biological Science; Mr. Miller had experience as a high school biology teacher prior to the project, and so had experience with this age group. Dr. Bruce Hayward, Professor of Biological Science, conducted the evening work in banding bats. Dr. Kenneth H. Ladner, Professor of Chemistry, conducted the astronomy evening session.

The hypothesis was that the intervention would enhance intervention-group students' opinions about SET fields and careers.

# METHOD

## Subjects

Subjects were minority and female students who were about to begin their sophomore or junior year in high school. Participation was not limited to high-achieving students or honor students. Recruitment was done primarily through the high school science teachers, who had been invited to an open house at WNMU for an introduction to the intervention.

In order to monitor the effects of the intervention, a control group of students demographically similar to the intervention participants was identified. Control-group students filled out the same protocols and provided the same information as the intervention-group students, but did not participate in any intervention activities. The control-group students were rewarded for their cooperation by receiving privileges at the WNMU physical education complex for the summer of 1989.

A total of 21 students were recruited: 13 as intervention-group students and eight as control-group students. Five of the intervention-group recruits dropped out before the intervention began and did not participate. Data were submitted for all the others, a total of eight intervention-group and eight control-group students. All students were members of groups underrepresented in SET fields: women and/or Hispanic students. Data from eight intervention-group and eight control-group students were analyzed and are included in this report.

Table 1 shows the sex and ethnic breakdown for the intervention and control groups.

**Table 1**

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | | | | | | |
| Anglo | 4 | | 2 | | 6 | |
| Black | | | | | | |
| Hispanic | 2 | 2 | 3 | 2 | 5 | 4 |
| Unknown | | | 1 | | 1 | |
| **TOTAL** | **6** | **2** | **6** | **2** | **12** | **4** |

### CASET Protocols and Other Instruments

The hypothesis was that the intervention would enhance intervention-group students' opinions about SET fields and careers. Demographic and descriptive data about the subjects were developed through the CASET High School Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This Protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gives a scalar measurement for that variable. Thus the completed Opinion Protocol provides a scale measuring each of the thirteen variables. The Opinion Protocol was designed to be administered to intervention- and control-group students before and after the intervention. The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B.

Preintervention measures of student performance were high school grade point average (GPA), Preliminary Scholastic Aptitude Test (PSAT) verbal and math percentiles, and California Test of Basic Skills (CTBS) percentile. Since this intervention did not have a performance-related hypothesis--that is, it did not specifically propose to enhance students' performance--no postintervention measures of performance were taken.

### Procedure

At the beginning of the intervention, intervention- and control-group students signed consent forms and transcript release forms. The first measures of opinion, and the measures of demographic information were made for intervention-group and control-group students on May 26, 1989. Intervention activities were conducted with the intervention group on August 14 - 18, 1989; all intervention-group students who participated attended each one of the activities. As a postintervention measure, the CASET Opinion Protocol was administered a second time to intervention- and control-group students on August 28 - 30, 1989. The completed CASET Student Protocols, preintervention and postintervention Opinion Protocols, high school transcripts, and standardized test scores for intervention- and control-group students were forwarded to CASET for analysis.

The items of the Opinion Protocol were coded by CASET according to the thirteen scales they represent. Items on the Opinion Protocol were scored in such a way that a larger number reflected a positive outcome (see Appendix B). The scales were organized into three constructs--SET Goal, Environmental Support, and Attitude--as shown in Appendix C.

## RESULTS

### Methodological Issues

The hypothesis was that the intervention would enhance opinions about SET fields and careers. Preintervention and postintervention measures of opinion were available for most students; the intervention was analyzed as a *nonequivalent control group* design. This type of quasi-experimental design has one common weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or

to interactions between preexisting characteristics and maturation. This uncertainty about causal influence may be addressed by analyzing the influence of preexisting characteristics on students' opinion; the analysis of covariance (ANCOVA), adjusting for preintervention opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that existed before the intervention.

## Demographic Results

The comparability of the intervention and control groups was examined by testing for differences on the items of the High School Student Protocol. The complete results are given in Appendix D. The groups differed on none of the 58 comparisons. It should be cautioned that the small number of subjects in each group ($n$ = 8) provided a low level of power for these 58 comparisons. Nevertheless, based on the information available, the groups appear to be comparable on demographic characteristics before the intervention.

## Performance Measures

*Group differences in preintervention performance.* Four preintervention measures of performance (high school GPA, PSAT verbal percentile, PSAT mathematics percentile, and CTBS total percentile) were tested for group differences, and the results are given in Table 2. The intervention and control groups differed significantly on one preintervention measure: The control-group students had higher mean high school GPAs ($M$ = 3.80) than did the intervention-group students ($M$ = 3.35), $t$ (13) = 2.02, $p \leq .10$ two-tailed. Though the differences were not significant, the other three preintervention measures favored the control group; the small samples lowered the probability of finding the differences between the groups statistically significant.

Because the control-group students had higher preintervention performance scores, the comparability of the two groups before the intervention was questionable. However, the primary measures of interest were the opinion measures, and these were examined more thoroughly.

**Table 2**

**GROUP COMPARISONS OF PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST(df) | Sig.$p$ |
|---|---|---|---|---|---|---|
| High School GPA | Control<br>Intervention | 7<br>8 | 3.80<br>3.35 | .30<br>.51 | -2.02<br>(13) | $\leq$.10 |
| PSAT Verbal Percentile | Control<br>Intervention | 3<br>3 | 46.67<br>35.67 | 28.22<br>33.84 | -0.43<br>(4) | ns |
| PSAT Math Percentile | Control<br>Intervention | 3<br>3 | 47.00<br>20.33 | 29.82<br>31.75 | -1.06<br>(4) | ns |
| CTBS Total Percentile | Control<br>Intervention | 3<br>2 | 89.67<br>81.50 | 11.85<br>16.26 | -0.66<br>(3) | ns |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences.

Opinion Measures

*Group differences on pre- and postintervention measures.* The means of the intervention- and control-group students were compared for the 13 opinion scales, three constructs, and total opinion score measured before and after the intervention. The results of the 17 t-tests are given in Table 3. Before the intervention began, the students in the control group had significantly higher scores on 4 of the 17 opinion measures: The control-group students' Locus of Control was more internal, their Persistence was higher, their level of Anxiety was lower, and their Equal Opportunity scores were higher. These findings supported the findings from the preintervention performance measures that suggested that the control-group students had advantages over the intervention-group students before the intervention.

After the intervention ended, the intervention-group and control-group students did not differ on any of the 17 measures. To adjust for preexisting differences and provide a more sensitive test of the intervention's effects on opinion, the final opinion measures were adjusted for preexisting opinion scores via ANCOVA.

**Table 3**

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

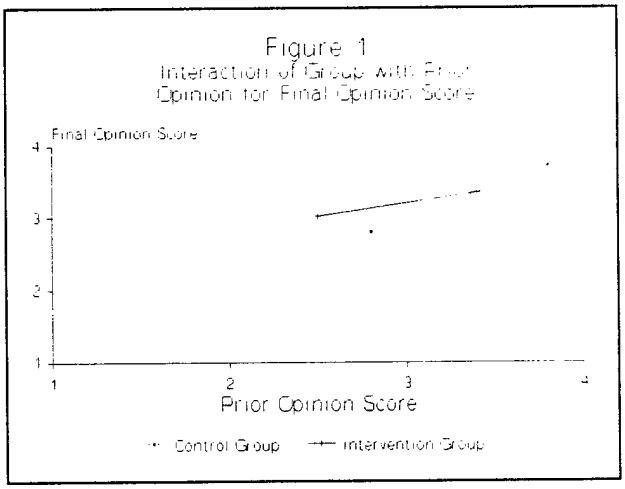
| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| OPINION,Total | Pretest | 3.34 | .36 | 3.08 | .30 | -1.54 | ns |
| | Posttest | 3.29 | .35 | 3.23 | .18 | -0.41 | ns |
| SET GOAL | Pretest | 3.54 | .34 | 3.39 | .27 | -0.97 | ns |
| | Posttest | 3.49 | .31 | 3.54 | .26 | 0.29 | ns |
| Value | Pretest | 3.69 | .26 | 3.72 | .36 | 0.20 | ns |
| | Posttest | 3.84 | .19 | 3.91 | .13 | 0.78 | ns |
| Cultural Value | Pretest | 3.69 | .26 | 3.44 | .42 | -1.44 | ns |
| | Posttest | 3.69 | .29 | 3.69 | .22 | 0.00 | ns |
| Self-Concept | Pretest | 3.35 | .61 | 3.12 | .28 | -0.98 | ns |
| | Posttest | 3.23 | .59 | 3.20 | .35 | -0.10 | ns |
| Aspiration | Pretest | 3.52 | .43 | 3.40 | .38 | -0.61 | ns |
| | Posttest | 3.38 | .41 | 3.50 | .49 | 0.56 | ns |
| ATTITUDE | Pretest | 3.23 | .49 | 2.85 | .35 | -1.75 | ns |
| | Posttest | 3.13 | .46 | 3.02 | .27 | -0.61 | ns |
| Math/Science Attitude | Pretest | 3.30 | .58 | 3.05 | .44 | -0.97 | ns |
| | Posttest | 3.25 | .51 | 3.41 | .46 | 0.66 | ns |

**GROUP DIFFERENCES ON PRETEST AND POSTTEST OPINION CONSTRUCTS AND SCALES**

| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig. p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| Locus of Control | Pretest | 3.38 | .38 | 2.83 | .62 | -2.12 | ≤.10 |
| | Posttest | 3.21 | .43 | 3.04 | .63 | -0.62 | ns |
| Persistence | Pretest | 3.59 | .35 | 3.09 | .61 | -2.00 | ≤.10 |
| | Posttest | 3.31 | .35 | 2.97 | .41 | -1.81 | ns |
| Study Habits | Pretest | 2.91 | .52 | 3.00 | .42 | 0.40 | ns |
| | Posttest | 3.09 | .38 | 3.19 | .26 | 0.58 | ns |
| Anxiety | Pretest | 3.04 | .78 | 2.38 | .62 | -1.90 | ≤.10 |
| | Posttest | 2.85 | .84 | 2.46 | .51 | -1.14 | ns |
| ENVIRONMENTAL SUPPORT | Pretest | 3.253.27 | .25 | 3.06 | .46 | -1.02 | ns |
| | Posttest | | .29 | 3.18 | .26 | -0.66 | ns |

*Group differences on opinion adjusting for prior scores.* A hierarchical ANCOVA adjusted for preintervention opinion scores before comparing groups on the postintervention measures of opinion; the results are given in Table 4. This table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding each variable to the multiple regression equation (one variable per row), and the significance test of each variable's contribution toward explaining the dependent measure. The columns of the table include the cumulative percentage of explained variance (cum $R^2$), added contribution in explained variance of the variable ($sR^2$), test of the contribution of the new variable ($F(sR^2)$), and the degrees of freedom (df) for the test.

**Figure 1**




By these analyses, the groups after the intervention did not differ generally on any opinion measure. However, group membership interacted with the measure of preintervention opinion for three postintervention opinion measures: Total Opinion score, Attitude construct score, and Attitude toward Math/Science score. The significant interactions indicated that the relationships between the prior opinion scores and the final opinion scores were different in the two groups. The interactions were analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of preintervention scores for which the groups differed.

Figures 1, 2, and 3 show a similar pattern: Students who entered the intervention with lower than average opinions developed significantly more positive final opinions than did comparable control-group students.

Figure 1 shows the nonparallel regression lines that indicate that for students with prior total Opinion scores at or below 3, the students in the intervention group had more positive final Opinion scores than did those in the control group.

**Figure 2**

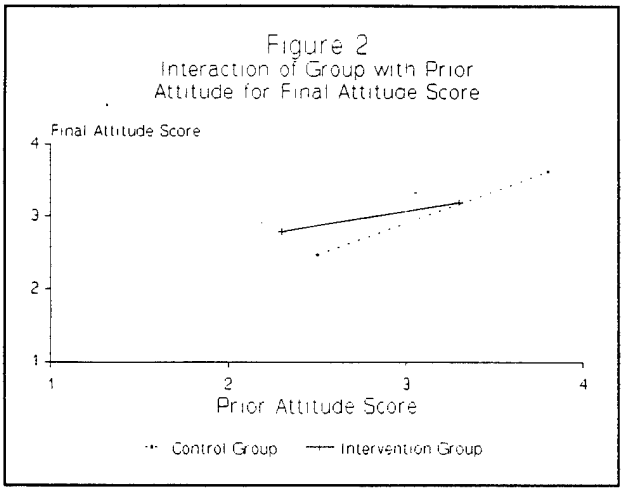



**Figure 3**

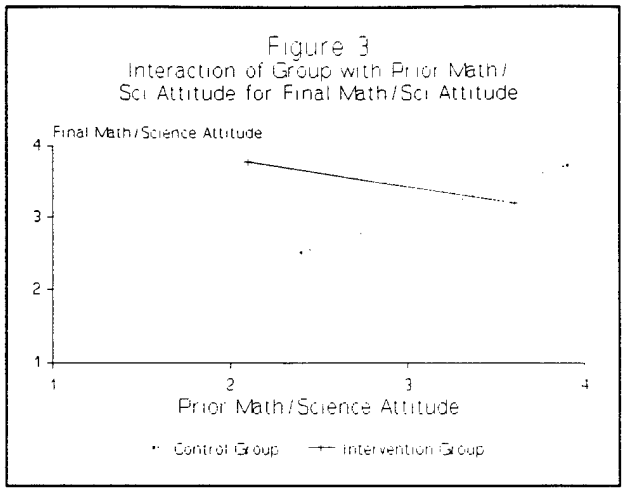



Figure 2 shows a similar difference between the two groups: Students who began with pre-intervention Attitude construct scores below 2.8 did better in the intervention group.

And Figure 3 displays another version of the same relation- ship: The interven- tion significantly raised the final opinion scores of students who entered with lower than average scores on the Attitude toward Math/ Science measure.

Tests of the hypothesis lead to the conclusion that the intervention had several positive effects on students' opinions who entered the intervention with lower opinions about SET fields and careers.

**Table 4**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| OPINION,Total | PREINTERVENTION | .66 | .66 | 27.55 | 1,14 | $\leq$.01 |
| | +GROUP | .71 | .05 | 2.15 | 1,13 | ns |
| | +PRE-x-GROUP | .82 | .10 | 6.81 | 1,12 | $\leq$.05 |
| SET GOAL | PREINTERVENTION | .51 | .51 | 14.39 | 1,14 | $\leq$.01 |
| | +GROUP | .58 | .07 | 2.16 | 1,13 | ns |
| | +PRE-x-GROUP | .58 | .00 | 0.00 | 1,12 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Value | PREINTERVENTION | .05 | .05 | 0.68 | 1,14 | ns |
| | +GROUP | .08 | .04 | 0.53 | 1,13 | ns |
| | +PRE-x-GROUP | .11 | .03 | 0.41 | 1,12 | ns |
| Cultural Value | PREINTERVENTION | .17 | .17 | 2.95 | 1,14 | ns |
| | +GROUP | .20 | .03 | 0.42 | 1,13 | ns |
| | +PRE-x-GROUP | .20 | .00 | 0.00 | 1,12 | ns |
| Self-Concept | PREINTERVENTION | .68 | .68 | 30.33 | 1,14 | $\leq$.01 |
| | +GROUP | .72 | .04 | 1.63 | 1,13 | ns |
| | +PRE-x-GROUP | .72 | .00 | 0.08 | 1,12 | ns |
| Aspiration | PREINTERVENTION | .39 | .39 | 9.01 | 1,14 | $\leq$.01 |
| | +GROUP | .45 | .06 | 1.51 | 1,13 | ns |
| | +PRE-x-GROUP | .46 | .00 | 0.03 | 1,12 | ns |
| ATTITUDE | PREINTERVENTION | .67 | .67 | 29.00 | 1,14 | $\leq$.01 |
| | +GROUP | .72 | .04 | 1.99 | 1,13 | ns |
| | +PRE-x-GROUP | .78 | .06 | 3.57 | 1,12 | $\leq$.10 |
| Math/Science Attitude | PREINTERVENTION | .11 | .11 | 1.74 | 1,14 | ns |
| | +GROUP | .18 | .07 | 1.13 | 1,13 | ns |
| | +PRE-x-GROUP | .54 | .36 | 9.44 | 1,12 | $\leq$.01 |
| Locus of Control | PREINTERVENTION | .59 | .59 | 20.21 | 1,14 | $\leq$.01 |
| | +GROUP | .65 | .06 | 2.31 | 1,13 | ns |
| | +PRE-x-GROUP | .65 | .00 | 0.00 | 1,12 | ns |
| Persistence | PREINTERVENTION | .55 | .55 | 16.97 | 1,14 | $\leq$.01 |
| | +GROUP | .56 | .01 | 0.28 | 1,13 | ns |
| | +PRE-x-GROUP | .57 | .01 | 0.30 | 1,12 | ns |
| Study Habits | PREINTERVENTION | .35 | .35 | 7.69 | 1,14 | $\leq$.05 |
| | +GROUP | .36 | .01 | 0.17 | 1,13 | ns |
| | +PRE-x-GROUP | .45 | .09 | 1.96 | 1,12 | ns |
| Anxiety | PREINTERVENTION | .74 | .74 | 40.34 | 1,14 | $\leq$.01 |
| | +GROUP | .75 | .01 | 0.67 | 1,13 | ns |
| | +PRE-x-GROUP | .76 | .00 | 0.19 | 1,12 | ns |
| Environmental Support | PREINTERVENTION | .22 | .22 | 3.92 | 1,14 | $\leq$.10 |
| | +GROUP | .22 | .00 | 0.04 | 1,13 | ns |
| | +PRE-x-GROUP | .23 | .01 | 0.12 | 1,12 | ns |

| HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING PREINTERVENTION OPINION | | | | | | |
|---|---|---|---|---|---|---|
| **FINAL OPINION CONSTRUCT/ Scale** | **INDEPENDENT VARIABLE MODELS*** | **Cumul. $R^2$** | **$sR^2$** | **$F(sR^2)$** | **df** | **Sig. p** |
| Academic Support | PREINTERVENTION | .19 | .19 | 3.24 | 1,14 | $\leq$.10 |
| | +GROUP | .25 | .06 | 1.11 | 1,13 | ns |
| | +PRE-x-GROUP | .32 | .07 | 1.28 | 1,12 | ns |
| Career Awareness | PREINTERVENTION | .03 | .03 | 0.40 | 1,14 | ns |
| | +GROUP | .05 | .02 | 0.28 | 1,13 | ns |
| | +PRE-x-GROUP | .15 | .11 | 1.50 | 1,12 | ns |
| Role Model | PREINTERVENTION | .52 | .52 | 15.47 | 1,14 | $\leq$.01 |
| | +GROUP | .56 | .04 | 1.05 | 1,13 | ns |
| | +PRE-x-GROUP | .62 | .06 | 1.76 | 1,12 | ns |
| Equal Opportunity | PREINTERVENTION | .11 | .11 | 1.65 | 1,14 | ns |
| | +GROUP | .14 | .03 | 0.50 | 1,131,1 | ns |
| | +PRE-x-GROUP | .14 | .00 | 0.03 | 2 | ns |

All models were analyzed as two-tailed tests.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure): (1) PRETEST OPINION SCORE: (2) PRETEST OPINION SCORE and GROUP ('+'); (3) PRETEST OPINION SCORE and GROUP and PRETEST OPINION SCORE-by-GROUP INTERACTION ('-x-').

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

Summary of Results

Table 5 summarizes the findings as effect sizes. As the effect sizes indicate, the intervention had a moderate-to-large positive effect on opinions about SET fields and careers. The hypothesis of enhanced opinion received some support from these results.

The sample had only 16 students, so finding no statistically significant differences for most of the analyses was not surprising. A sample of 44 to 68 students would have been necessary to have a 50-percent chance (power = .50) of detecting a moderate-to-large difference (d = .7) such as the effect of the intervention on SET Goal construct or Attitude construct in Table 4 (Gatsonis & Sampson, 1989); a sample of 97 to 153 students would have been necessary to have the recommended sensitivity (power = .80) to detect a difference of this same size.

**Table 5**

| EFFECT SIZES | | | |
|---|---|---|---|
| **VARIABLE** | **Posttest** | **Adjusted Posttest** | **Group-by-Pre Interaction** |
| Total Opinion | -.20 | .73 | 1.30** |

| EFFECT SIZES | | | |
|---|---|---|---|
| **VARIABLE** | **Posttest** | **Adjusted Posttest** | **Group-by-Pre Interaction** |
| SET Goal | .14 | .73 | .00 |
| Attitude | -.30 | .71 | .94* |
| Environmental Support | -.33 | -.10 | .17 |

* $p \leq .10$
** $p \leq .05$

The measure of effect size is in pooled standard deviation units calculated according to B. T. Johnson (1989). A positive sign indicates that the intervention group outperformed the control group; a negative sign indicates that the control group had the higher score.

## DISCUSSION

The hypothesis of enhanced opinion as a result of the intervention received partial support: The intervention-group students who began with lower Total Opinion scores, lower Attitude construct scores, and lower Attitudes toward Math/Science had more positive final attitudes about SET fields and careers. These effects were moderate-to-large; other general effects of the intervention did not reach statistical significance due to the low power (about .25) of the tests, primarily as a result of the small sample.

Though the intervention was analyzed as a quasi-experiment with the ensuing caution about causal conclusions, the groups appeared comparable before the intervention. Comparisons on a total of 79 preintervention measures found significant differences on only six percent, which included a broad range of demographic (the groups differed on 0 of 58 measures), performance (1 of 4 measures), and opinion measures (4 of 17 measures). However, because of the small samples and the resulting low power, the number of preexisting differences between the groups may have been greater. All of the differences favored the control group.

The intervention's success in raising scores on the opinion measures, though limited to students with lower initial opinions, was nevertheless impressive because the control-group students seemed to have preexisting advantages on the opinion and performance measures. Because the adjustments for preintervention opinions via ANCOVA may not have completely removed the preexisting advantages of the control-group students and because the samples were so small, the intervention's success may have been greater than these results indicate. A longer-term measure of opinion or opinion-related behavior, i.e., enrollment in subsequent courses, would provide a useful additional measure on which to evaluate this intervention. Later semesters of this intervention will provide important evidence to verify that the intervention is associated with positive changes in attitudes about SET fields and careers.

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# APPENDICES

# APPENDIX A

# HIGH SCHOOL STUDENT PROTOCOL

Participant Number: _____

## HIGH SCHOOL STUDENT PROTOCOL

Thank you for agreeing to participate in this important project. It is geared to help us develop new programs for students and improve existing programs.

Your opinions and experience are important to us. Please read each question carefully and answer completely and accurately to the best of your ability. All of your answers will be kept in confidence. Your answers will be grouped with those of other students in other places, and together they will help us better understand students' needs and preferences today.

Please ask your administrator if any of these questions are unclear to you.

Thanks for your help!

1. Sex:
   - ___ a. Male
   - ___ b. Female

2. When were you born? _____ _____ _____
   month day year

3. Ethnicity/race:
   - ___ a. Anglo
   - ___ b. Black
   - ___ c. Asian American
   - ___ d. American Indian (Please specify the tribe which best describes your heritage.)

     _____
   - ___ e. Hispanic (Which of the following best describes your heritage?)
     - ___ a. Cuban-American
     - ___ b. Mexican-American
     - ___ c. Puerto Rican
     - ___ d. Other Specify _____
   - ___ f. Other Specify _____

4. Are you a United States citizen?
   - ___ a. Yes
   - ___ b. No

5. Name of your school: _____

   City: _____ State: _____

6. Class:
   ___ a. High School Freshman
   ___ b. High School Sophomore
   ___ c. High School Junior
   ___ d. High School Senior
   ___ e. Other Specify _____

7. Which of the following college entrance exams have you taken?
   ___ a. I haven't taken any
   ___ b. ACT
   ___ c. PSAT or SAT
   ___ d. Other Specify _____
   ___ f. Other Specify _____

8. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Less than high school graduation
   ___ b. High school graduation
   ___ c. Two-year college degree (community college or junior college)
   ___ d. Four-year college degree
   ___ e. Education beyond four years of college
   ___ f. Other Specify _____

9. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

10. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)
   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Job
   ___ d. Previous personal earnings and savings
   ___ e. Family trust fund, insurance plan, or other similar arrangement
   ___ f. Other Specify _____

11. You may want to receive help outside your regular high school course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities

___ c. Improving mathematical ability
___ d. Finding part-time work
___ e. Counseling about personal problems
___ f. Increasing reading ability
___ g. Developing good study habits
___ h. Improving writing ability

12. What is or are the occupation(s) of the person(s) with whom you live? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

_____ _____

13. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average
___ d. Don't know

14. Are you:
___ a. An only child (skip to question 13)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

15. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

16. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

17. What was the highest level of school your mother completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more
___ f. Don't know

18. What is the language spoken most often by adults in your household where you grew up? (Check only one)
___ a. English

___ b. Spanish
___ c. The language of my tribe (What is that language?) _____
___ d. Another language - Specify _____

19. Which of the following did your parent(s) or guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

20. Which of the following comes closest to describing how much your parent(s) or guardian(s) read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

21. Which of the following comes closest to describing how much you read?
___ a. Not at all
___ b. Sometimes
___ c. A lot

22. Which of these items do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

23. What kind of high school or secondary school do you attend?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

24. Are you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes (Please list them.)

_____

_____

_____

25. Have you ever taken part in any of these activities? (Check all that apply)
    ___ a. Math and science clubs
    ___ b. Field trip to science museum, laboratory, or other place where scientists work
    ___ c. Watching science programs on TV
    ___ d. A talk by a scientist
    ___ e. Science/math fair
    ___ f. Other science/math competition
    ___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL ITEMS WITH DIRECTIONALITY AND SCALES

**Legend:**

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of any ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |

| | | | |
|---|---|---|---|
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

    i. _____

    ii. _____

    iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF THE HIGH STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 8 | CONTROL n = 8 |
| 1. Sex: | | |
| Women | 75% | 75% |
| Men | 25% | 25% |
| 2. Age | 16.53 | 16.12 |
| 6. Class: | | |
| .Freshmen | 0% | 0% |
| .Sophomores | 12% | 38% |
| .Juniors | 88% | 62% |
| .Seniors | 0% | 0% |
| .Other | 0% | 0% |
| 7. Students taken a college entrance exam | 50% | 25% |
| .Missing | 0% | 12% |
| 8. Higher education expected: | | |
| .Less than high school graduation | 0% | 0% |
| .High school graduation | 0% | 0% |
| .Two years of college | 0% | 0% |
| .Four years of college | 50% | 25% |
| .One or more years after college | 50% | 75% |
| 9. Studies most influenced by: | | |
| .Parents | 62% | 62% |
| .Another family member | 0% | 38% |
| .Teacher | 12% | 0% |
| .Counselor | 12% | 0% |
| .Minister | 0% | 0% |
| .Friend | 0% | 0% |
| .Science professional | 0% | 0% |
| .Nonscience professional | 0% | 0% |
| .No one at all | 0% | 0% |
| .Missing | 12% | 0% |
| 10. Sources of income:[a] | | |
| .Parents/guardians | 88% | 100% |
| .Spouse | 0% | 0% |
| .Job | 25% | 25% |
| .Personal savings | 0% | 0% |
| .Family trust, etc. | 12% | 12% |
| .Other | 0% | 12% |
| Number of sources of income * | 1.25 | 1.50 |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 8 | CONTROL n = 8 |
| 11. Student needs help in:[a] | | |
| .Counseling on educational plans | 62% | 88% |
| .Counseling on career plans | 62% | 75% |
| .Improving math ability | 62% | 75% |
| .Finding part-time work | 62% | 50% |
| .Counseling on personal problems | 0% | 25% |
| .Increasing reading ability | 12% | 25% |
| .Developing good study habits | 38% | 38% |
| .Improving writing ability | 12% | 25% |
| Number of areas needing help * | 3.12 | 4.00 |
| 12. Sources of outside income: | | |
| .None | 0% | 0% |
| .One | 62% | 25% |
| .Two | 38% | 75% |
| 13. Family income: | | |
| .Below U.S. average | 25% | 12% |
| .About average | 75% | 62% |
| .Above average | 0% | 25% |
| 14. Birth order of student: | | |
| .Only child | 0% | 0% |
| .Oldest child | 25% | 75% |
| .Youngest child | 25% | 12% |
| .In-between child | 50% | 12% |
| 15. Number of siblings: | | |
| .None | 0% | 0% |
| .One | 38% | 25% |
| .Two | 25% | 50% |
| .Three or more | 38% | 25% |
| 16. Father's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 0% | 12% |
| .High school graduate | 62% | 12% |
| .Some college | 12% | 25% |
| .College degree or more | 25% | 50% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 8 | CONTROL n = 8 |
| 17. Mother's education: | | |
| .Grade school or less | 12% | 0% |
| .Some high school | 0% | 12% |
| .High school graduate | 25% | 25% |
| .Some college | 12% | 12% |
| .College degree or more | 50% | 50% |
| 18. Language spoken most at home: | | |
| .English | 88% | 100% |
| .Spanish | 12% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| 19. Parents involvement during student's years in school:[a] | | |
| .Attend PTA meetings | 75% | 38% |
| .Attend parent-teacher conferences .Visit student's class | 75% | 100% |
| .Phone/visit if there's a problem | 100% | 75% |
| .Do volunteer work | 62% | 75% |
| .Assist student in course selection | 62% | 75% |
| .Assist in student's homework | 88% | 75% |
| Number of parental involvements * | 100% | 75% |
| | 5.62 | 5.12 |
| 20. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 25% | 38% |
| .A lot | 75% | 62% |
| 21. Student reads: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 38% | 12% |
| .A lot | 62% | 88% |
| 22. Items in student's home:[a] | | |
| .Desk | 100% | 100% |
| .Daily newspaper | 62% | 100% |
| .Encyclopedia | 100% | 88% |
| .Typewriter | 100% | 88% |
| .Calculator | 100% | 100% |
| .Television | 100% | 100% |
| .Computer | 75% | 62% |
| .Video Cassette Recorder (VCR) | 75% | 100% |
| Number of support items * | 7.12 | 7.38 |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 8 | CONTROL n = 8 |
| 23. Type of high school attended: | | |
| .Public | 100% | 100% |
| .Private | 0% | 0% |
| .No formal high school | 0% | 0% |
| 24. Member math/science club in high school | 38% | 38% |
| 25. All activities student took part in:[a] | | |
| .Math/science club | 38% | 38% |
| .Field trip | 88% | 100% |
| .Watching science programs on TV | 75% | 100% |
| .Listen to talk by scientist | 62% | 62% |
| .Science/math fair | 62% | 88% |
| .Other science/math competition | 50% | 75% |
| .Play/work in computer lab | 75% | 100% |
| Number of activities * | 4.50 | 5.62 |

[a] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# WILBERFORCE UNIVERSITY

# INTERVENTIONS:

# JUNIOR HIGH SCHOOL LEVEL

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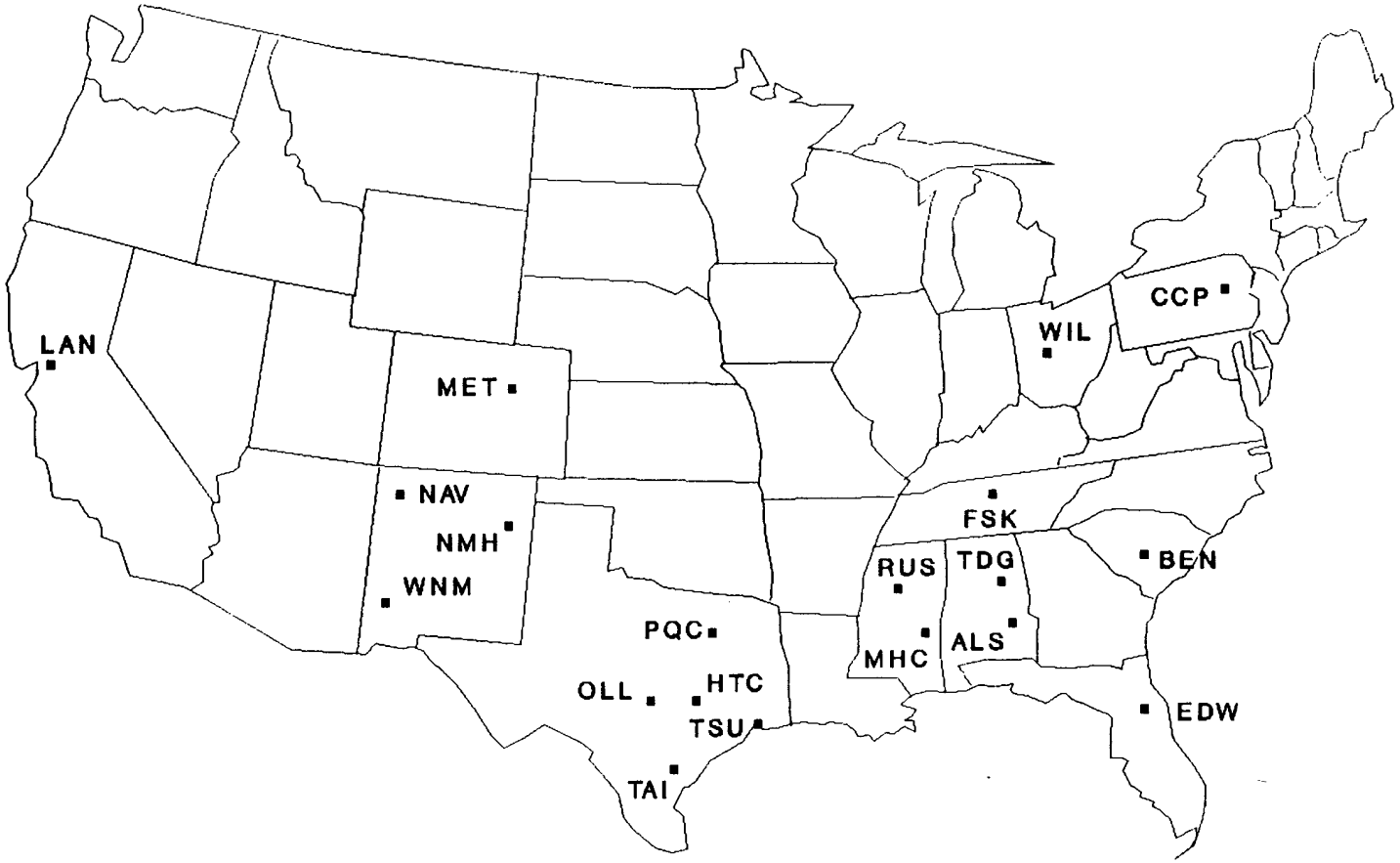
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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected came from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention-group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his or her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF WILBERFORCE UNIVERSITY

Wilberforce University is a historically Black, four-year, private, coeducational institution located in Wilberforce, Ohio. The University serves approximately 770 students and has 56 faculty members. The University, organized into General Studies, Business and Economics, Humanities, Natural Science, and Social Science Divisions, offers Bachelor of Arts and Bachelor of Science degrees. The student body is approximately 62 percent female and 38 percent male and is predominantly Black. The president of Wilberforce University is Dr. Yvonne Walker-Taylor.

Degrees offered at Wilberforce University in quantitative subjects are Bachelor of Arts in chemistry, and Bachelor of Science in comprehensive science, computer information systems, and mathematics. The University also offers its science and mathematics majors dual-degree programs in engineering and computer science in cooperation with the University of Dayton in Dayton, Ohio. Upon completion of a dual-degree program, a student is awarded a bachelor's degree in science or mathematics from Wilberforce University and a second bachelor's degree in engineering or computer science from the University of Dayton.

Wilberforce has a population of less than 5000, although it is near the heavily populated urban areas of Dayton, Springfield, Columbus, and Cincinnati. The state of Ohio has a population of nearly 11 million. According to U.S. Census Bureau estimates, the adult population of Ohio is 88 percent Anglo, 10 percent Black, 1 percent Hispanic, and 1 percent other ethnic origins. Other nearby institutions of higher education include Antioch College, Cedarville College, Central State University, Sinclair College, University of Dayton, Wilmington College, and Wright State University.

# PART II

# SUMMARY OF THE WILBERFORCE UNIVERSITY (WU)

# INTERVENTIONS

This page is a summary of the two junior high school interventions conducted by Wilberforce University, a historically Black, four-year, private institution located in Wilberforce, Ohio. Wilberforce University is a member of a consortium formed by The Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Wilberforce University Intervention Activities:

During the summer of 1989 and 1990, Wilberforce University conducted a summer enrichment program for high-achieving seventh- and eighth-grade students. This program consisted of instruction in mathematics, science, computer science, computer literacy, engineering, communications skills, and career planning; talks by visiting scientists; field trips to nearby scientific and military facilities; and workshops for improving self-esteem, study strategies, and students' attitudes. Participants were recruited from several public junior high schools in Dayton, Ohio, and qualified for the program on the basis of strong academic performance. The program was conducted over five weeks during the summer of 1989 and over four weeks during the summer of 1990.

Findings:

- The intervention improved the mathematics performance of these young students.
- The intervention was more effective in improving performance than in enhancing opinions.

Recommendations:

- Both the academic and emotional needs of bright, young students must be met if they are to fully benefit from a college program such as this one.
- A higher level of parental involvement is also recommended, particularly for young junior high school students.

# PART III

# CASE STUDY OF THE WILBERFORCE UNIVERSITY

# 1989 JUNIOR HIGH SCHOOL

# SUMMER SEMESTER INTERVENTION

## ABSTRACT

In 1989 Wilberforce University, Wilberforce, Ohio, initiated and tested against a control group a summer enrichment intervention program for high-achieving junior high school students. Participants were 46 seventh- and eighth-grade students (32 girls and 14 boys) from Dayton, Ohio area public schools; a majority of the participants were Black. Participants had a 3.0 or higher grade point average and had scored at or above the 89th percentile on the California Achievement Test (CAT). The intervention was repeated in the summer of 1990.

The Wilberforce University program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance on a content test of mathematics, and (b) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* The major components of the five-week intervention were instruction in mathematics, chemistry, biology, physics, computer science, engineering, communication skills, study strategies, and career planning at the Wilberforce University campus; talks given by visiting scientists; field trips to nearby scientific and military sites; and workshops and a seminar-luncheon for parents.

*DATA:* All the participants furnished demographic data through the CASET Middle/Junior High School Student Protocol. All participants were administered pre- and postintervention CASET Opinion Protocols. Other data collected were national standardized test scores and scores on an institution-specific content test of mathematics (administered to intervention-group students at the beginning and at the end of the program).

The outcome measure of performance was the posttest score on the content test of mathematics (available for intervention-group students only). The preintervention measures of performance were the pretest score on the content test of mathematics (available for intervention-group students only), grade equivalent scores on the Iowa Test of Basic Skills (ITBS), and percentile scores on the CAT.

*RESEARCH DESIGN:* The research design was quasi-experimental; however, intervention and control groups were not formed by random assignment. Demographic and opinion data were analyzed in the context of a nonequivalent control group design. Because preintervention and postintervention measures of performance were available only for the intervention group, performance data were analyzed in terms of a one-group pretest-posttest design. Through analysis of preintervention measures it appeared that the intervention and control groups were comparable.

*FINDINGS:* The intervention had little positive effect on the participants; the program's success was not clearly demonstrated for the variables that were measured. The hypotheses of enhanced performance and enhanced opinions as a result of the intervention received little support. The intervention-group students did have higher postintervention scores on the mathematics test, based on a repeated-measures t-test, but because there were no performance measures from the control group, conclusions about the causal effects of the intervention could not be reached. After adjusting for preintervention opinion scores, the control-group students had higher postintervention scores on four opinion scales than did the intervention-group students.

## DESCRIPTION OF THE INTERVENTION

Wilberforce University developed a summer intervention for high-achieving junior-high school students. Thirty seventh- and eighth-grade students from the Dayton, Ohio area public schools, all of whom had a 3.0 or higher grade point average (GPA) and had scored at or above the 89th percentile on the California Achievement Test (CAT), were invited to participate in the program at Wilberforce. The intervention was set up to address the problem of the small number of minority students prepared to pursue technical careers upon graduation from high school. This summer program was designed to encourage students to stay on the math and science track while in high school; to make students aware of the kinds of opportunities available to individuals in technical fields; to provide students with subject matter to strengthen their academic skills; and to provide a supportive, nurturing environment to help increase student's self-esteem.

The first implementation of this intervention took place in the summer of 1989. Students took classes on the Wilberforce campus in the following areas: mathematics, chemistry, biology, physics, computer science, engineering, communication skills, study strategies, and career planning. Efforts were made to increase the number of positive role models available to students. In addition, meetings were held with parents to encourage them to become more active in planning their children's educational and occupational future.

Classes were held Monday through Thursday from 9:30 a.m. to 2:30 p.m., with a lunch break and morning and afternoon breaks. Fridays were set aside for field trips. Students were divided into two groups for classes to allow more individual attention in small groups. Four hour-long classes per day were scheduled; after the first and third classes students had a 15-minute break, and after the second class they had a 45-minute lunch.

Both the relative frequency and the sequencing of the classes were carefully planned in light of their subject matter. Each student had a class in mathematics every morning, for a total of 17 hours of mathematics classes. Other classes were rotated so that, for example, a student might have biology after lunch one week and the following week have engineering in that time slot. The other classes were: computer literacy, 12 hours; communication skills, 12 hours; engineering, 8 hours; biology, 5 hours; chemistry, 5 hours; physics, 4 hours; study strategies, 3 hours; career planning, 2 hours. The study strategies course was held the first week and the engineering course the final two weeks.

Lunches on Thursdays were an hour long to allow for talks given by visiting scientists. Talks on the five Thursdays featured, in turn: a visiting chemist, a visiting biologist, a visiting computer scientist, and two visiting engineers.

On Fridays students visited the following Dayton-area sites: Wright Patterson Air Force Base; the Chevy Robotics plant; the Air Force Museum; the Center of Science and Industry. The final Friday of the intervention was devoted to a recognition luncheon.

A seminar-luncheon for parents was held on the Saturday prior to the beginning of the intervention, to inform parents of the goals and objectives of the program and of their own role in its success. The importance of regular attendance was emphasized. Workshops were offered to parents in these areas: helping children improve academic performance; helping children make wise career choices; increasing children's self-confidence and self-esteem. The children's progress was shared with the parents during the intervention. Parents also attended the recognition luncheon at the end of the intervention.

The intervention began Monday, June 26, 1989, and continued through Friday, July 28, 1989. No activities were scheduled July 3 or 4, because of the holiday. The project director and faculty for this CASET intervention were all faculty and staff members of Wilberforce University. The project director was Ms. Jennie Hodges Sethna, Director of the Dual Degree Program in Computer Science and Engineering for Wilberforce. Intervention faculty included:

- **Mathematics:** Mr. Mohamed W. Abas, Instructor in Mathematics
- **Study Strategies and Career Planning:** Ms. Dianne Turner Ingham, Director, Special Services Program
- **Biology:** Dr. Wilfred R. Ball, Professor of Biology
- **Chemistry:** Mr. Delbert R. Buffinger, Instructor in Chemistry
- **Communication Skills:** Ms. Muriel Wright-Brailey, Chairperson, Humanities Division
- **Physics:** Dr. Anooshirvan Jafari, Associate Professor of Physics
- **Computer Literacy:** Mr. Edward Asikele, Instructor in Computer Science
- **Engineering:** Dr. Augustus Morris, Instructor in Mathematics

The two major hypotheses were that the intervention activities would: (a) enhance performance on the content measure, and (b) enhance opinions about SET fields and careers.

## METHOD

### Subjects

Subjects were high-achieving minority and female seventh- and eighth-grade students in the Dayton, Ohio area. With the cooperation of the local public school systems, a list was compiled of students who met the dual criteria of a 3.0 or higher GPA and a score at the 89th percentile or higher on the California Achievement Test (CAT). Eighty-one students met these criteria; thirty of these were invited to participate in the CASET intervention.

In order to monitor the effects of the intervention, a control group of seventh- and eighth-grade students in the Dayton area schools was identified; these students met the same two performance criteria as the intervention-group students. Control-group students filled out the same protocols and provided the same information as the intervention-group students, but did not participate in any intervention activities.

Data were submitted for a total of 47 students: 24 intervention-group students and 23 control-group students. One control-group student was eliminated from the sample because the student was not a U.S. citizen. (Noncitizens are not a target population for this study.) Data from the remaining 46 students were analyzed and are the subject of this report.

Table 1 shows the ethnic and sex breakdown for the intervention and control groups.

**Table 1**

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| American Indian | | | | | | |
| Anglo | 3 | | 1 | | 4 | |

| ETHNIC AND SEX DISTRIBUTION | | | | | | |
|---|---|---|---|---|---|---|
| | CONTROL | | INTERVENTION | | TOTAL | |
| RACE/ETHNICITY | WOMEN | MEN | WOMEN | MEN | WOMEN | MEN |
| Black | 11 | 7 | 14 | 7 | 25 | 14 |
| Hispanic | | | | | | |
| Unknown | 1 | | 2 | | 3 | |
| **TOTAL** | **15** | **7** | **17** | **7** | **32** | **14** |

CASET Protocols and Other Instruments

The two major hypotheses were that the intervention activities would: (a) enhance performance on the content measure, and (b) enhance opinions about SET fields and careers.

Demographic and descriptive data about the subjects were developed through the Middle/Junior High School Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

To assess opinion information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of 13 attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. CASET used these 13 attitudinal variables as the basis for the Opinion Protocol. For each of the 13 variables, several questions were developed, varying in directionality. Combining the question for each variable gave a scalar measurement for that variable. Thus the completed Opinion Protocol provided a scale measuring each of the 13 variables.

For middle school and junior high school students, CASET adapted the CASET Opinion Protocol items, changing questions to make them more appropriate to the younger age group while addressing the same 13 attitudinal variables as the older-level Opinion Protocol. An additional change was that for the younger students, there were only two possible answers, "yes" and "no," rather than the four-point scale of the older students' Opinion Protocol. The Opinion Protocol questions, together with the scales (attitudinal variables) they represented, are shown in Appendix B.

The preintervention measures of performance were of two kinds: faculty-made content test scores and nationally standardized test scores. The institution developed a test of content in mathematics, consisting of 28 multiple-choice items, which was administered to intervention-group students before the intervention. As an additional preintervention measure of achievement, the institution gathered and submitted standardized test scores for intervention- and control-group students: grade equivalent scores from the Iowa Test of Basic Skills (ITBS) and percentile scores from the CAT. The faculty-made 28-item test of mathematics also served as the postintervention achievement measure. This measure was administered to intervention-group students at the end of the intervention activities. The test was scored by institution faculty, and the pre- and postintervention scores for intervention-group students were sent to CASET.

Procedure

As each student joined the CASET project as an intervention- or control-group student, parents signed a consent form and transcript release form. At the beginning of the intervention, intervention- and control-group students completed the CASET Middle/Junior High School Student Protocol and Opinion Protocol. Intervention-group students also took the faculty-developed test of mathematical content. At the conclusion of the intervention activities, intervention- and control-group students were again administered the Opinion Protocol, and intervention-group students again took the test of mathematical content.

The content tests were scored by the intervention faculty, who forwarded to CASET content test scores for intervention-group students, and CASET instruments, preintervention standardized test scores (ITBS grade equivalents and CAT percentiles), and report cards for intervention- and control-group students.

The items of the Opinion Protocol were coded by CASET according to the 13 scales they represent. Items on the Opinion Protocol were scored in such a way that a larger number reflected a more positive opinion (see Appendix B). The scales were organized into three constructs--SET Goal, Environmental Support, and Attitude--as shown in Appendix C.

## RESULTS

Methodological Issues

The two major hypotheses were that the intervention activities would: (a) enhance performance on the content measure, and (b) enhance opinions about SET fields and careers. The preintervention and postintervention measures of opinion were analyzed in terms of a *nonequivalent control group* design. This type of quasi-experimental design has one major weakness for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or to interactions between preexisting characteristics and maturation. This uncertainty may be addressed by analyzing the influence of preexisting characteristics on students' opinions; the analysis of covariance (ANCOVA), adjusting for preintervention opinion, was used to improve the likelihood of detecting a group difference and to reduce group differences that may have existed prior to the intervention.

Of the 24 control-group students, responses on the postintervention Opinion Protocol from only 10 students were evaluated. The postintervention Opinion Protocols of the other 14 students were eliminated because the time interval between their pre- and postintervention opinion measures was more than 46 days, which was over 40% more than the 32-day interval between the intervention-group students' pre- and postintervention opinion measurements.

The preintervention and postintervention measures of performance were available only for the intervention group; therefore, these data were analyzed in terms of a *one-group pretest-posttest* design. This type of preexperimental design has six possible weaknesses for making causal conclusions about the intervention's effects (Cook & Campbell, 1979): Group differences may be due either to the intervention or to other influences operating such as history, maturation, testing, instrumentation, regression, and/or selection-maturation interaction. Of these six possible weaknesses, only regression and instrumentation can be ruled out (as they were ruled out for the opinion results); the four remaining weaknesses for deriving causal conclusions about the intervention's effects on performance will be revisited in the discussion.

## Demographic Results

The comparability of the intervention and control groups prior to the intervention was examined by testing for differences on the items of the Student Protocol. The complete results are given in Appendix D. The groups differed significantly on five of the 38 comparisons. Four of the differences favored the intervention group: (a) More students in the intervention group planned to go to graduate school (92%) than did the control-group students (59%); (b) more of the intervention-group students had computers in their homes (58%) than did the control-group students (27%) (c) the intervention-group students had more support items in their homes ($\underline{M}$ = 6.75) than did the control-group students ($\underline{M}$ = 5.64), $\underline{t}$ (44) = 2.07, $\underline{p} \leq .05$; and (d) more of the intervention-group students had played or worked in a computer lab (96%) than had the control-group students (68%). More of the control-group students' parents had attended PTA meetings (41%) than had the parents of the intervention-group students (12%). Based on finding demographic differences on 13 percent of the measures, the groups were judged to be fairly comparable on demographic characteristics prior to the intervention.

## Performance Measures

*Group differences in performance.* The three preintervention measures and the one postintervention measure of performance were used to test the first hypothesis of group differences in performance, and the results are given in Table 2. The control group and the intervention group did not differ on either standardized pretest measure. The nonsignificant differences on these measures provided more evidence that the groups were equivalent prior to the intervention.

The intervention group showed a significant gain from preintervention to postintervention on the mathematics test scores: The mean pretest score was 11.5 (41.1%) and the mean posttest score was 14.25 (50.9%). However, because no mathematics test scores were collected from the control-group students, the increase in the intervention-group test scores may have been due to factors other than the intervention.

**Table 2**

**GROUP COMPARISONS OF PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | Sig. $\underline{p}$ |
|---|---|---|---|---|---|---|
| CAT Percentile | Control<br>Intervention | 14<br>14 | 90.14<br>90.00 | 8.37<br>7.62 | -0.05<br>(26) | ns |
| ITBS Grade Equivalent | Control<br>Intervention | 8<br>10 | 5.50<br>6.10 | .93<br>.99 | 1.31<br>(16) | ns |
| Mathematics Test Score (Intervention only) | Pretest<br>Posttest | 24<br>24 | 11.50<br>14.25 | 4.47<br>3.47 | 5.45<br>(23) | $\leq .01$ |

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

*Interrelationships among performance measures.* The interrelatedness of the performance measures was examined via intercorrelations of the three measures, presented in Table 3. The CAT percentile was significantly correlated with preintervention and postintervention mathematics performance, but the ITBS grade equivalent was not related significantly to the mathematics test scores. The preintervention-postintervention correlation for mathematics test scores was .84.

**Table 3**

**INTERCORRELATIONS AMONG PERFORMANCE MEASURES[a]**

| | **CAT Percentile (n) Sig. p-Value** | **ITBS Grade Equivalent (n) Sig. p-Value** | **Mathematics Pretest (n) Sig. p-Value** |
|---|---|---|---|
| Mathematics Pretest | .62<br>(14)<br>≤.01 | .17<br>(10)<br>ns | 1.00 |
| Mathematics Posttest | .59<br>(14)<br>≤.05 | .28<br>(10)<br>ns | .84<br>(24)<br>≤.01 |

[a] All correlations were analyzed as one-tailed tests.

Opinion Measures

*Group differences on pre- and postintervention measures.* The second hypothesis was that the intervention would produce enhanced opinions of SET fields, and this hypothesis was tested by evaluating the students' responses to the Opinion Protocol. The means of the intervention-group and control-group students were compared for the 13 opinion scales, three constructs, and the total opinion score, measured before and after the intervention. These results are given in Table 4. Before the intervention began, the control and intervention groups did not differ on any of the 17 opinion measures. After the intervention ended, the intervention group had higher scores on the Aspiration scale. (Because one-tailed tests of statistical significance were made for the postintervention measures, no control-group advantages were examined.)

These first tests of the intervention's effects on postintervention opinion did not take into account students' opinions prior to the intervention. The postintervention difference may have been the further development of preexisting differences and not the result of the intervention. In order to adjust for preexisting differences, the final opinion variables were adjusted for preexisting differences via ANCOVA.

Table 4

| GROUP DIFFERENCES ON PRETEST AND POSTTEST - OPINION CONSTRUCTS AND SCALES | | | | | | | |
|---|---|---|---|---|---|---|---|
| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t - Test | Sig. p |
| | | Mean | SD | Mean | SD | | |
| OPINION, Total | Pretest | 1.66 | .09 | 1.66 | .06 | 0.08 | ns |
| | Posttest | 1.68 | .08 | 1.65 | .08 | -0.90 | ns |
| SET GOAL | Pretest | 1.64 | .08 | 1.66 | .06 | 0.71 | ns |
| | Posttest | 1.64 | .08 | 1.67 | .06 | 1.00 | ns |
| Value | Pretest | 1.50 | .00 | 1.50 | .00 | 0.00 | ns |
| | Posttest | 1.48 | .08 | 1.48 | .07 | 0.15 | ns |
| Cultural Value | Pretest | 1.73 | .04 | 1.68 | .16 | -1.12 | ns |
| | Posttest | 1.72 | .14 | 1.73 | .15 | 0.01 | ns |
| Self-Concept | Pretest | 1.75 | .25 | 1.80 | .16 | 0.69 | ns |
| | Posttest | 1.85 | .17 | 1.81 | .14 | -0.63 | ns |
| Aspiration | Pretest | 1.54 | .14 | 1.60 | .19 | 0.92 | ns |
| | Posttest | 1.48 | .14 | 1.61 | .14 | 2.50 | $\leq$.01 |
| ATTITUDE | Pretest | 1.71 | .16 | 1.71 | .10 | 0.06 | ns |
| | Posttest | 1.74 | .12 | 1.70 | .14 | -0.86 | ns |
| Math/Science Attitude | Pretest | 1.79 | .12 | 1.84 | .15 | 0.83 | ns |
| | Posttest | 1.80 | .12 | 1.74 | .21 | -0.75 | ns |
| Locus of Control | Pretest | 1.80 | .23 | 1.92 | .18 | 1.59 | ns |
| | Posttest | 1.90 | .16 | 1.86 | .22 | -0.51 | ns |
| Persistence | Pretest | 1.65 | .29 | 1.54 | .26 | -1.06 | ns |
| | Posttest | 1.78 | .22 | 1.62 | .23 | -1.85 | ns |
| Study Habits | Pretest | 1.50 | .24 | 1.50 | .24 | 0.00 | ns |
| | Posttest | 1.50 | .17 | 1.55 | .18 | 0.74 | ns |
| Anxiety | Pretest | 1.73 | .30 | 1.71 | .28 | -0.26 | ns |
| | Posttest | 1.75 | .25 | 1.73 | .30 | -0.19 | ns |
| ENVIRONMENTAL SUPPORT | Pretest | 1.60 | .07 | 1.57 | .10 | -0.71 | ns |
| | Posttest | 1.61 | .07 | 1.54 | .09 | -2.31 | ns |
| Academic Support | Pretest | 1.97 | .10 | 1.97 | .09 | 0.15 | ns |
| | Posttest | 1.97 | .10 | 1.92 | .15 | -0.97 | ns |

| GROUP DIFFERENCES ON PRETEST AND POSTTEST - OPINION CONSTRUCTS AND SCALES | | | | | | | |
|---|---|---|---|---|---|---|---|
| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t - Test | Sig. p |
| | | Mean | SD | Mean | SD | | |
| Career Awareness | Pretest | 1.67 | .00 | 1.62 | .11 | -1.16 | ns |
| | Posttest | 1.67 | .00 | 1.62 | .11 | -1.16 | ns |
| Role Model | Pretest | 1.35 | .23 | 1.32 | .30 | -0.29 | ns |
| | Posttest | 1.43 | .27 | 1.27 | .24 | -1.70 | ns |
| Equal Opportunity | Pretest | 1.40 | .14 | 1.38 | .15 | -0.45 | ns |
| | Posttest | 1.37 | .10 | 1.33 | .10 | -0.88 | ns |
| All pretests were analyzed as two-tailed tests. All posttests were analyzed as one-tailed tests. | | | | | | | |
| Pretest n's: Control = 10; Intervention = 24 Posttest n's: Control = 10; Intervention = 24 | | | | | | | |

*Group differences on opinion adjusting for prior scores.* Table 5 reports further tests of the second hypothesis that measured the effects of the intervention on opinions about SET fields after adjusting for preintervention opinion scores in ANCOVAs. By these analyses, the intervention and control groups differed overall on three opinion measures: The intervention group had significantly higher Aspiration scores (adjusted means were 1.61 for the intervention group and 1.51 for the control group), and the control-group students had significantly higher Self-Concept (control group M = 1.87, intervention group M = 1.81) and Environmental Support scores (control group M = 1.60, intervention group M = 1.54). These results roughly paralleled the t-test results of Table 4. In addition to the one overall advantage for the intervention group, there were significant interactions between preintervention opinion score and group membership for five postintervention opinion measures: Total Opinion, Attitude construct, Math/Science Attitude, Locus of Control, and Equal Opportunity.

**Table 5**

| HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES - COVARYING PREINTERVENTION OPINION | | | | | | |
|---|---|---|---|---|---|---|
| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
| OPINION,Total | PREINTERVENTION | .58 | .58 | 44.15 | 1,32 | ≤.01 |
| | +GROUP | .61 | .03 | 2.22 | 1,31 | ns |
| | +PRE-x-GROUP | .65 | .04 | 3.67 | 1,30 | ≤.10 |
| SET GOAL | PREINTERVENTION | .66 | .66 | 61.29 | 1,32 | ≤.01 |
| | +GROUP | .66 | .01 | 0.49 | 1,31 | ns |
| | +PRE-x-GROUP | .67 | .00 | 0.29 | 1,30 | ns |

HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES - COVARYING PREINTERVENTION OPINION

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Value | PREINTERVENTION | .00 | .00 | 0.02 | 1,32 | ns |
| | +GROUP | | | | | |
| | +PRE-x-GROUP | | | | | |
| Cultural Value | PREINTERVENTION | .30 | .30 | 14.00 | 1,32 | ≤.01 |
| | +GROUP | .32 | .01 | 0.56 | 1,31 | ns |
| | +PRE-x-GROUP | .33 | .01 | 0.59 | 1,30 | ns |
| Self-Concept | PREINTERVENTION | .53 | .53 | 35.76 | 1,32 | ≤.01 |
| | +GROUP | .57 | .04 | 2.89 | 1,31 | ≤.10 |
| | +PRE-x-GROUP | .57 | .01 | 0.41 | 1,30 | ns |
| Aspiration | PREINTERVENTION | .45 | .45 | 26.16 | 1,32 | ≤.01 |
| | +GROUP | .54 | .09 | 6.11 | 1,31 | ≤.05 |
| | +PRE-x-GROUP | .56 | .02 | 1.21 | 1,30 | ns |
| ATTITUDE | PREINTERVENTION | .46 | .46 | 27.44 | 1,32 | ≤.01 |
| | +GROUP | .49 | .02 | 1.51 | 1,31 | ns |
| | +PRE-x-GROUP | .55 | .07 | 4.53 | 1,30 | ≤.05 |
| Math/Science Attitude | PREINTERVENTION | .29 | .29 | 13.14 | 1,32 | ≤.01 |
| | +GROUP | .34 | .05 | 2.11 | 1,31 | ns |
| | +PRE-x-GROUP | .44 | .10 | 5.33 | 1,30 | ≤.05 |
| Locus of Control | PREINTERVENTION | .14 | .14 | 5.10 | 1,32 | ≤.05 |
| | +GROUP | .18 | .04 | 1.47 | 1,31 | ns |
| | +PRE-x-GROUP | .27 | .09 | 3.74 | 1,30 | ≤.10 |
| Persistence | PREINTERVENTION | .14 | .14 | 5.10 | 1,32 | ≤.05 |
| | +GROUP | .20 | .06 | 2.36 | 1,31 | ns |
| | +PRE-x-GROUP | .20 | .00 | 0.14 | 1,30 | ns |
| Study Habits | PREINTERVENTION | .12 | .12 | 4.53 | 1,32 | ≤.05 |
| | +GROUP | .14 | .02 | 0.61 | 1,31 | ns |
| | +PRE-x-GROUP | .15 | .01 | 0.35 | 1,30 | ns |
| Anxiety | PREINTERVENTION | .67 | .67 | 66.32 | 1,32 | ≤.01 |
| | +GROUP | .67 | .00 | 0.00 | 1,31 | ns |
| | +PRE-x-GROUP | .68 | .01 | 0.78 | 1,30 | ns |
| ENVIRONMENTAL SUPPORT | PREINTERVENTION | .21 | .21 | 8.68 | 1,32 | ≤.01 |
| | +GROUP | .32 | .10 | 4.75 | 1,31 | ≤.05 |
| | +PRE-x-GROUP | .32 | .00 | 0.04 | 1,30 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES - COVARYING PREINTERVENTION OPINION**

| FINAL OPINION CONSTRUCT/Scale | INDEPENDENT VARIABLE MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Academic Support | PREINTERVENTION | .37 | .37 | 19.06 | 1,32 | $\leq$.01 |
| | +GROUP | .41 | .03 | 1.80 | 1,31 | ns |
| | +PRE-x-GROUP | .41 | .00 | 0.18 | 1,30 | ns |
| Career Awareness | PREINTERVENTION | .07 | .07 | 2.49 | 1,32 | ns |
| | +GROUP | .09 | .02 | 0.77 | 1,31 | ns |
| | +PRE-x-GROUP | | | | | |
| Role Model | PREINTERVENTION | .09 | .09 | 3.14 | 1,32 | $\leq$.10 |
| | +GROUP | .16 | .07 | 2.78 | 1,31 | ns |
| | +PRE-x-GROUP | .17 | .01 | 0.27 | 1,30 | ns |
| Equal Opportunity | PREINTERVENTION | .18 | .18 | 7.24 | 1,32 | $\leq$.05 |
| | +GROUP | .20 | .01 | 0.56 | 1,31 | ns |
| | +PRE-x-GROUP | .32 | .12 | 5.51 | 1,30 | $\leq$.05 |

All models were analyzed as two-tailed tests.

* Three models of independent variables were tested for each dependent variable (posttest opinion measure): (1) PRETEST OPINION SCORE; (2) PRETEST OPINION SCORE and GROUP ('+'); (3) PRETEST OPINION SCORE and GROUP and PRETEST OPINION SCORE-by-GROUP INTERACTION ('-x-').

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

**Figure 1**

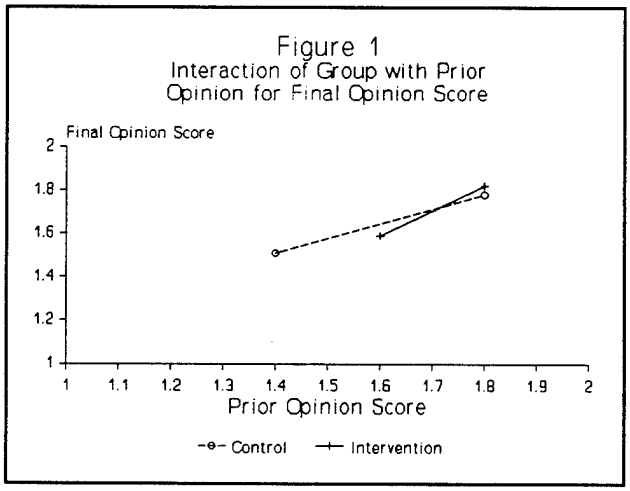
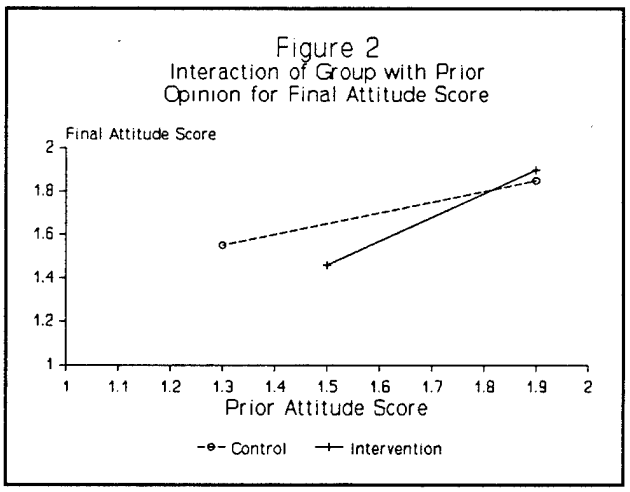



**Figure 2**



The interactions were analyzed further using the Johnson-Neyman technique (Rogosa, 1980) which allows one to determine the intersection point of the two regression lines and the range of preintervention scores for which the groups differed. Figures 1 through 5 show the nonparallel regression lines that indicated that the relationship between the preintervention and postintervention measures was different for the intervention and control groups.

In Figure 1, for students with preintervention Total Opinion scores at or below 1.7 (overall M = 1.7), the control-group students had more positive postintervention Total Opinion scores than did the intervention-group students.

Figure 2 indicates that for those students with prior Attitude construct scores of 1.7 or less (overall M = 1.7), the control-group students had more positive postintervention Attitude scores than did the intervention-group students.

**Figure 3**

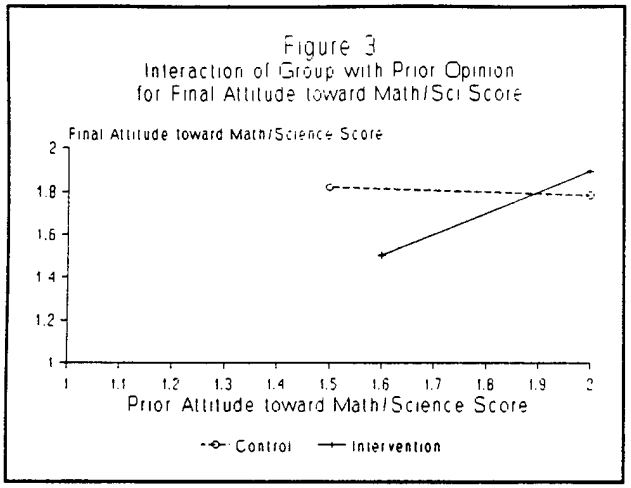
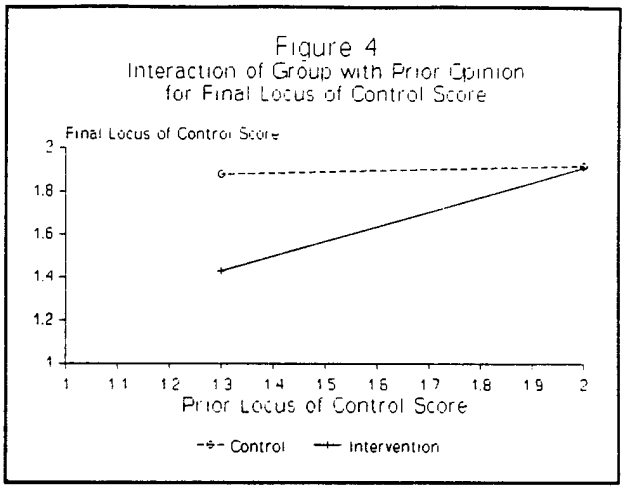



**Figure 4**



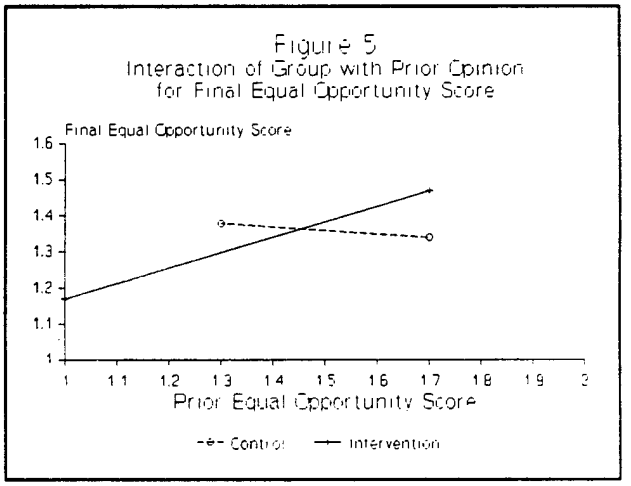

In Figure 3, for students with preintervention Attitude toward Math/Science scores at or below 1.8 (overall M = 1.8), the control group students had more positive postintervention Math/Science Attitude scores than did the intervention group students.

Figure 4 indicates that for those students with prior Locus of Control scores of 1.85 or less (overall M = 1.9), the control group students had more positive postintervention Attitude scores than did the intervention group students.

**Figure 5**

Finally, in Figure 5, for students with prior Equal Opportunity scores at or above 1.6 (overall M = 1.3), the intervention group students had more positive final Equal Opportunity scores than did the control group students; for students with prior scores at or below 1.35, the control group students had higher Equal Opportunity scores than did the intervention group students.

For four of the five interactions, the control group students had higher postintervention opinion scores for a wider range of the preintervention opinion scores than did the intervention group students; for the fifth measure -- Equal Opportunity -- the groups were roughly equal. In summary, the ANCOVA results did not support the second hypothesis of enhanced opinion resulting from the intervention.



## DISCUSSION

The two hypotheses of enhanced performance and enhanced opinion as a result of the intervention received little support. The intervention group had higher scores on the postintervention mathematics test, based on a repeated-measures t-test; however, the absence of control-group students' performance results severely restricts conclusions about the possible causal effects of the intervention on performance. After adjusting for preintervention opinion scores, the intervention group students had higher Aspiration scores than did the control-group students. However, the control-group students had higher scores on two opinion scales -- Self-Concept and Equal Opportunity. In addition, those control-group students who had begun with lower opinions had higher postintervention opinion scores on four other opinion scales -- Total Opinion, Attitude construct, Math/Science Attitude, and Locus of Control (more internal) -- than did the comparable intervention-group students. Based on these results, the hypotheses of enhancements due to the intervention cannot be accepted.

The two groups in this nonequivalent control group design were not formed by random assignment, and because the groups may have differed prior to the start of the intervention, the groups were compared on a variety of demographic, performance, and opinion measures. Comparisons on all 57 preintervention measures found significant differences between the control and intervention groups on only five demographic measures. Based on finding so few preexisting differences, the groups were judged comparable on preintervention measures.

To strengthen the causal conclusions of the intervention, and to rule out some questions about the interactions between preexisting differences and maturation, one would want to obtain performance results from the control group and to have documentation of the criteria used to select students into either the control group or intervention group (cf. Cook & Campbell, 1979). With this information, one could better decide if the outcomes favoring either group were products of the program or the outgrowths of preexisting differences between the groups.

The primary measure of postintervention performance -- the mathematics test -- seemed to have been a valid measure, as it correlated significantly with the CAT percentiles. One improvement in measurement would be to have separate scores for mathematics, computer science, chemistry, and physics; analyses of these separate scores would permit some evaluation of the quality of the intervention's components. A test with separate scores, together with measures of students' attendance, would improve the quality of the conclusions about the intervention's effects and provide more specific recommendations for improvements in the intervention.

As with any quasi-experimental design, the replication of some or all of these findings in a subsequent implementation of this intervention will greatly strengthen conclusions about the positive effects of this intervention.

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# APPENDICES

# APPENDIX A

# MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

Participant Number: _____

## MIDDLE/JUNIOR HIGH SCHOOL STUDENT PROTOCOL

Thank you for agreeing to participate in this important project. It is geared to help us develop new programs for students and improve existing programs.

Your opinions and experience are important to us. Please read each question carefully and answer completely and accurately to the best of your ability. All of your answers will be kept in confidence. Your answers will be grouped with those of other students in other places, and together they will help us better understand students' needs and preferences today.

Please ask your administrator if any of these questions are unclear to you.

Thanks for your help!

1. Sex:
   - ___ a. Male
   - ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   - ___ a. Anglo
   - ___ b. Black
   - ___ c. Asian American
   - ___ d. American Indian (Please specify the tribe which best describes your heritage.)

     _____
   - ___ e. Hispanic (Which of the following best describes your heritage?)
     - ___ a. Cuban-American
     - ___ b. Mexican-American
     - ___ c. Puerto Rican
     - ___ d. Other Specify _____
   - ___ f. Other Specify _____

4. Are you a United States citizen?
   - ___ a. Yes
   - ___ b. No

5. Name of your school: _____

   City: _____ State: _____

6. Class:
   ___ a. 4th grade
   ___ b. 5th grade
   ___ c. 6th grade
   ___ d. 7th grade
   ___ e. 8th grade

7. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Less than high school graduation
   ___ b. High school graduation
   ___ c. Two-year college degree (community college or junior college)
   ___ d. Four-year college degree
   ___ e. Education beyond four years of college
   ___ f. Other Specify _____

8. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

9. What is or are the occupation(s) of the person(s) with whom you live? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")
   _____ _____

10. Would you say that your family's income is:
   ___ a. Below the U.S. average
   ___ b. About average
   ___ c. Above average
   ___ d. Don't know

11. Are you:
   ___ a. An only child (skip to question 13)
   ___ b. The oldest child
   ___ c. The youngest child
   ___ d. An in-between child

12. How many brothers and sisters do you have?
   ___ a. One
   ___ b. Two
   ___ c. Three or more

13. What was the highest level of school your father completed? (Check only the highest)
    ___ a. Grade school or less
    ___ b. Some high school but did not graduate
    ___ c. High school graduate
    ___ d. Some college but no degree
    ___ e. College degree or more
    ___ f. Don't know

14. What was the highest level of school your mother completed? (Check only the highest)
    ___ a. Grade school or less
    ___ b. Some high school but did not graduate
    ___ c. High school graduate
    ___ d. Some college but no degree
    ___ e. College degree or more
    ___ f. Don't know

15. What is the language spoken most often by adults in your household? (Check only one)
    ___ a. English
    ___ b. Spanish
    ___ c. The language of my tribe (What is that language?) _____
    ___ d. Another language - Specify _____

16. Which of the following did your parent(s) or guardian(s) ever do during your years in school? (Check all that apply)
    ___ a. Attend Parent-Teacher Association (PTA) meetings
    ___ b. Attend parent-teacher conferences
    ___ c. Visit your classes
    ___ d. Phone or visit your teacher, counselor, or principal when you had a problem
    ___ e. Do volunteer work such as fund-raising or assisting with school projects
    ___ f. Help you with your homework

17. Which of the following comes closest to describing how much your parent(s) or guardian(s) read?
    ___ a. Not at all
    ___ b. Sometimes
    ___ c. A lot

18. Which of the following comes closest to describing how much you read?
    ___ a. Not at all
    ___ b. Sometimes
    ___ c. A lot

19. Which of these items do you have in your family home? (Check all that apply)
    ___ a. A desk
    ___ b. Daily newspaper
    ___ c. Encyclopedia
    ___ d. Typewriter
    ___ e. Pocket calculator
    ___ f. Television

___ g. Computer
___ h. Video cassette recorder (VCR)

20. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL ITEMS WITH DIRECTIONALITY AND SCALES

## Opinion Protocol Items with Directionality and Scales

Legend:

**SH Study Habits**
**AT Attitude toward math/science**
**SC Self-Concept**
**AX Anxiety**
**VL Value**
**LC Locus of Control**
**CA Career Awareness**
**PS Persistence**
**CV Cultural Value**
**AS Academic Support**
**AP Aspiration**
**EO Equal Opportunity**
**RM Role Model**

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | Do you study each day rather than just before exams? |
| 2. | + | AT | Are scientists smarter than most people? |
| 3. | + | SC | Can you imagine yourself as a scientist? |
| 4. | - | AX | Do word problems in mathematics make you nervous? |
| 5. | + | VL | Do you think mathematics is needed in most jobs? |
| 6. | + | VL | Is science important to our country? |
| 7. | + | LC | When you make plans, can you usually make them work? |
| 8. | + | CA | Do girls have a good chance of becoming scientists when they grow up? |
| 9. | + | PS | Do you usually finish the things you start? |
| 10. | + | CV | Is it important to you that your people be proud of you? |
| 11. | - | SH | Do you prefer to study alone? |
| 12. | - | AT | Do scientists do boring work? |
| 13. | + | AS | If you have problems at school, is there someone who will help you? |

| | | | |
|---|---|---|---|
| 14. | - | AX | Do tests make you nervous? |
| 15. | + | SH | Do you get your homework done on time? |
| 16. | - | SC | Are science experiments hard for you to understand? |
| 17. | + | AP | Do you want to take any more mathematics courses? |
| 18. | + | CV | Are your friends good at mathematics? |
| 19. | - | EO | Does a person's color make a difference in whether or not they get to be a scientist? |
| 20. | - | PS | Do you get bored with your school work by the middle of the school year? |
| 21. | - | PS | Do you have trouble keeping your mind on your homework? |
| 22. | + | EO | Do people care if a good scientist is a man or a woman? |
| 23. | + | AP | Are you thinking of becoming a scientist? |
| 24. | - | AT | Is mathematics boring? |
| 25. | + | RM | Are many people of your ethnic/racial group successful scientists? |
| 26. | + | AP | Do you try to get good grades in science? |
| 27. | - | LC | Is success mostly a matter of luck? |
| 28. | + | AT | Do most scientists enjoy their work? |
| 29. | + | AT | Do you enjoy solving mathematics problems? |
| 30. | + | VL | Does mathematics come in handy outside of class? |
| 31. | - | AX | Do you feel scared when you have to work a mathematics problem? |

| | | | |
|---|---|---|---|
| 32. | + | CA | Can you really become a scientist if you want to? |
| 33. | + | CA | Do you think there are a lot of jobs for scientists? |
| 34. | - | AX | Do tests scare you even when you have studied for them? |
| 35. | + | SC | Do you think you are a good science student? |
| 36. | + | SH | Do you like to read about science? |
| 37. | + | RM | Have you ever met a scientist? |
| 38. | + | VL | Is science an important subject? |
| 39. | + | SC | Are you good at figuring out mathematics problems? |
| 40. | + | AP | Do you want to improve your mathematics skills? |
| 41. | + | AS | Do the teachers in your school care how well you do in school? |
| 42. | + | CV | Do your people think highly of scientists? |
| 43. | - | AP | Would you like to spend less time on science in school? |
| 44. | - | AS | Do your teachers think you don't do very well? |
| 45. | + | CV | Does your family care a lot about education? |
| 46. | - | AT | Are scientists unfriendly? |
| 47. | - | AX | Do you worry about being able to understand your science assignments? |
| 48. | + | RM | Is there a scientist you look up to? |
| 49. | - | EO | Are boys better in science than girls? |

| | | | |
|---|---|---|---|
| 50. | + | LC | Can you control whether or not you have a good day? |
| 51. | - | SC | Is science too hard for you? |
| 52. | - | PS | Do you often quit when things get tough? |
| 53. | - | AX | Do you get scared when you are called on to answer a question in mathematics? |
| 54. | + | AT | Is science interesting? |
| 55. | + | SC | Are you very good at mathematics? |

56. What do you want to be when you grow up?

a. _____

b. _____

c. _____

57. Please describe the work you feel scientists do in a typical work day. If you don't know, just use your imagination.

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF

# THE MIDDLE/JUNIOR HIGH STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 24 | CONTROL n = 22 |
| 1. Sex: | | |
| Women | 71% | 68% |
| Men | 29% | 32% |
| 2. Age | 13.44 | 13.42 |
| 6. Class: | | |
| .Seventh grade | 12% | 36% |
| .Eighth grade | 88% | 64% |
| 7. Higher education expected: | | |
| .Less than high school | 0% | 0% |
| .High school graduation | 0% | 4% |
| .Two-year college degree | 0% | 4% |
| .Four-year college degree | 8% | 32% |
| .One or more years after college | 92% | 59%[a] |
| 8. Studies most influenced by: | | |
| .Parents | 83% | 50% |
| .Another family member | 4% | 4% |
| .Teacher | 4% | 9% |
| .Counselor | 0% | 4% |
| .Minister | 0% | 0% |
| .Friend | 4% | 0% |
| .Science professional | 0% | 9% |
| .Nonscience professional | 0% | 0% |
| .No one at all | 0% | 18% |
| .Missing | 4% | 4% |
| 9. Sources of income: | | |
| .None | 0% | 14% |
| .One | 38% | 32% |
| .Two | 58% | 41% |
| .Missing | 4% | 14% |
| 10. Family income: | | |
| .Below U.S. average | 0% | 4% |
| .About average | 33% | 36% |
| .Above average | 12% | 18% |
| .Unknown or missing | 54% | 41% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 24 | CONTROL n = 22 |
| 11. Birth order of student: | | |
| .Only child | 8% | 23% |
| .Oldest child | 33% | 27% |
| .Youngest child | 29% | 32% |
| .In-between child | 29% | 14% |
| .Missing | 0% | 4% |
| 12. Number of siblings: | | |
| .None | 8% | 23% |
| .One | 17% | 27% |
| .Two | 29% | 23% |
| .Three or more | 42% | 23% |
| .Missing | 4% | 4% |
| 13. Father's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 4% | 9% |
| .High school graduate | 12% | 18% |
| .Some college | 12% | 18% |
| .College degree or more | 42% | 23% |
| .Missing | 29% | 32% |
| 14. Mother's education: | | |
| .Grade school or less | 0% | 0% |
| .Some high school | 0% | 9% |
| .High school graduate | 8% | 23% |
| .Some college | 25% | 32% |
| .College degree or more | 54% | 32% |
| .Missing | 12% | 4% |
| 15. Language spoken most at home: | | |
| .English | 100% | 96% |
| .Spanish | 0% | 4% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| 16. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 12% | 41%[a] |
| .Attend parent-teacher conferences .Visit student's class | 79% | 77% |
| .Phone/visit if there's a problem | 62% | 68% |
| .Do volunteer work | 62% | 73% |
| .Assist in student's homework | 42% | 23% |
| Number of parental involvements * | 88% | 86% |
| | 3.46 | 3.68 |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 24 | CONTROL n = 22 |
| 17. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 25% | 41% |
| .A lot | 75% | 50% |
| .Missing | 0% | 9% |
| 18. Student reads: | | |
| .Not at all | 4% | 4% |
| .Sometimes | 38% | 36% |
| .A lot | 58% | 54% |
| .Missing | 0% | 4% |
| 19. Items in student's home:[b] | | |
| .Desk | 88% | 64% |
| .Daily newspaper | 88% | 82% |
| .Encyclopedia | 79% | 68% |
| .Typewriter | 75% | 68% |
| .Calculator | 96% | 82% |
| .Television | 100% | 96% |
| .Computer | 58% | 27%[a] |
| .Video Cassette Recorder (VCR) | 92% | 77% |
| Number of support items * | 6.75 | 5.64[a] |
| 20. All activities student took part in:[b] | | |
| .Math/science club | 25% | 32% |
| .Field trip | 96% | 91% |
| .Watching science programs on TV | 79% | 77% |
| .Listen to talk by scientist | 38% | 36% |
| .Science/math fair | 62% | 64% |
| .Other science/math competition | 46% | 32% |
| .Play/work in computer lab | 96% | 68%[a] |
| Number of activities * | 4.42 | 4.00 |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.

* Mean value reported in lieu of percent responses

# CASET RESEARCH REPORT:

# WILBERFORCE UNIVERSITY

# INTERVENTIONS:

# COLLEGE LEVEL

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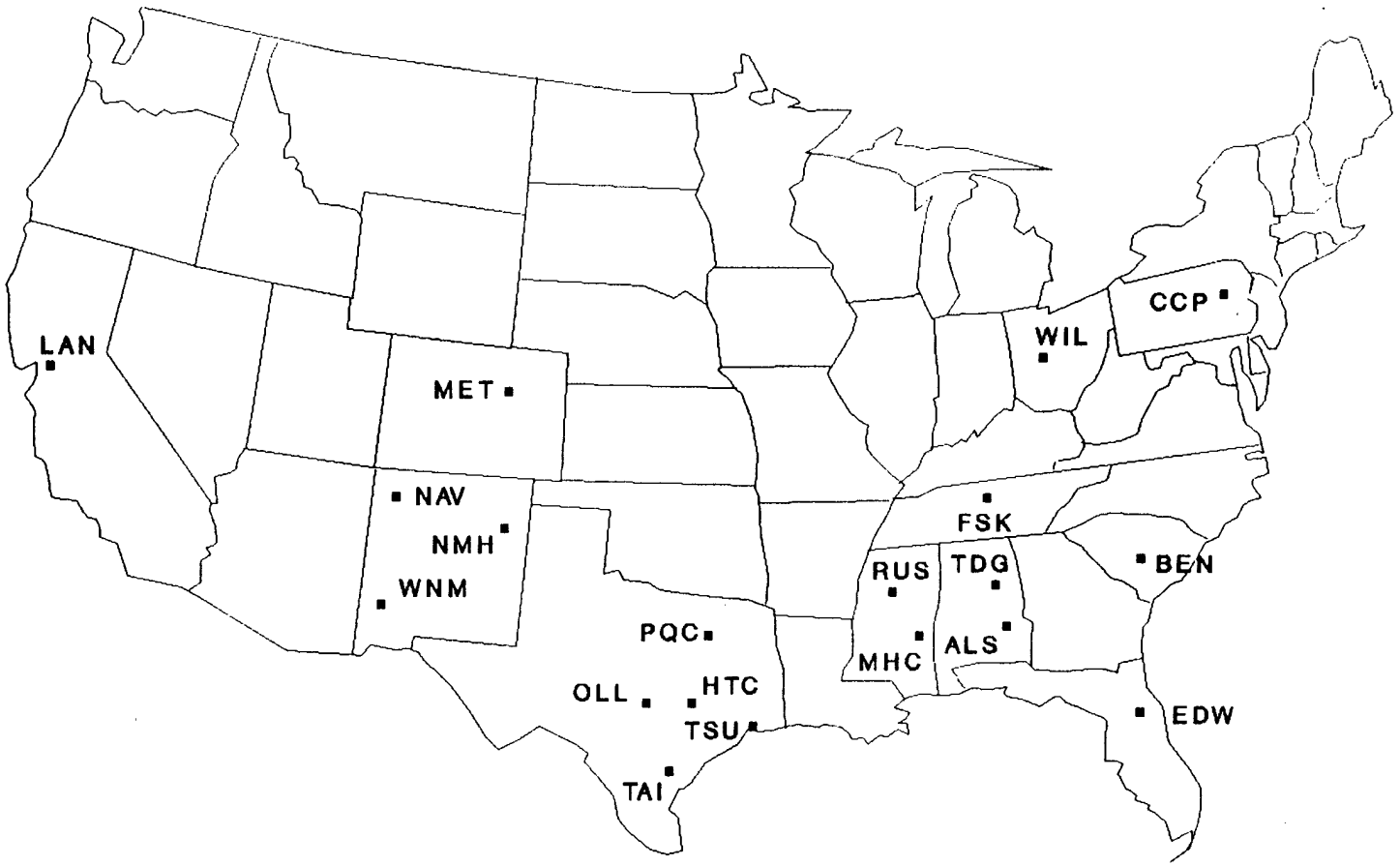

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# CASET Consortium Intervention Sites




**LEGEND**

ALS - Alabama State Univ., Montgomery, AL
BEN - Benedict College, Columbia, SC
CCP - Community College of Phil., Philadelphia, PA
EWC - Edward Waters College, Jacksonville, FL
FSK - Fisk University, Nashville, TN
HTC - Huston-Tillotson College, Austin, TX
LAN - Laney College, Oakland, CA
MHC - Mary Holmes College, West Point, MS
MET - Metropolitan State College, Denver, CO
NAV - Navajo Community College, Shiprock, NM
NMH - New Mexico Highlands Univ., Las Vegas, NM
OLL - Our Lady of the Lake, San Antonio, TX
PQC - Paul Quinn College, Dallas, TX
RUS - Rust College, Holly Springs, MS
TDG - Talladega College, Talladega, AL
TAI - Texas A & I University, Kingsville, TX
TSU - Texas Southern University, Houston, TX
WNM - Western New Mexico, Silver City, NM
WIL - Wilberforce University, Wilberforce, OH

# PART I

# BACKGROUND

## CASET AND THE CASET CONSORTIUM

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, 1990, and 1991.

This report is one of a group of project reports produced by CASET to present the findings of the individual institutions' research.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, [with students]; each collected data to measure the effects of those interventions. Data collected come from the CASET protocols described in this report, outcome measures developed by the institutions according to the purposes of their interventions, and background information on the students, such as transcripts and test scores. All of these measures were taken on the intervention- group students, as well as on a control group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules. Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

Informed consent forms signed by all intervention- and control-group members (by parent or guardian when the student was below the age of consent in his/her state of residence at the time of the signing) are on file in the CASET offices.

Institutions were encouraged to develop and improve their consortium interventions in the light of their ongoing experiences; in addition, meetings were held in 1988 and 1989 at NASA/Johnson Space Center so that project directors could interact and profit from each other's experience.

One semester (in most cases, the first semester) of each institution's intervention research is described in a project report such as this one. Subsequent semesters of implementation and research are reported in brief replication reports, which can be appended to the project report. Final output from the CASET project will include descriptive modules of successful interventions, and a meta-analysis examining the CASET research findings.

## DESCRIPTION OF WILBERFORCE UNIVERSITY

Wilberforce University is a historically Black, four-year, private, coeducational institution located in Wilberforce, Ohio. The University serves approximately 770 students and has 56 faculty members. The University, organized into General Studies, Business and Economics, Humanities, Natural Science, and Social Science Divisions, offers Bachelor of Arts and Bachelor of Science degrees. The student body is approximately 62 percent female and 38 percent male and is predominantly Black. The president of Wilberforce University is Dr. Yvonne Walker-Taylor.

Degrees offered at Wilberforce University in quantitative subjects are Bachelor of Arts in chemistry, and Bachelor of Science in comprehensive science, computer information systems, and mathematics. The University also offers its science and mathematics majors dual-degree programs in engineering and computer science in cooperation with the University of Dayton in Dayton, Ohio. Upon completion of a dual-degree program, a student is awarded a bachelor's degree in science or mathematics from Wilberforce University and a second bachelor's degree in engineering or computer science from the University of Dayton.

Wilberforce has a population of less than 5000, although it is near the heavily populated urban areas of Dayton, Springfield, Columbus, and Cincinnati. The state of Ohio has a population of nearly 11 million. According to U.S. Census Bureau estimates, the adult population of Ohio is 88 percent Anglo, 10 percent Black, 1 percent Hispanic, and 1 percent other ethnic origins. Other nearby institutions of higher education include Antioch College, Cedarville College, Central State University, Sinclair College, University of Dayton, Wilmington College, and Wright State University.

# PART II

# SUMMARY OF THE WILBERFORCE UNIVERSITY (WU) INTERVENTIONS

This page is a summary of the two college-level interventions conducted by Wilberforce University, a historically Black, four-year private institution located in Wilberforce, Ohio. The college is a member of a consortium formed by the Center for the Advancement of Science, Engineering, and Technology (CASET) as part of a multiyear research study. The purpose of the CASET study was to determine and test strategies to encourage and enhance the recruitment and retention of American Indians, Blacks, Hispanics, and women in quantitative study and careers as a means of alleviating the current and projected shortage of qualified American nationals in the scientific, engineering, and technological (SET) work force.

Wilberforce University Intervention Activities:

In Fall of 1989 and Spring of 1990, Wilberforce University conducted two intervention programs for college students pursuing dual degrees in engineering and mathematics, science or computer science. The Fall intervention focused on mathematics courses in which the students were enrolled; the Spring intervention focused on the technical communications course in which students were enrolled that semester. Intervention activities included tutoring, computer-assisted tutorials, counseling, seminars including study strategies sessions, personal development workshops, lectures, field trips, and membership in the National Society of Black Engineers for each student. Participants were college students pursuing dual degrees; most participants were Black.

Findings:

- The most effective components were those seeming to be more psychosocial than academic in nature. Specifically:
- The field trips and counseling components of the intervention were positively correlated with both performance and opinion.
- The seminars were related positively to performance.
- Tutoring was not related to performance, and was negatively correlated with opinion.
- The intervention was particularly successful, both in the performance and opinion areas, for those students growing up without many academic support items in the home (daily newspapers, calculators, desks etc.).

Recommendations:

- This intervention demonstrates that, particularly for students from less affluent backgrounds, a psychosocially-based approach may be more effective than a more academic approach.
- This is one of several CASET interventions that demonstrate the effectiveness of field trips for students. Field trips, including the travel experience as well as viewing scientists at work, seem to make the possibility of life as a scientist real and accessible for students who may not have had a sense of access to this life.

# PART III

# CASE STUDY OF THE WILBERFORCE UNIVERSITY

# 1989 FALL SEMESTER INTERVENTION

## ABSTRACT

In the fall of 1989 Wilberforce University, Wilberforce, Ohio, initiated and tested against a control group an intervention program designed to enhance the mathematics skills of dual-degree engineering students. Participants were 38 Black undergraduate college students (24 women and 14 men) enrolled in Basic Math, Introductory Algebra, or College Algebra. Intervention-group students were dual-degree majors; control-group students were not dual-degree-seeking, but were majors in a variety of SET- and non-SET-related fields. The intervention was repeated in the spring of 1990.

The Wilberforce University program is part of a research study being conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, Austin, Texas, under funding from the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

*HYPOTHESES:* Hypotheses were that the intervention would: (a) enhance performance in mathematics courses, and (b) enhance opinions about science, engineering, and technology (SET) fields and careers.

*COMPONENTS:* Major components of the nine-week intervention were mathematics tutoring sessions conducted by advanced mathematics students, counseling sessions, motivational seminars, lectures by scientists and engineers, and field trips to local industries. In addition, each intervention-group student gained membership into the National Society of Black Engineers.

*DATA:* All the participants furnished demographic data through the CASET College Student Protocol. All participants were administered CASET Opinion Protocols (two weeks after the intervention began and again at the end of the program). Other data collected were mathematics midterm grades, mathematics final exam grades, national standardized test scores, e.g., SAT and ACT scores, semester GPAs, and attendance at program activities.

The outcome measure of performance was the mathematics final exam grade. The early measure of performance was the mathematics midterm grade.

*RESEARCH DESIGN:* Analysis of demographic measures indicated differences between the two groups in the number of academic support items in subjects' homes and amount of parental reading. Because there were no true premeasures of performance or opinion, subsequent data analyses were performed in a nonequivalent control group design using support items and parental reading as premeasures. Additional analyses adjusted for SAT/ACT math scores and mathematics midterm grades.

*FINDINGS:* The intervention had some positive effect on the participants and can be considered successful in that performance and opinion were enhanced for certain students in the sample. After adjusting for preexisting group differences, performance and opinion analyses indicated that, in general, the intervention had a moderately positive effect on performance and a smaller effect on opinion. More specifically, both performance and opinion were enhanced for those intervention-group students with few academic support items in their homes--a key target group for intervention work. The findings suggest that counseling and field trips were successful components, seminars were less so, and student tutoring was unsuccessful.

## DESCRIPTION OF THE INTERVENTION

Dual-degree students pursuing science or mathematics degrees from Wilberforce University and engineering or computer science degrees from the University of Dayton were offered an intervention focused on improving their performance in their respective mathematics classes. It was felt that improving mathematical skills for these students would aid them, not only in the current class, but also later, in their more advanced science and engineering classes.

Activities took place from October 3, 1989, to December 9, 1989. Components of the intervention were:

- Tutoring, including computer-assisted tutorials
- Counseling to reduce levels of frustration
- Seminars including study strategies sessions
- Personal development workshops
- Lectures by scientists and engineers
- Field trips to local industries: Honda Motor Plant and Wright Patterson Air Force Base
- Membership in the National Society of Black Engineers for each student

Students participating received tutoring in the following mathematics courses, in which they were enrolled (course number and name are shown):

- MATH 100 Basic Mathematics
- MATH 101 Introductory Algebra
- MATH 113 College Algebra

The CASET Project Director for this project at Wilberforce University was Jennie Hodges Sethna, Director of the Dual Degree Engineering and Computer Science Program. Mr. Tjioe H. Kwan, Associate Professor of Mathematics and Director of the Basic Math Program at Wilberforce University, served as Math Coordinator; Ms. Dianne T. Ingham, Director of the Special Services Program and Speech Laboratory Supervisor at Wilberforce, served as Study Strategies Coordinator and conducted the workshops and motivational seminars. Tutors in mathematics were recruited from Calculus II and Calculus III classes.

## METHOD

### Subjects

Participants were Black college students enrolled in the mathematics courses named above, and pursuing dual degrees in engineering (from the University of Dayton) and science or mathematics (from Wilberforce University). Control-group students were Black college students enrolled in the same mathematics courses. Control-group students were not dual-degree students, but were majoring in one of the following disciplines: mathematics, chemistry, physics, biology, computer information systems, accounting, finance, or health care administration.

Of the 51 students currently enrolled in the dual-degree program, 19 were selected to participate in this intervention. Students in the intervention and control groups were matched on sex, year in college, and section of a given mathematics course.

Thirteen intervention- and twelve control-group students were selected from the Basic Mathematics course (Mathematics 100); five intervention- and six control-group students from Introductory Algebra (Mathematics 101); and one intervention- and one control-group student from College Algebra (Mathematics 113).

In the intervention group, there were 12 females and 7 males. All of the intervention students were freshmen. The make-up of the control group in sex and year in college was the same as that of the intervention group.

## CASET Protocols and Other Instruments

Demographic and descriptive data about the subjects were developed through the CASET College Student Protocol, which also provided information on parental attitudes, students' needs and preferences, academic track, financial background, educational aspiration, career expectation, and academic support. This protocol is shown in Appendix A.

To assess attitudinal information relative to SET careers, CASET developed a 57-item Opinion Protocol. A review of the literature on underrepresented minorities in SET fields yielded a set of thirteen attitudinal variables thought to be significant in recruitment, retention, and performance in SET areas. CASET used these thirteen attitudinal variables as the basis for the Opinion Protocol. For each of the thirteen variables, several question items were developed, varying in directionality. Combining the question items for each variable gives a scalar measurement for that variable. Thus the completed Opinion Protocol provides a scale measuring each of the thirteen variables.

The Opinion Protocol question items, together with the scales (attitudinal variables) they represent, are shown in Appendix B.

The Opinion Protocol was administered twice: (a) two weeks after the start of the intervention, and (b) after the end of the intervention.

Performance and opinion were measured early and late in the intervention. The early measure of performance was the grade at midterm, which was based on work before and after the intervention began. The late measure of performance was the final exam grade. Semester GPA was an additional measure of academic performance. Both the early and late opinion measures were made with the CASET Opinion Protocol. Students provided demographic information on the College Student Protocol.

Intervention faculty provided all grades for intervention- and control-group students; examinations, scoring, and grade assignments were developed by the University mathematics faculty. Examinations and grading systems were the same for intervention and control-group students.

## Procedure

At the beginning of the intervention, control and intervention group members signed informed consent forms and transcript release forms. The first measures of opinion, performance, and demographic information were made in mid-October 1989, and the final measures of opinion and performance were made in mid-December 1989. At the end of the intervention, the CASET Opinion Protocol was administered to all students along with the faculty-generated final examinations in the respective mathematics courses.

Intervention faculty graded the mathematics final examination and forwarded to CASET those grades for the intervention students along with assigned cumulative grades in mathematics courses at midterm, and the completed CASET instruments. The college also supplied college transcripts for intervention and control students, and documentation of the extent of participation by each student in each component of the intervention, such as the number of seminars and the number of tutoring sessions attended by each student.

The items of the Opinion Protocol were coded by CASET according to the thirteen scales they represent. Scoring of the positively worded items on the Opinion Protocol was reversed so that scores could be totaled meaningfully (see Appendix B). The scales were organized into three constructs - SET Goal, Environmental Support, and Attitude as shown in Appendix C.

## RESULTS

Methodological Issues

This intervention had no preintervention assessment of opinion and performance for all participants (control and intervention students), but had two measures of opinion and performance: (a) an early measure made after about two weeks of the intervention, and (b) a late measure made after the intervention. Thus the design was a posttest-only design with two measurement times, one during and one after the intervention.

This type of pre-experimental design has several weaknesses (Cook and Campbell, 1979): group differences may be due to the intervention or, alternately, to preexisting differences between the groups, to differential withdrawal from the groups, or to interactions between preexisting characteristics and maturation. Some of these potential problems can be verified, but some cannot and therefore weaken the causal conclusions that can be drawn.

A design that would allow for stronger causal conclusions--the nonequivalent control group design--can be constructed if a pre-intervention measure of performance and opinion can be found. Such a design would still retain one weakness: the possible interaction between preexisting characteristics and maturation. In this intervention, two preexisting characteristics that were related to performance and opinion were used, subject to two considerations: (a) the characteristics would be used in an analysis of covariance (ANCOVA) to improve the likelihood of detecting a group difference, and (b) the characteristics would reduce any group differences that existed prior to the intervention via statistical adjustment.

One potential source of preintervention measures was the Student Protocol's demographic characteristics; these variables were tested for group differences, and two that differed between groups (the number of academic support items in the home and the amount that parents read) were selected as the preintervention measures. The eight support items were a desk, a daily newspaper, encyclopedia, typewriter, calculator, television, computer, and a video cassette recorder (VCR).

The variable used as the preintervention measure of support items in the home was the total number of those eight items that the student reported had been in his or her home while growing up. The amount that their parents read was reported by the students as "none," "some," or "a lot." A nonequivalent control group design was constructed using number of support items and amount of parents' reading as the preintervention measures.

Additionally, 60 percent of the students had standardized test scores in math (SAT or ACT). For this subsample, these test scores constituted an additional preintervention measure for analysis.

The analyses of the performance measures followed this plan: (a) the performance measures during and after the intervention were tested for group differences; (b) the performance measures during and after the intervention were tested for group differences with an adjustment for number of support items and parents' reading which would remove some preexisting influences from the intervention's effects; (c) because a substantial percentage of students reported SAT or ACT math scores, these scores' percentiles were included as an additional adjustment in an analysis of performance differences between groups with stronger causal ramifications; (d) a fourth set of analyses adjusted for midsemester grades, number of support items, and amount of parental reading to determine whether the groups differed due to the effects of the intervention after midsemester; and (e) a final set of analyses tested whether postintervention performance

measures were correlated with the degree of participation in the four components of the intervention. If all or most of the results of these analyses converged on the same conclusions about the effects of the intervention, the causal conclusions would be strengthened. The opinion analyses followed an abbreviated version of this same analytic plan.

## Demographic Results

The comparability of the intervention and control groups was examined by testing for differences on the items of the College Student Protocol. The complete results are given in Appendix B. Of the 96 comparisons, the groups differed on only two: (a) the intervention group reported a greater number of support items in their homes (7.00 vs. 6.16 out of a possible 8) and (b) the intervention group students reported that their parents read more than did the control group students (95 percent vs. 58 percent read a lot). (A third apparent difference, that the intervention group had more SET majors--100 percent vs. 26 percent--emerged because the biomedical areas are not defined as SET fields in the CASET research.)

Though only two differences emerged (support items and parents' reading), both favored the intervention group and suggested that the intervention group may have had an advantage over the control group prior to the intervention.

## Performance Measures

*Effects of class on performance.* Before analysis of the midterm grades, final exam grades, and semester GPAs for group differences, an additional variable--the student's math class--was tested for significant influences. As described above, students were enrolled in one of three classes--MATH 100, MATH 101, and MATH 113. Because of small enrollment sizes, students enrolled in MATH 113 were not included in this analysis. The three performance measures--midterm grade, final exam grade and semester GPA--were analyzed to test for a difference between the classes and between the intervention groups. Analyses for these three variables indicated that the two classes did not differ, nor did class membership interact with group membership (see Table 1). The effects of the intervention remained significant (at the one-tailed probability level) for the midterm grade and the final exam grade.

**Table 1**

**PERFORMANCE AS A FUNCTION OF GROUP AND CLASS**

| MEASURE | SOURCE OF VARIATION | SUM OF SQUARES | DF | MEAN SQUARE | F | SIG. p |
|---|---|---|---|---|---|---|
| MIDTERM GRADE | MAIN EFFECTS | 3.086 | 2 | 1.543 | 1.206 | ns |
| | GP | 3.041 | 1 | 3.041 | 2.376 | <.10 |
| | CLASS | .016 | 1 | .016 | .013 | ns |
| | 2way Interactions | 1.676 | 1 | 1.676 | 1.310 | ns |
| | GP CLASS | 1.676 | 1 | 1.676 | 1.310 | ns |
| | Explained | 4.762 | 3 | 1.587 | 1.240 | |
| | Residual | 37.117 | 29 | 1.280 | | |
| | Total | 41.879 | 32 | 1.309 | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| FINAL EXAM | MAIN EFFECTS | 4.673 | 2 | 2.337 | 1.326 | ns |
| | GP | 4.460 | 1 | 4.460 | 2.530 | <.10 |
| | CLASS | .127 | 1 | .127 | .072 | ns |
| | 2way Interactions | 2.271 | 1 | 2.271 | 1.288 | ns |
| | GP CLASS | 2.271 | 1 | 2.271 | 1.288 | ns |
| | Explained | 6.944 | 3 | 2.315 | 1.313 | ns |
| | Residual | 51.117 | 29 | 1.763 | | |
| | Total | 58.061 | 32 | 1.814 | | |
| SEMESTER GPA | MAIN EFFECTS | 1.990 | 2 | .995 | 1.480 | ns |
| | GP | 0.780 | 1 | .780 | 1.160 | ns |
| | CLASS | 1.112 | 1 | 1.112 | 1.654 | ns |
| | 2way Interactions | .004 | 1 | .004 | .006 | ns |
| | GP CLASS | .004 | 1 | .004 | .006 | ns |
| | Explained | 1.994 | 3 | .665 | .989 | ns |
| | Residual | 19.498 | 29 | .672 | | |
| | Total | 21.492 | 32 | .672 | | |

*Group comparisons of performance.* The group's performances at midterm, on the final exam, and for semester GPA were compared via t-tests, given in Table 2. The intervention group outperformed the control group on the midterm grade, the final exam, and semester GPA; the magnitude of the advantage averaged .6 of a standard deviation. If the groups had been formed via random assignment, these results would argue in favor of a positive outcome caused by the intervention. However, preintervention differences may have persisted throughout the intervention and been reflected in these measures; the subsequent analyses examined this possibility.

**Table 2**

**GROUP COMPARISONS OF PERFORMANCE MEASURES**

| MEASURE | GROUP | N | MEAN | SD | t-TEST (df) | SIG.P | d |
|---|---|---|---|---|---|---|---|
| Midterm Grade | Control | 19 | 1.42 | 1.22 | 2.24 | ≤.05 | .69 |
| | Intervention | 19 | 2.26 | 1.10 | (36) | | |
| Final Exam Grade | Control | 17 | 1.29 | 1.45 | 2.06 | ≤.05 | .64 |
| | Intervention | 18 | 2.22 | 1.22 | (33) | | |
| Semester GPA | Control | 19 | 2.11 | .97 | 1.91 | ≤.05 | .54 |
| | Intervention | 19 | 2.63 | .69 | (36) | | |

NOTE: d is a measure of effect size, computed as the difference between the intervention and control groups' means, divided by the control group's standard deviation.

For pretest comparisons, the computed statistics were compared to critical values for two-tailed probabilities because there was no hypothesized direction for preexisting differences. For the posttest comparisons, the hypothesis that the intervention group would exceed the control group permitted the more sensitive test of a directional hypothesis using the one-tailed probability level.

*Performance adjusted for support items and parents' reading.* A second test of group differences in performance was made, adjusting for the number of support items and parental reading in an ANCOVA via hierarchical regression. The results, presented in Table 3, indicated that the intervention group outperformed the control group on the midterm grade; the groups were not significantly different on the final exam and the semester's GPA after controlling for variations in

number of support items and parental reading. However, for each performance measure, the effects of the intervention interacted with support, indicating that the level of support and group membership were interrelated in their effects on performance. These significant interactions were interpreted according to the Johnson-Neyman technique (Rogosa, 1980).

The table of hierarchical ANCOVA results (adapted from Cohen & Cohen, 1975) presents the results from adding the first and each subsequent variable to the multiple regression equation and the resulting significance test of the variable's contribution to explaining the dependent variable.

**Table 3**

**HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON PERFORMANCE MEASURES COVARYING SUPPORT ITEMS AND PARENTS' READING**

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES MODELS* | Cumul. $R^2$ | $Sr^2$ | $F(Sr^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| MIDTERM GRADE | SUPPORT | .0594 | .0594 | 2.15 | 1,34 | <.10 |
| | +PARENTS' READING | .1398 | .0804 | 3.08 | 1,33 | ≤.05 |
| | +GROUP | .1944 | .0546 | 2.17 | 1,32 | ≤.10 |
| | +SUPPORT-x-GROUP | .2683 | .0740 | 3.13 | 1,31 | ≤.05 |
| | +PREADING-x-GROUP | .2813 | .0129 | 0.54 | 1,30 | ns |
| FINAL EXAM GRADE | SUPPORT | .0418 | .0418 | 1.35 | 1,31 | ns |
| | +PARENTS' READING | .2732 | .2314 | 9.55 | 1,30 | ≤.01 |
| | +GROUP | .3040 | .0308 | 1.28 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .4010 | .0970 | 4.53 | 1,28 | ≤.05 |
| | +PREADING-x-GROUP | .4010 | .0000 | 0.00 | 1,27 | ns |
| SEMESTER GPA | SUPPORT | .0790 | .0790 | 2.91 | 1,31 | ≤.05 |
| | +PARENTS' READING | .1399 | .0610 | 2.34 | 1,30 | ≤.10 |
| | +GROUP | .1659 | .0260 | 1.00 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .3055 | .1396 | 6.23 | 1,28 | ≤.01 |
| | +PREADING-x-GROUP | .3062 | .0006 | 0.03 | 1,27 | ns |

All models were analyzed as one-tailed tests.

* Five models of independent variable were tested for each dependent variable: (1) SUPPORT alone; (2) SUPPORT with '+' PARENTS' READING; (3) SUPPORT with PARENTS READING with '+' GROUP; (4) SUPPORT with PARENTS' READING with GROUP with SUPPORT-by-GROUP INTERACTION '-x-'; (5) SUPPORT with PARENTS' READING with GROUP with SUPPORT-by-GROUP INTERACTION with PREADING-by-GROUP INTERACTION.

NOTE: $Sr^2$ is the proportion of variance attributed to the last entered independent variable: $F(Sr^2)$ is the value for the test of significance for that proportion of variance.

The columns of the table are the cumulative percentage of explained variance (cum $R^2$), added contribution in explained variance of the variable ($sR^2$), F test of the contribution of the new variable, and the degrees of freedom for the test. Because the hypothesis was directional--improvement for the intervention group--the test statistics were compared to one-tailed probability levels; for F statistics, this involved converting from the F to t statistic (F = t2) and determining the corresponding one-tailed critical value.

The significant group-by-support interaction indicated that the regression lines for support and performance differed between control and intervention students. According to the Johnson-Neyman technique, the interaction is interpreted by determining the intersection point of the lines, the 95 percent confidence interval around the intersection, and the ranges of scores for which the groups performed differently.

The significant interactions of the effects of number of support items in the home and group membership on performance are graphed in Figures 1 - 3. Each figure shows the group regression lines that related support items to performance; the three figures are similar, and they converge on the finding that for students with fewer support items in the home, the intervention was related to significantly higher math performance. The analysis of performance covarying support items and parental reading found a significantly higher level of performance for the intervention group on the midterm grade; significant interactions indicated that for students with fewer support items, the intervention was especially helpful.

**Figure 1**

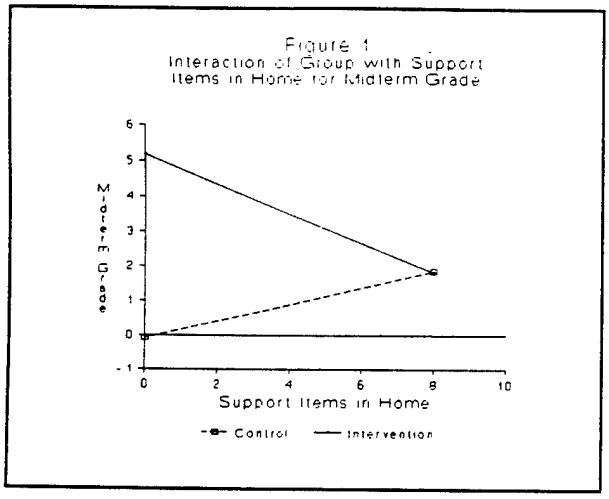



**Figure 2**

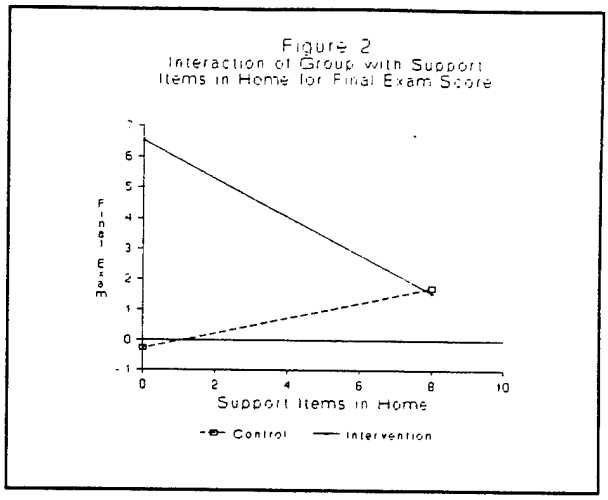
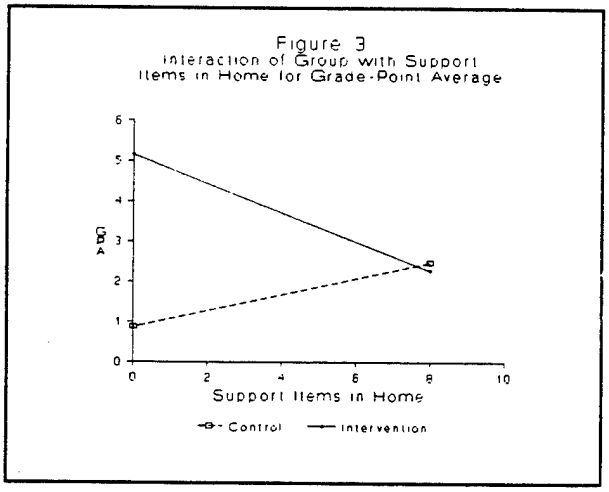



**Figure 3**




*Performance adjusted for support items, parents' reading, and math aptitude.* A third test of group differences in performance adjusted for the number of support items, amount of parental reading, and standardized math aptitude test score percentile in an ANCOVA via hierarchical regression. These analyses used all students who had standardized math test scores, a 60 percent subsample. The results in Table 4 indicated that the subsample of students with standardized test scores outperformed the other students on each of the three performance measures, that the intervention group

outperformed the control group when the effect of having a standardized test score was separated out, and that the effect of having the standardized test score was the same for control and intervention groups, i.e., group and pretest did not interact significantly.

**Table 4**

**A COMPARISON OF STUDENTS WITH AND WITHOUT STANDARDIZED MATH SCORES - PERFORMANCE AS A FUNCTION OF GROUP AND PRETEST SCORE**

| MEASURE | SOURCE OF VARIATION | SUM OF SQUARES | DF | MEAN SQUARE | F | SIG. p |
|---|---|---|---|---|---|---|
| MIDTERM GRADE | MAIN EFFECTS | 14.083 | 2 | 7.042 | 6.684 | ≤.01 |
| | GP | 4.579 | 1 | 4.579 | 4.347 | ≤.05 |
| | PRETEST | 9.230 | 1 | 9.230 | 8.761 | ≤.01 |
| | 2way Interactions | .229 | 1 | .229 | .217 | ns |
| | GP PRETEST | .229 | 1 | .229 | .217 | ns |
| | Explained | 14.312 | 3 | 4.771 | 4.528 | ≤.01 |
| | Residual | 32.659 | 31 | 1.054 | | |
| | Total | 46.971 | 34 | 1.382 | | |
| FINAL EXAM GRADE | MAIN EFFECTS | 18.032 | 2 | 9.016 | 5.811 | ≤.01 |
| | GP | 7.165 | 1 | 7.165 | 4.618 | ≤.05 |
| | PRETEST | 10.501 | 1 | 10.501 | 6.768 | ≤.01 |
| | 2way Interactions | .041 | 1 | .041 | .026 | ns |
| | GP PRETEST | .041 | 1 | .041 | .026 | ns |
| | Explained | 18.073 | 3 | 6.024 | 3.883 | ≤.01 |
| | Residual | 48.098 | 31 | 1.552 | | |
| | Total | 66.171 | 34 | 1.946 | | |
| SEMESTER GPA | MAIN EFFECTS | 5.090 | 2 | 2.545 | 3.679 | ≤.05 |
| | GP | 2.065 | 1 | 2.065 | 2.985 | ≤.05 |
| | PRETEST | 2.921 | 1 | 2.921 | 4.223 | ≤.05 |
| | 2way Interactions | .662 | 1 | .662 | .957 | ns |
| | GP PRETEST | .662 | 1 | .662 | .957 | ns |
| | Explained | 5.751 | 3 | 1.917 | 2.771 | ≤.05 |
| | Residual | 21.445 | 31 | .692 | | |
| | Total | 27.197 | 34 | .800 | | |

* p≤.05 (one-tailed)
** p≤.01 (one-tailed)

Thus, the ANCOVA results adjusting for support, parental reading, and preintervention math aptitude were based on a 60 percent subsample of the groups that were the better math students; the results are presented in Table 5.

Table 5

HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON PERFORMANCE MEASURES COVARYING MATH APTITUDE, SUPPORT, AND PARENTS' READING

| DEPENDENT VARIABLE | INDEPENDENT VARIABLES MODELS* | Cumul. $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| MIDTERM GRADE | MATH APTITUDE | .1657 | .1657 | 3.97 | 1,20 | ≤.05 |
| | +SUPPORT | .2205 | ..0548 | 1.33 | 1,19 | ns |
| | +PARENTS' READING | .2638 | .0433 | 1.06 | 1,18 | ns |
| | +GROUP | .3594 | .0956 | 2.54 | 1,17 | ≤.10 |
| | +MATHAPT-x-GROUP | .3750 | .0156 | 0.40 | 1,16 | ns |
| | +SUPPORT-x-GROUP | .3949 | .0199 | 0.49 | 1,15 | ns |
| FINAL EXAM GRADE | MATH APTITUDE | .1637 | .1637 | 3.92 | 1,20 | ≤.05 |
| | +SUPPORT | .2157 | .0520 | 1.26 | 1,19 | ns |
| | +PARENTS' READING | .3384 | .1288 | 3.34 | 1,18 | ≤.05 |
| | +GROUP | .3980 | .0596 | 1.68 | 1,17 | ns |
| | +MATHAPT-x-GROUP | .3989 | .0009 | 0.02 | 1,16 | ns |
| | +SUPPORT-x-GROUP | .4738 | .0748 | 2.13 | 1,15 | ≤.10 |
| SEMESTER GPA | MATH APTITUDE | .1388 | .1388 | 3.22 | 1,20 | ≤.05 |
| | +SUPPORT | .1832 | .0441 | 1.03 | 1,19 | ns |
| | +PARENTS' READING | .1849 | .0017 | 0.04 | 1,18 | ns |
| | +GROUP | .1980 | .0131 | 0.28 | 1,171,1 | ns |
| | +MATHAPT-x-GROUP | .2152 | .0172 | 0.35 | 6 | ns |
| | +SUPPORT-x-GROUP | .3372 | .1220 | 2.76 | 1,15 | ≤.10 |

All models were analyzed as one-tailed tests.

Six models of independent variable were tested for each dependent variable: (1) math aptitude alone; (2) math aptitude with '+' support; (3) math aptitude '+' support '+' parents' reading; (4) math aptitude '+' support '+' parents' reading '+' group; (5) math aptitude '+' support '+' parents' reading '+' group '+' mathapt-by-group interaction; (6) math aptitude '+' support '+' parents' reading '+' group '+' mathapt-by-group interaction '+' support-by-group interaction.

NOTE: $sR^2$ is the proportion of variance attributed to the last entered independent variable; $F(sR^2)$ is the value for the test of significance for that proportion of variance.

The results for the subsample covarying math aptitude paralleled the results of Table 3, except that the interaction between support and group intervention remained significant for final exam and GPA, but not for midterm grade. This analysis used only 60 percent of the students in the two groups (only those with ACT or SAT scores), but this smaller sample with preintervention math measures permitted stronger causal inferences than did the larger sample considered without a preintervention measure. The trade-off was that the analyses included fewer students, which lowered the chances of finding significant differences. These results, taken together with the analyses reported above, argue persuasively that the intervention contributed to higher performance on the midterm for all students, and to higher performance on the final exam and GPA for students with fewer support items in the home.

*Performance adjusted for support and midterm grade.* A fourth test of group differences examined differences between the groups on the final exam and for semester grades after removing the influences of midterm grade, number of support items, and parents' reading. These analyses tested for effects of the eight weeks of the intervention after midterm, removing effects on performance of preexisting differences, events in the beginning of the semester, and the first two weeks of the intervention. The results are presented in Table 6.

Table 6

| HIERARCHICAL ANALYSIS OF COVARIANCE TESTING FOR GROUP EFFECTS ON PERFORMANCE MEASURES COVARYING MIDTERM GRADE, SUPPORT, AND PARENTS' READING | | | | | | |
|---|---|---|---|---|---|---|
| **DEPENDENT VARIABLE** | **INDEPENDENT VARIABLES MODELS** | **Cumul. $R^2$** | **$sR^2$** | **$F(sR^2)$** | **df** | **Sig. p** |
| FINAL EXAM GRADE | MIDTERM GRADE | .7672 | .7672 | 102.18 | 1,31 | ≤.01 |
| | +SUPPORT | .7673 | .0000 | 0.00 | 1,30 | ns |
| | +PARENTS' READING | .7931 | .0258 | 3.61 | 1,29 | ≤.05 |
| | +GROUP | .7953 | .0022 | 0.31 | 1,28 | ns |
| | +MIDTERM-x-GROUP | .7964 | .0010 | 0.14 | 1,27 | ns |
| | +SUPPORT-x-GROUP | .8153 | .0189 | 2.66 | 1,26 | ≤.10 |
| | +PREADING-x-GROUP | .8214 | .0062 | 0.86 | 1,25 | ns |
| SEMESTER GPA | MIDTERM GRADE | .4270 | .4270 | 25.34 | 1,34 | ≤.01 |
| | +SUPPORT | .4428 | .0158 | 0.94 | 1,33 | ns |
| | +PARENTS' READING | .4482 | .0054 | 0.32 | 1,32 | ns |
| | +GROUP | .4487 | .0005 | 0.03 | 1,31 | ns |
| | +MIDTERM-x-GROUP | .4527 | .0040 | 0.22 | 1,30 | ns |
| | +SUPPORT-x-GROUP | .5005 | .0477 | 2.77 | 1,29 | ≤.10 |
| | +PREADING-x-GROUP | .5101 | .0096 | 0.55 | 1,28 | ns |

The results from Table 6 indicated that the support-by-group interaction remained a significant influence on final exam and GPA after adjusting for midterm grades and support. These findings are compelling because the analysis adjusted for differences at midterm which removed preexisting differences and the early influence of the intervention. The consistent findings were that the intervention had significant effects on midterm grades, and the group-by-support interaction influenced performance on all three measures, helping intervention students with fewer support items.

*Performance correlated with participation.* A final set of analyses correlated the level of participation in the intervention's components with scores on the midterm grade, final exam, and semester GPA. The correlations are given in Table 7.

From the correlations' significance tests, it appears that attendance at seminars and counseling was correlated positively with performance. Field trip attendance was significantly related to GPA only, and attendance at tutoring sessions was not significantly related to any measure of performance. When the correlations between performance and attendance for the 10 students with standardized test scores were examined, the same pattern emerged with slight changes, i.e., seminar, field trip, and counseling participation were significantly related to all performance measures, and tutoring was not related to any performance measure.

**Table 7**

| PERFORMANCE CORRELATED WITH DEGREE OF PARTICIPATION IN THE INTERVENTION COMPONENTS | | | | |
|---|---|---|---|---|
| **PERFORMANCE MEASURE** | **SEMINARS r Sig. p** | **TUTORING r Sig. p** | **FIELD TRIPS r Sig. p** | **COUNSELING r Sig. p** |
| MIDTERM GRADE | .46 ≤.10 | .20 ns | .29 ns | .54 ≤.05 |
| FINAL EXAM GRADE | .47 ≤.10 | .05 ns | .35 ns | .53 ≤.05 |
| SEMESTER GPA | .68 ≤.01 | -.09 ns | .48 ≤.10 | .49 ≤.10 |
| NOTE: The Pearson correlation coefficients were computed on 15 cases - all analyzed as two-tailed tests. | | | | |

Opinion Measures

The analyses of the opinion measures followed a similar but briefer scheme than that used for performance: (a) the opinion measures during and after the intervention were tested for group differences; (b) a second set of analyses adjusted for midsemester opinion, number of support items, and amount of parental reading to determine whether the groups differed due to the effects of the intervention after midsemester; and (c) a third set of analyses tested whether postintervention opinion measures were correlated with the degree of participation in the four components of the intervention. If the results of these analyses converged on the same conclusions about the effects of the intervention, the causal conclusions would be strengthened.

*Group comparisons of opinion.* Table 8 compares the groups' midterm and final scores on the opinion measures. At midterm, the intervention group had higher opinion scores on several measures related to the SET Goal construct: Value, Self-Concept, and Aspiration. After the intervention, the intervention group had a higher score on one opinion measure--Academic Support. All four differences favored the intervention group. Because the groups were not formed by random assignment, these differences after the intervention may have been due to the intervention or to preexisting differences between the groups; therefore, ANCOVAs using midterm opinion, number of support items in the home, and amount of parental reading as covariates were conducted.

**Table 8**

| GROUP DIFFERENCES ON OPINION CONSTRUCTS AND SCALES. | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CONSTRUCT/Scale** | **TEST** | **CONTROL** | | **INTERVENTION** | | **t-Test** | **Sig.p** |
| | | **Mean** | **SD** | **Mean** | **SD** | | |
| OPINION, Total | Midtest | 2.94 | 0.30 | 3.07 | 0.26 | 1.40 | ns |
| | Post | 2.96 | 0.30 | 2.97 | 0.29 | 0.10 | ns |

GROUP DIFFERENCES ON OPINION CONSTRUCTS AND SCALES.

| CONSTRUCT/Scale | TEST | CONTROL | | INTERVENTION | | t-Test | Sig.p |
|---|---|---|---|---|---|---|---|
| | | Mean | SD | Mean | SD | | |
| SET GOAL | Midtest | 3.06 | 0.31 | 3.25 | 0.30 | 1.93 | ≤.10 |
| | Post | 3.11 | 0.36 | 3.16 | 0.31 | 0.51 | ns |
| Value | Midtest | 3.21 | 0.57 | 3.51 | 0.35 | 1.98 | ≤.10 |
| | Post | 3.45 | 0.43 | 3.30 | 0.33 | -1.21 | ns |
| Cultural Value | Pre | 3.53 | 0.35 | 3.43 | 0.38 | -0.77 | ns |
| | Post | 3.46 | 0.37 | 3.45 | 0.41 | -0.12 | ns |
| Self-Concept | Midtest | 2.76 | 0.54 | 3.02 | 0.39 | 1.73 | ≤.10 |
| | Post | 2.78 | 0.48 | 2.97 | 0.44 | 1.29 | ns |
| Aspiration | Midtest | 2.91 | 0.41 | 3.14 | 0.41 | 1.72 | ≤.10 |
| | Post | 2.96 | 0.48 | 3.05 | 0.47 | 0.62 | ns |
| ATTITUDE | Midtest | 2.85 | 0.36 | 2.94 | 0.32 | 0.78 | ns |
| | Post | 2.85 | 0.32 | 2.80 | 0.34 | -0.47 | ns |
| Math/Science Attitude | Midtest | 2.97 | 0.32 | 3.12 | 0.39 | 1.28 | ns |
| | Post | 2.98 | 0.35 | 3.00 | 0.42 | 0.13 | ns |
| Locus of Control | Midtest | 3.34 | 0.48 | 3.18 | 0.45 | -1.11 | ns |
| | Post | 3.22 | 0.41 | 3.12 | 0.54 | -0.63 | ns |
| Persistence | Midtest | 3.00 | 0.60 | 3.03 | 0.42 | 0.16 | ns |
| | Post | 2.85 | 0.61 | 2.76 | 0.40 | 0.50 | ns |
| Study Habits | Midtest | 2.71 | 0.33 | 2.64 | 0.41 | -0.59 | ns |
| | Post | 2.73 | 0.29 | 2.67 | 0.36 | -0.56 | ns |
| Anxiety | Midtest | 2.46 | 0.67 | 2.75 | 0.59 | 1.38 | ns |
| | Post | 2.58 | 0.64 | 2.51 | 0.62 | -0.35 | ns |
| ENVIRONMENTAL SUPPORT | Midtest | 2.93 | 0.42 | 3.03 | 0.24 | 0.95 | ns |
| | Post | 2.94 | 0.34 | 3.00 | 0.33 | 0.55 | ns |
| Academic Support | Midtest | 2.98 | 0.69 | 3.19 | 0.39 | 1.16 | ns |
| | Post | 2.96 | 0.47 | 3.21 | 0.39 | 1.75 | ≤.05 |
| Career Awareness | Midtest | 3.06 | 0.32 | 3.21 | 0.39 | 1.29 | ns |
| | Post | 2.96 | 0.38 | 3.12 | 0.39 | 1.27 | ns |
| Role Model | Midtest | 2.69 | 0.74 | 2.72 | 0.60 | 0.12 | ns |
| | Post | 2.81 | 0.61 | 2.74 | 0.77 | -0.34 | ns |
| Equal Opportunity | Midtest | 2.98 | 0.49 | 3.03 | 0.40 | 0.30 | ns |
| | Post | 3.04 | 0.38 | 2.95 | 0.48 | -0.63 | ns |

All midtests were analyzed as two-tailed tests. All posttests were analyzed as one-tailed tests.
NOTE: Midtest n's: Control = 19; Intervention = 19.
Posttests n's: Control = 18; Intervention = 19.
Note: "SET" stands for "Science, Engineering, and Technology."

*Final opinion adjusted for midterm, support items, and parents' reading.* As part of the nonequivalent control group design, the number of support items in the home and parental reading were used as covariates in analyses to examine the effects of group membership on postintervention opinion scores. Table 9 presents the adjusted, postintervention opinion results.

The intervention and control groups differed on seven opinion measures: Overall Opinion, SET Goal Construct, Value, Attitude Construct, Persistence, Anxiety, and Academic Support. The control group had higher scores on all of these except Academic Support.

**Table 9**

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING MIDTERM OPINION, SUPPORT ITEMS, AND PARENTS' READING**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS | Cumul . $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| OPINION, Overall | MIDTERM OPINION | .7057 | .7057 | 79.12 | 1,33 | ≤.01 |
| | +SUPPORT | .7110 | .0053 | 0.59 | 1,32 | ns |
| | +PARENTS' READING | .7401 | .0291 | 3.47 | 1,31 | ≤.05 |
| | +GROUP | .7763 | .0362 | 4.86 | 1,30 | ≤.05 |
| | +MIDTERM-x-GROUP | .7805 | .0042 | 0.56 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .8032 | .8032 | 3.22 | 1,28 | ≤.10 |
| | +PREADING-x-GROUP | .8378 | .8378 | 5.76 | 1,27 | ≤.05 |
| SET GOAL | MIDTERM OPINION | .5833 | .5833 | 48.59 | 1,33 | ≤.01 |
| | +SUPPORT | .5999 | .0044 | 0.35 | 1,32 | ns |
| | +PARENTS' READING | .6285 | .0286 | 2.39 | 1,31 | ≤.10 |
| | +GROUP | .6575 | .0290 | 2.54 | 1,30 | ≤.10 |
| | +MIDTERM-x-GROUP | .6699 | .0124 | 1.09 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .6886 | .0187 | 1.68 | 1,28 | ns |
| | +PREADING-x-GROUP | .6891 | .0005 | 0.04 | 1,27 | ns |
| Value | MIDTERM OPINION | .1212 | .1212 | 4.55 | 1,33 | ≤.05 |
| | +SUPPORT | .1263 | .0051 | 0.19 | 1,32 | ns |
| | +PARENTS' READING | .2254 | .0991 | 3.97 | 1,31 | ≤.05 |
| | +GROUP | .3988 | .1734 | 8.65 | 1,30 | ≤.01 |
| | +MIDTERM-x-GROUP | .3989 | .0002 | 0.01 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .3990 | .0000 | 0.00 | 1,28 | ns |
| | +PREADING-x-GROUP | .4114 | .0124 | 0.57 | 1,27 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING MIDTERM OPINION, SUPPORT ITEMS, AND PARENTS' READING**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS | Cumul . $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Cultural Value | | | | | | |
| | MIDTERM OPINION | .4496 | .4496 | 26.95 | 1,33 | ≤.01 |
| | +SUPPORT | .4844 | .0349 | 2.16 | 1,32 | ≤.10 |
| | +PARENTS' READING | .4983 | .0139 | 0.86 | 1,31 | ns |
| | +GROUP | .4983 | .0000 | 0.00 | 1,30 | ns |
| | +MIDTERM-x-GROUP | .5156 | .0173 | 1.04 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .5213 | .0057 | 0.33 | 1,28 | ns |
| | +PREADING-x-GROUP | .5302 | .0089 | 0.51 | 1,27 | ns |
| Self-Concept | | | | | | |
| | MIDTERM OPINION | .4338 | .4338 | 25.28 | 1,33 | ≤.01 |
| | +SUPPORT | .4348 | .0010 | 0.06 | 1,32 | ns |
| | +PARENTS' READING | .4972 | .0624 | 3.85 | 1,31 | ≤.05 |
| | +GROUP | .4972 | .0000 | 0.00 | 1,30 | ns |
| | +MIDTERM-x-GROUP | .4972 | .0001 | 0.00 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .5635 | .0663 | 4.25 | 1,28 | ≤.05 |
| | +PREADING-x-GROUP | .5636 | .0000 | 0.00 | 1,27 | ns |
| Aspiration | | | | | | |
| | MIDTERM OPINION | .5514 | .5514 | 40.56 | 1,33 | ≤.01 |
| | +SUPPORT | .5538 | .0024 | 0.17 | 1,32 | ns |
| | +PARENTS' READING | .5705 | .0168 | 1.21 | 1,31 | ns |
| | +GROUP | .5836 | .0131 | 0.94 | 1,30 | ns |
| | +MIDTERM-x-GROUP | .5837 | .0001 | 0.01 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .5889 | .0052 | 0.35 | 1,28 | ns |
| | +PREADING-x-GROUP | .5971 | .0082 | 0.55 | 1,27 | ns |
| ATTITUDE | | | | | | |
| | MIDTERM OPINION | .6297 | .6297 | 56.11 | 1,33 | ≤.01 |
| | +SUPPORT | .6320 | .0023 | 0.20 | 1,32 | ns |
| | +PARENTS' READING | .6602 | .0283 | 2.58 | 1,31 | ≤.10 |
| | +GROUP | .7079 | .0476 | 4.89 | 1,30 | ≤.05 |
| | +MIDTERM-x-GROUP | .7130 | .0051 | 0.52 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .7180 | .0051 | 0.50 | 1,28 | ns |
| | +PREADING-x-GROUP | .8148 | .0967 | 14.10 | 1,27 | ≤.01 |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING MIDTERM OPINION, SUPPORT ITEMS, AND PARENTS' READING**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS | Cumul . $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Math/Science Attitude | | | | | | |
| | MIDTERM OPINION | .5648 | .5648 | 42.83 | 1,33 | ≤.01 |
| | +SUPPORT | .5658 | .0010 | 0.07 | 1,32 | ns |
| | +PARENTS' READING | .5687 | .0029 | 0.21 | 1,31 | ns |
| | +GROUP | .5847 | .0160 | 1.15 | 1,30 | ns |
| | +MIDTERM-x-GROUP | .5849 | .0002 | 0.01 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .5849 | .0000 | 0.00 | 1,28 | ns |
| | +PREADING-x-GROUP | .6055 | .0206 | 1.41 | 1,27 | ns |
| Locus of Control | | | | | | |
| | MIDTERM OPINION | .0968 | .0968 | 3.54 | 1,33 | ≤.05 |
| | +SUPPORT | .1257 | .0289 | 1.06 | 1,32 | ns |
| | +PARENTS' READING | .1654 | .0397 | 1.48 | 1,31 | ns |
| | +GROUP | .2001 | .0347 | 1.30 | 1,30 | ns |
| | +MIDTERM-x-GROUP | .2286 | .0285 | 1.07 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .2385 | .0099 | 0.36 | 1,28 | ns |
| | +PREADING-x-GROUP | .3388 | .1002 | 4.09 | 1,27 | ≤.05 |
| Persistence | | | | | | |
| | MIDTERM OPINION | .5052 | .5052 | 33.69 | 1,33 | ≤.01 |
| | +SUPPORT | .5252 | .0200 | 1.35 | 1,32 | ns |
| | +PARENTS' READING | .5326 | .0074 | 0.49 | 1,31 | ns |
| | +GROUP | .5660 | .0334 | 2.31 | 1,30 | ≤.10 |
| | +MIDTERM-x-GROUP | .5905 | .0245 | 1.73 | 1,29 | ≤.10 |
| | +SUPPORT-x-GROUP | .6185 | .0280 | 2.06 | 1,28 | ≤.10 |
| | +PREADING-x-GROUP | .6187 | .0002 | 0.02 | 1,27 | ns |
| Study Habits | | | | | | |
| | MIDTERM OPINION | .2308 | .2308 | 9.90 | 1,33 | ≤.01 |
| | +SUPPORT | .2328 | .0020 | 0.08 | 1,32 | ns |
| | +PARENTS' READING | .2329 | .0001 | 0.00 | 1,31 | ns |
| | +GROUP | .2335 | .0006 | 0.02 | 1,30 | ns |
| | +MIDTERM-x-GROUP | .2476 | .0141 | 0.54 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .2477 | .0001 | 0.01 | 1,28 | ns |
| | +PREADING-x-GROUP | .2501 | .0023 | 0.08 | 1,27 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING MIDTERM OPINION, SUPPORT ITEMS, AND PARENTS' READING**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS | Cumul . $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Anxiety | | | | | | |
| | MIDTERM OPINION | .6218 | .6218 | 54.26 | 1,33 | ≤.01 |
| | +SUPPORT | .6624 | .0406 | 3.85 | 1,32 | ≤.05 |
| | +PARENTS' READING | .6918 | .0293 | 2.95 | 1,31 | ≤.05 |
| | +GROUP | .7488 | .0570 | 6.81 | 1,30 | ≤.01 |
| | +MIDTERM-x-GROUP | .7539 | .0051 | 0.60 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .7539 | .0001 | 0.01 | 1,28 | ns |
| | +PREADING-x-GROUP | .8531 | .0992 | 18.24 | 1,27 | ≤.01 |
| ENVIRONMENTAL SUPPORT | | | | | | |
| | MIDTERM OPINION | .6102 | .6102 | 51.66 | 1,33 | ≤.01 |
| | +SUPPORT | .6135 | .0032 | 0.27 | 1,32 | ns |
| | +PARENTS' READING | .6334 | .0199 | 1.68 | 1,31 | ns |
| | +GROUP | .6376 | .0042 | 0.35 | 1,30 | ns |
| | +MIDTERM-x-GROUP | .6673 | .0297 | 2.59 | 1,29 | ≤.10 |
| | +SUPPORT-x-GROUP | .7055 | .0382 | 3.63 | 1,28 | ≤.05 |
| | +PREADING-x-GROUP | .7067 | .0012 | 0.11 | 1,27 | ns |
| Academic Support | | | | | | |
| | MIDTERM OPINION | .4580 | .4580 | 27.88 | 1,33 | ≤.01 |
| | +SUPPORT | .4590 | .0010 | 0.06 | 1,32 | ns |
| | +PARENTS' READING | .4704 | .0115 | 0.67 | 1,31 | ns |
| | +GROUP | .5066 | .0362 | 2.20 | 1,30 | ≤.10 |
| | +MIDTERM-x-GROUP | .5284 | .0218 | 1.34 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .5289 | .0005 | 0.03 | 1,28 | ns |
| | +PREADING-x-GROUP | .5518 | .0229 | 1.38 | 1,27 | ns |
| Career Awareness | | | | | | |
| | MIDTERM OPINION | .2520 | .2520 | 11.11 | 1,33 | ≤.01 |
| | +SUPPORT | .3044 | .0525 | 2.41 | 1,32 | ≤.10 |
| | +PARENTS' READING | .3321 | .0276 | 1.28 | 1,31 | ns |
| | +GROUP | .3329 | .0009 | 0.04 | 1,30 | ns |
| | +MIDTERM-x-GROUP | 3341 | .0012 | 0.05 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .3499 | .0157 | 0.68 | 1,28 | ns |
| | +PREADING-x-GROUP | 3733 | .0234 | 1.01 | 1,27 | ns |

**HIERARCHICAL ANALYSIS OF COVARIANCE OF FINAL OPINION MEASURES COVARYING MIDTERM OPINION, SUPPORT ITEMS, AND PARENTS' READING**

| FINAL OPINION CONSTRUCT/ Scale | INDEPENDENT VARIABLES MODELS | Cumul . $R^2$ | $sR^2$ | $F(sR^2)$ | df | Sig. p |
|---|---|---|---|---|---|---|
| Role Model | | | | | | |
| | MIDTERM OPINION | .5286 | .5286 | 37.00 | 1,33 | ≤.01 |
| | +SUPPORT | .5288 | .0002 | 0.02 | 1,32 | ns |
| | +PARENTS' READING | .5583 | .0295 | 2.07 | 1,31 | ≤.10 |
| | +GROUP | .5642 | .0059 | 0.40 | 1,30 | ns |
| | +MIDTERM-x-GROUP | .6040 | .0398 | 2.91 | 1,29 | ≤.05 |
| | +SUPPORT-x-GROUP | .6474 | .0434 | 3.45 | 1,28 | ≤.05 |
| | +PREADING-x-GROUP | .6539 | .0065 | 0.51 | 1,27 | ns |
| Equal Opportunity | | | | | | |
| | MIDTERM OPINION | .1658 | .1658 | 6.56 | 1,33 | ≤.01 |
| | +SUPPORT | .1741 | .0084 | 0.32 | 1,32 | ns |
| | +PARENTS' READING | .1882 | .0141 | 0.54 | 1,31 | ns |
| | +GROUP | .2157 | .0275 | 1.05 | 1,30 | ns |
| | +MIDTERM-x-GROUP | .2166 | .0009 | 0.03 | 1,29 | ns |
| | +SUPPORT-x-GROUP | .2751 | .0586 | 2.26 | 1,28 | ≤.10 |
| | +PREADING-x-GROUP | .3730 | .0979 | 4.22 | 1,27 | ≤.05 |

All models were analyzed as one-tailed tests.

Note: $sR^2$ is the proportion of variance attributed to the last entered independent variable, and $F(sR^2)$ is the test of significance for that proportion of variance.

**Figure 4**

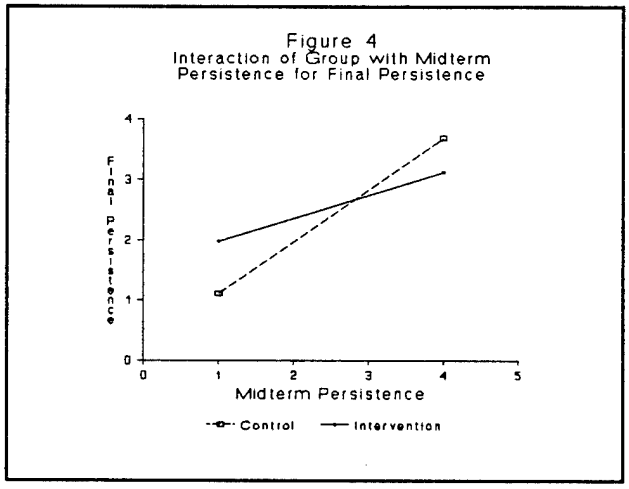
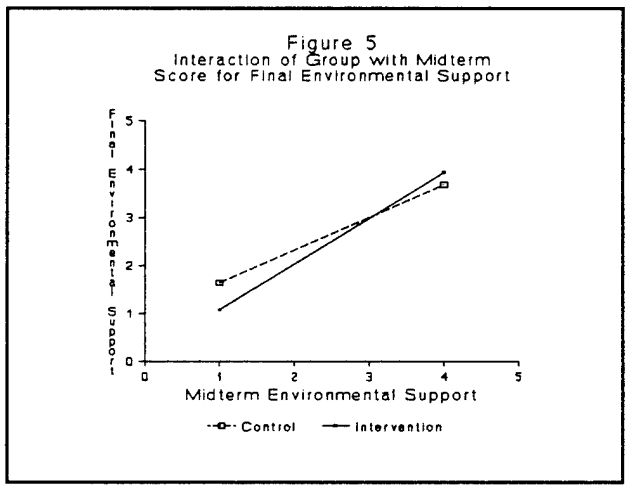



**Figure 5**




In addition to these overall differences, there were 14 significant interactions between group membership and midterm opinion score, support items, or parental reading. These interactions are given in Figures 4 - 17.

Figures 4, 5, and 6 graph the interactions between midterm opinion scores and final opinion scores for three opinion measures: Persistence, Environmental Support, and Role Model; midterm scores interacted with group membership for these three variables, affecting students with low midterm scores differently in the two groups. Figure 4 indicates that for students with lower than average Persistence at midterm, the intervention group had higher final Persistence scores than did the control group.

**Figure 6**

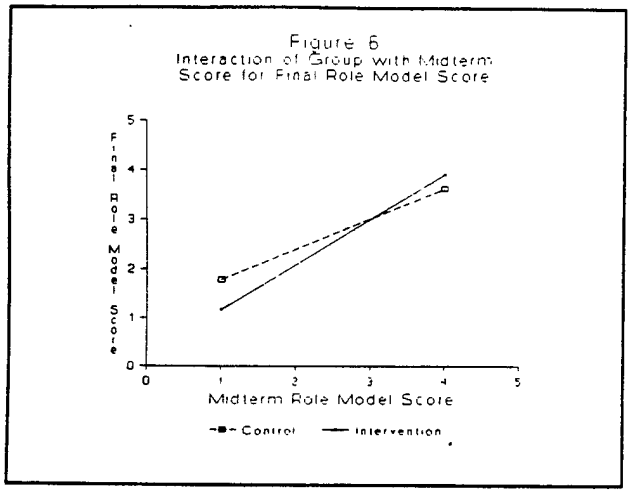
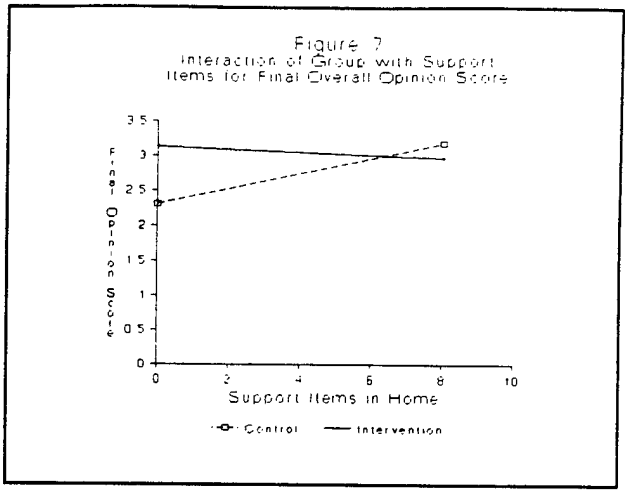



**Figure 7**




Figures 5 and 6 are similar, and they depict interactions that favored control over intervention students with lower midterm Environmental Support and Role Model scores. The findings for the midterm-by-group interaction were mixed: intervention students did better on Persistence, but control students did better on the Environmental Support and Role Model variables.

**Figure 8**

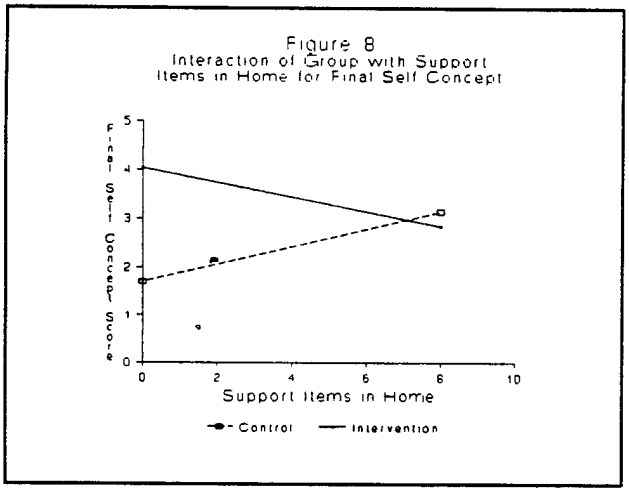
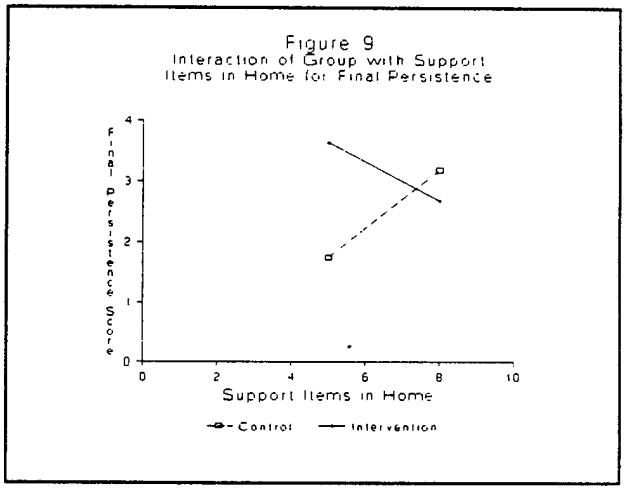



**Figure 9**




Figures 7 through 12 depict interactions between number of support items in the home and final opinion scores for six opinion measures. The interactions all point to the same conclusion: the intervention significantly enhanced students' final opinions if the student had few support items in the home. The measures that showed this interaction were Overall Opinion, Self-Concept, Persistence, Environmental Support, Role Model, and Equal Opportunity.

Figure 10

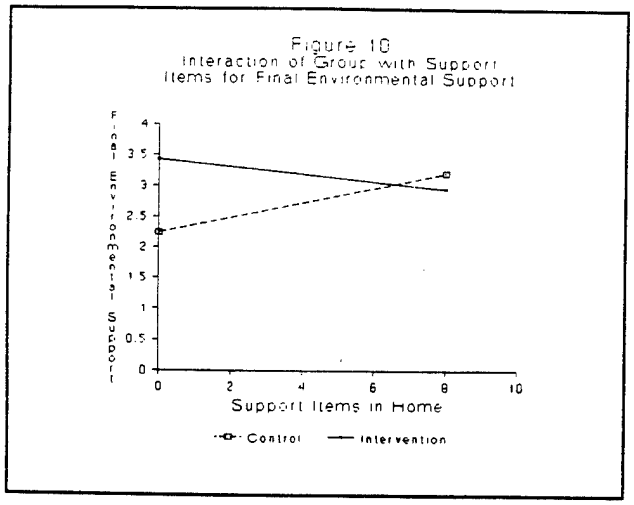



Figure 11

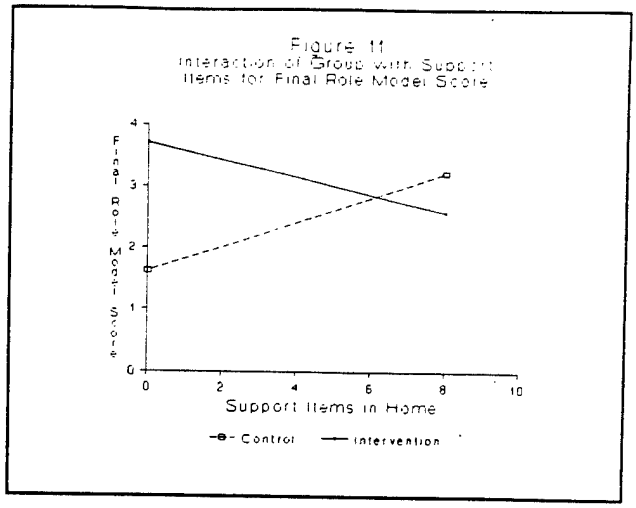



Figure 12

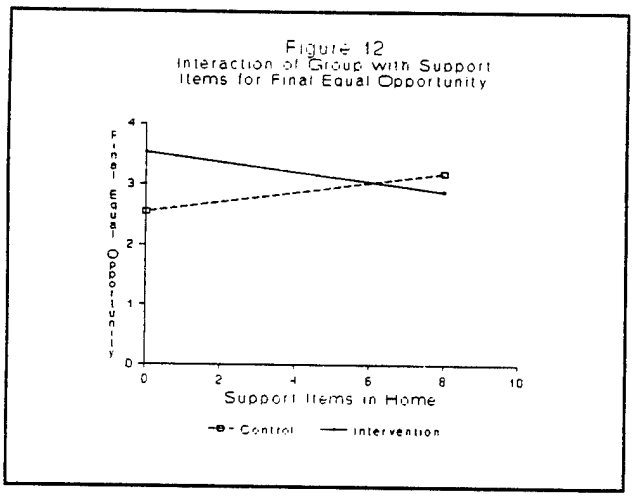
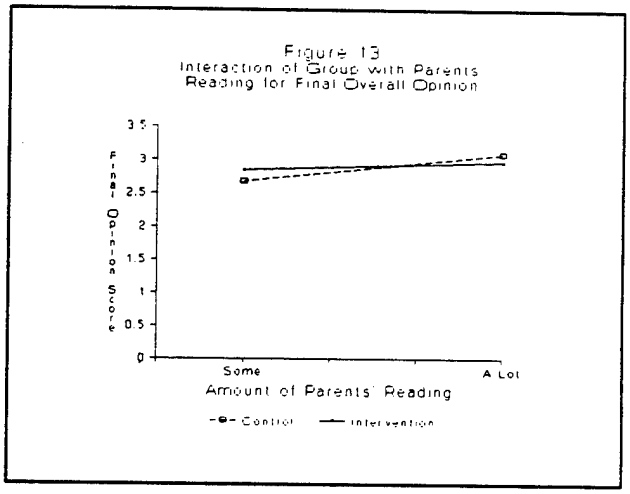



Figure 13




The student-reported amount of reading by parents interacted with group membership for five opinion measures, as shown in figures 13 through 17. Four of these interactions indicated that students whose parents read some (not a lot) did better in one group or the other: (a) figures 13 and 17 show that intervention students whose parents read some had higher scores on the Overall Opinion and Equal Opportunity measures than did similar control students; and (b) figures 15 and 16 indicate that control students whose parents read some had higher scores on Locus of Control and Anxiety measures (control students had lower levels of anxiety). Figure 14 indicates that control students whose parents read a lot had higher Attitude Construct scores than did similar intervention students. The findings for the interactions of parents' reading and group membership on the opinion measures were mixed: four interactions pertained to students of parents who read some; two of the interactions favored intervention students and two favored control students; an additional interaction between parental reading and group membership favored control students among those whose parents read a lot.

**Figure 14**

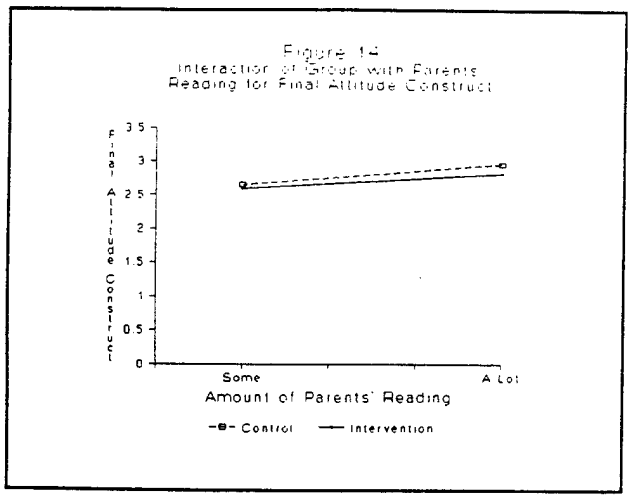



**Figure 15**

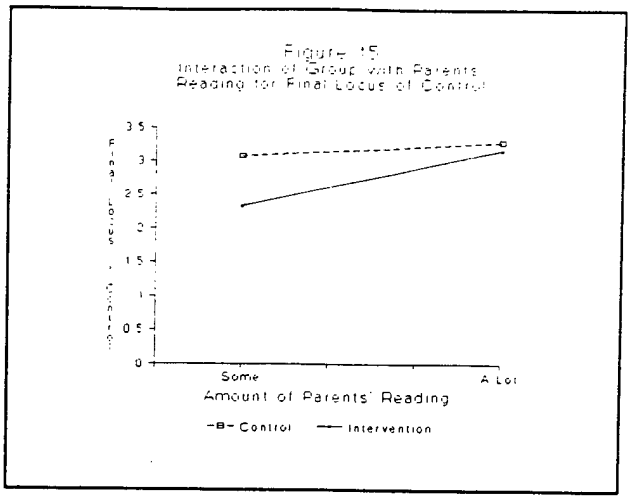



**Figure 16**

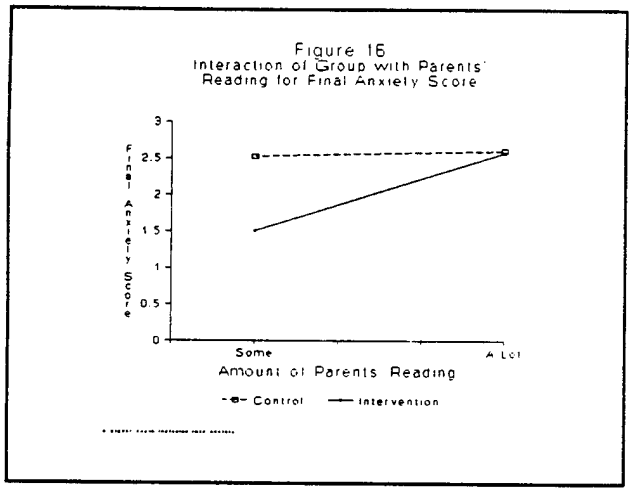
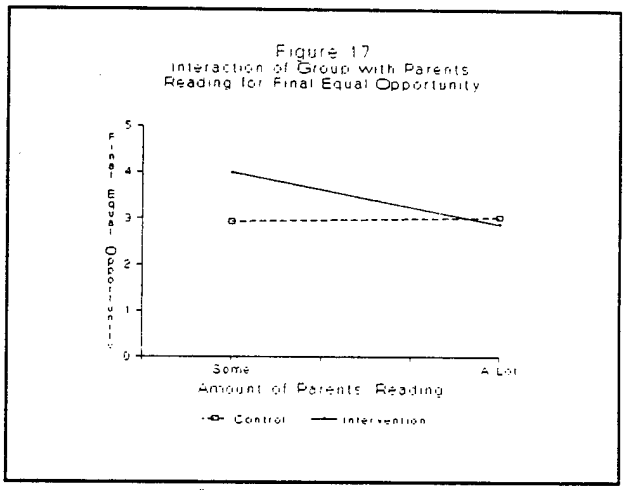



**Figure 17**




In summary, the effects of the intervention on opinion were mixed: (a) of seven significant differences between the groups, six favored the control group; (b) all six interactions between group membership and number of support items in the home favored intervention students with fewer support items; and (c) other significant interactions were equally divided among some favoring intervention and some favoring control students whose parents read some but not a lot.

*Opinion correlated with participation.* Correlations of postintervention opinion measures with levels of participation in the components of the intervention are given in Table 10. From an examination of the correlations, it seems that greater participation in the field trips and in counseling were related to more positive opinion scores, while greater participation in tutoring was related to lower opinion scores. There was no clear relationship between seminars and opinion. Combined with the correlations between participation and performance, it seemed that the field trips and counseling were successful (positively correlated with performance and opinion), the seminars were somewhat successful (positively related to performance and not related to opinion), and the tutoring was not successful (not related to performance and

negatively correlated with opinion). The advantages of the control group in the postintervention opinion measures may have been partly the result of the tutoring that the intervention students attended.

**Table 10**

**POST-OPINION MEASURES CORRELATED WITH DEGREE OF PARTICIPATION IN THE INTERVENTION COMPONENTS[a]**

| OPINION CONSTRUCT/Scale | Seminars | Tutoring | Field Trips | Counseling |
|---|---|---|---|---|
| OPINION, Total | -.13 | -.11 | .43 p≤.05 | .25 |
| SET GOAL | .14 | -.52 p≤.05 | .39 | .33 |
| Value | -.03 | -.66 p≤.01 | -.04 | -.11 |
| Cultural Value | .26 | -.13 | .56 p≤.05 | .18 |
| Self Concept | -.11 | -.44 | -.09 | .07 |
| Aspiration | .25 | -.22 | .55 p≤.05 | .53 p≤.05 |
| ATTITUDE | -.09 | -.14 | .22 | .15 |
| Math/Science Attitude | -.24 | -.03 | .05 | .04 |
| Locus of Control | .10 | -.13 | .16 | .20 |
| Persistence | .10 | -.53 p≤.01 | .24 | .29 |
| Study Habits | .30 | .16 | .63 p≤.01 | .53 p≤.05 |
| Anxiety | -.20 | -.24 | -.30 | -.12 |
| Environmental Support | -.17 | -.24 | .22 | .33 |
| Academic Support | .16 | -.02 | .36 | .37 |
| Career Awareness | .00 | -.19 | .33 | .35 |
| Role Model | -.01 | -.30 | . 02 | .29 |
| Equal Opportunity | -.50 p≤.05 | .04 | .00 | -.18 |

[a] All two-tailed tests.

NOTE: r, the Pearson correlation coefficients, were computed on 16 cases.

*Summary of intervention effect sizes.* The general effects of the intervention may be seen more clearly by examining the effect sizes of the various analyses of performance and opinion measures, given in Table 11. According to a rule of thumb for effect sizes (Cohen, 1977), .2 is a small effect, .5 is a medium-sized effect, and .8 is a large effect. The intervention had a moderate effect on performance after adjusting for group differences on preexisting characteristics. When final exam scores were adjusted for preexisting characteristics and midterm grades, the overall benefits of the intervention were small; however, the intervention did benefit students with fewer academic support items in the home.

For opinion, the overall effects of the intervention appear to be negligible; the mean effect sizes for the final opinion measures, with or without adjustments for midterm and preexisting covariates, were not significantly different from zero. Overall, the intervention seemed to have lowered the Value of SET careers, but increased the sense of Academic Support; other positive effects of the intervention on opinion did occur for students with fewer support items in the home.

**Table 11**

| EFFECT SIZES | | | | |
|---|---|---|---|---|
| **VARIABLE** | **Midtest** | **Posttest** | **Posttest: Covar. A** | **Posttest: Covar. B** |
| **PERFORMANCE** (Mean) | 0.31 | 0.87 | 0.40 | 0.12 |
| Midterm Grade | | 1.03 | 0.49 | |
| Final Exam | | 0.70 | 0.39 | 0.19 |
| Semester GPA | | 0.88 | 0.33 | 0.06 |
| **OPINION** (Mean) | 0.31 | 0.05 | | -0.09 |
| Value | 0.91 | -0.40 | | -0.99 |
| Cultural Value | -0.35 | -0.04 | | 0.00 |
| Self-Concept | 0.79 | 0.42 | | 0.00 |
| Aspiration | 0.79 | 0.20 | | 0.33 |
| Math/Science Attitude | 0.59 | 0.10 | | 0.28 |
| Locus of Control | -0.51 | -0.21 | | -0.39 |
| Persistence | 0.07 | 0.16 | | 0.51 |
| Study Habits | -0.27 | -0.18 | | -0.05 |
| Anxiety | 0.63 | -0.12 | | -0.88 |
| Academic Support | 0.53 | 0.58 | | 0.50 |
| Career Awareness | 0.59 | 0.42 | | 0.07 |
| Role Model | 0.06 | -0.11 | | -0.21 |
| Equal Opportunity | 0.14 | -0.21 | | -0.35 |

The measure of effect size is in pooled standard deviation units calculated according to Johnson (1989). A positive sign indicates that the intervention group outperformed the control group; a negative sign indicates that the control group had the higher score.
Note: "Covar. A" (Covariates A) refers to adjusting the variable for support and parental reading; "Covar. B" (Covariates B) refers to adjusting for midterm score, support, and parental reading.

## DISCUSSION

The intervention's goals were to improve math performance and enhance opinions as they relate to math and science fields. In both respects, the findings indicate partial success. A closer look suggests some quite specific successes.

Two findings about the effects of the intervention are particularly interesting:

1. For students with fewer support items in the home, the intervention appears to have been successful in enhancing performance and opinion. For other students, it had little effect on performance, and may have had a negative effect on opinion.

2. Looking at the relative contributions of the different components of the intervention, it seems that the field trips and counseling were successful (positively correlated with performance and opinion), the seminars were somewhat successful (positively related to performance and not related to opinion), and the tutoring was not successful (not related to performance and negatively correlated with opinion).

The performance of the intervention participants as a whole shows little effect associated with the intervention. During the course of the intervention, their opinions in the areas measured by the Opinion Protocol became more negative. However, for those students whose homes included fewer support items (daily newspapers, calculators, desks, etc.) while they were growing up, the intervention was associated with positive changes both in performance and in opinion.

Furthermore, we find that the components associated with these positive changes are those which seem to be more psychosocial than academic in nature. Counseling and seminars seem to improve performance; field trips help to a lesser extent. Only tutoring seems to make no contribution to enhanced performance. Positive changes in opinion are associated with field trips and counseling, while greater participation in the tutoring (by student tutors) was related to *lower* opinion scores.

We can only speculate about the reasons the intervention seems to have been effective for the low-support group of students. However, if this effect is replicated in the further semesters of intervention at Wilberforce, this will be an important finding because these students represent a key target group for intervention work. It is clear that we need to harvest SET majors and workers from groups which have not been a particularly productive source in the past, and those students from homes which might be described as "academically deprived" would seem to be one such group.

The fact that low-support students' performance improved during the semester--their overall grade point average, as well as their performance in the courses that were the specific focus of the intervention--indicates that their performance before the intervention was short of their capacity. If the counseling and other activities of the intervention help them to more fully realize their potential and lead to success in SET-area study, then something of real value to this group and to the society at large has occurred.

The findings reported here suggest that counseling was the most effective component in this intervention, followed by field trips. Seminars may enhance performance, but they have no effect on opinion. Tutoring as offered in this intervention seems to have had only negative value.

It should be noted in this context that the tutoring in this intervention was performed by student tutors. Whether a different sort of tutoring program would have yielded the same results is a subject for further research.

Whether or not tutoring might ever have a positive effect for this low-support-item group, the current study indicates that the psychosocial elements of counseling and field trips, as well as the seminars on study skills, were helpful. Why these elements were helpful for the low-support-item group, but not for the students as a whole, is an interesting question. The lower number of academic support items in the home may indicate a home orientation that is less academic. Perhaps the counseling, field trips, and seminars develop a more academic peer group for the students, who

now find themselves operating in an environment in which those around them expect and value academic success. By the same token, tutoring could then have a negative effect because of its association with remediation, with needing help.

If these findings are replicated in the next semester of intervention at Wilberforce University, this will strengthen the finding that counseling and field trips, and perhaps seminars, are effective techniques for students from homes with fewer academic support items in the home. A further test would be to develop an intervention based on these components alone, and to offer that intervention to a population of students from homes with fewer support items. This replication would ameliorate the major weakness of the nonequivalent control group design's internal validity: possible interaction between preexisting characteristics and maturation.

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## SOURCES

Population figures, geographical data, and other background information reported in the CASET Consortium reports were drawn from the following sources:

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Documents supplied by CASET consortium institutions: baseline reports, research proposals, college catalogs, and bulletins

# APPENDICES

# APPENDIX A

# COLLEGE STUDENT PROTOCOL

## College Student Protocol

1. Sex:
   ___ a. Male
   ___ b. Female

2. When were you born? ____ ____ ____
   month day year

3. Ethnicity/race:
   ___ a. Anglo
   ___ b. Black
   ___ c. Asian American
   ___ d. Am. Indian (Please specify the tribe which best describes your heritage.) _____
   ___ e. Hispanic Which of the following best describes your heritage?
      ___ a. Cuban-American
      ___ b. Mexican-American
      ___ c. Puerto Rican
      ___ d. Other Specify _____
   ___ f. Other Specify _____

4. Are you a United States citizen?
   ___ a. Yes
   ___ b. No

5. Name of your school: _____

6. Class:
   ___ a. College freshman
   ___ b. College sophomore
   ___ c. College junior
   ___ d. College senior
   ___ e. Other (e.g., special or temporary student, etc.)
      Specify _____

7. Have you declared a college major?
   ___ a. No
   ___ b. Yes ..... Please specify your major. _____

8. Have you taken any advanced placement tests for college credit?
   ___ a. No
   ___ b. Yes ..... Please list tests taken. _____

9. As you see your situation at the present time, how much higher education do you expect to get? (Check only one)
   ___ a. Two years of college
   ___ b. Four years of college
   ___ c. One or more years after college
   ___ d. Other Specify _____

10. Who has influenced you the most in your studies? (Check only one)
   ___ a. My parent(s)
   ___ b. Another family member
   ___ c. A teacher
   ___ d. A counselor
   ___ e. A minister
   ___ f. A friend
   ___ g. A professional in a science-related occupation
   ___ h. A professional in another occupation
   Specify occupation _____
   ___ i. No one at all

11. What will be your sources of financial support during the coming year while you are in school? (Check all that apply)

   ___ a. Parent(s) or guardian(s)
   ___ b. Wife or husband
   ___ c. Work-study
   ___ d. Job other than work-study
   ___ e. Tuition or other scholarship
   ___ f. Loan
   ___ g. Previous personal earnings and savings
   ___ h. GI Bill, ROTC, or other governmental assistance (other than scholarship or loan)
   ___ i. Family trust fund, insurance plan, or other similar arrangement
   ___ j. Other Specify _____

12. You may want to receive help outside your regular college course work. If so, check the letter for each area in which you may want help. (Check all that apply)
   ___ a. Counseling about educational plans and opportunities
   ___ b. Counseling about career plans and opportunities
   ___ c. Improving mathematical ability
   ___ d. Finding part-time work
   ___ e. Counseling about personal problems
   ___ f. Increasing reading ability
   ___ g. Developing good study habits
   ___ h. Improving writing ability

13. What is or was the occupation of the person(s) with whom you lived during the years you were growing up? (Please be specific: "a telephone operator," not "works for the phone company"; "a cashier," not "works in a store"; "a homemaker," not "works at home")

   _____ _____

14. Would you say that your family's income is:
___ a. Below the U.S. average
___ b. About average
___ c. Above average

15. Are you:
___ a. An only child (skip to question 17)
___ b. The oldest child
___ c. The youngest child
___ d. An in-between child

16. How many brothers and sisters do you have?
___ a. One
___ b. Two
___ c. Three or more

17. What was the highest level of school your father completed? (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

18. Indicate the extent of your mother's education. (Check only the highest)
___ a. Grade school or less
___ b. Some high school but did not graduate
___ c. High school graduate
___ d. Some college but no degree
___ e. College degree or more

19. What was the language spoken most often by adults in the household where you grew up? (Check only one)
___ a. English
___ b. Spanish
___ c. The language of my tribe .... What is that language? _____
___ d. Other
Specify _____

20. Which of the following did your parent(s)/guardian(s) ever do during your years in school? (Check all that apply)
___ a. Attend Parent-Teacher Association (PTA) meetings
___ b. Attend parent-teacher conferences
___ c. Visit your classes
___ d. Phone or visit your teacher, counselor, or principal when you had a problem
___ e. Do volunteer work such as fund-raising or assisting with school projects
___ f. Assist you in course selection
___ g. Help you with your homework

21. Which of the following comes closest to describing your parent(s)/guardian(s)?
___ a. Do(es) not read at all
___ b. Sometimes read(s)
___ c. Read(s) a lot

22. Which of the following comes closest to describing you?
___ a. Do not read at all
___ b. Sometimes read
___ c. Read a lot

23. How many of these do you have in your family home? (Check all that apply)
___ a. A desk
___ b. Daily newspaper
___ c. Encyclopedia or other reference books
___ d. Typewriter
___ e. Pocket calculator
___ f. Television
___ g. Computer
___ h. Video cassette recorder (VCR)

24. From what kind of high school or secondary school did you graduate?
___ a. Public high school
___ b. Private or religious
___ c. No formal high school (e.g., GED)

25. Were you a member of any math and/or science clubs, societies, or associations at your high school?
___ a. No
___ b. Yes.....Please list the math and/or science clubs you belonged to.

_____

_____

_____

_____

26. Have you ever taken part in any of these activities? (Check all that apply)
___ a. Math and science clubs
___ b. Field trip to science museum, laboratory, or other place where scientists work
___ c. Watching science programs on TV
___ d. A talk by a scientist
___ e. Science/math fair
___ f. Other science/math competition
___ g. Play or work in a computer lab

# APPENDIX B

# OPINION PROTOCOL WITH DIRECTIONALITY AND SCALES OF ITEMS

Legend:

| | |
|---|---|
| SH Study Habits | PS Persistence |
| AT Attitude toward math/science | CV Cultural Value |
| SC Self-Concept | AS Academic Support |
| AX Anxiety | AP Aspiration |
| VL Value | EO Equal Opportunity |
| LC Locus of Control | RM Role Model |
| CA Career Awareness | |

| # | Dir. | Scale | |
|---|---|---|---|
| 1 | + | SH | I study each day rather than just before exams. |
| 2 | + | AT | You have to be a lot smarter than average to be a scientist. |
| 3 | - | SC | I cannot imagine myself as an engineer or a scientist. |
| 4 | - | AX | Word problems in math make me nervous. |
| 5 | - | VL | There is little need for mathematics in most jobs. |
| 6 | + | VL | Science is of great importance to a country's development. |
| 7 | + | LC | When I make plans, I am almost certain I can make them work. |
| 8 | + | CA | There are many opportunities for women in engineering. |
| 9 | + | PS | Once I start something, I finish it. |
| 10 | + | CV | It matters to me to be considered a successful member of any ethnic/racial group. |
| 11 | - | SH | I prefer to study alone. |
| 12 | - | AT | Scientists do boring work. |
| 13 | + | AS | If I run into problems concerning school, I have someone who will listen to me and help me. |
| 14 | - | AX | Tests make me so nervous that I don't do as well on them as I could. |
| 15 | + | SH | I make it a point to get my assignments in on time. |
| 16 | - | SC | I could never understand physics. |
| 17 | - | AP | I don't want to take any more math courses. |
| 18 | - | CV | None of my friends have ever been good at math. |

| | | | |
|---|---|---|---|
| 19 | + | EO | Qualified people in my ethnic/racial group have as much chance as anyone else to get a science job. |
| 20 | - | PS | I find myself losing interest in my studies by the middle of the semester. |
| 21 | - | PS | I have trouble keeping my mind from wandering as I study. |
| 22 | + | EO | There is practically no discrimination against women in science jobs. |
| 23 | + | AP | I am seriously considering a career in science. |
| 24 | - | AT | Math is boring. |
| 25 | + | RM | Many people of my ethnic/racial group are successful scientists. |
| 26 | + | AP | I try to be one of the best students in my science classes. |
| 27 | - | LC | Success is more a matter of luck than of ability. |
| 28 | + | AT | Most scientists enjoy their work. |
| 29 | + | AT | I enjoy solving math problems. |
| 30 | + | VL | Mathematics comes in handy even outside of class. |
| 31 | - | AX | I feel tense when I have to work a math problem. |
| 32 | - | CA | I don't know what I'd need to do in order to become a scientist. |
| 33 | + | CA | There are lots of jobs I can do with a college degree in science. |
| 34 | - | AX | I dread taking tests even when I am reasonably well prepared. |
| 35 | + | SC | I feel I have the ability to learn more science. |
| 36 | - | SH | I only do as much as I have to in my science classes. |
| 37 | - | RM | I've never met an engineer. |
| 38 | - | VL | Science is not as important as people think. |
| 39 | + | SC | I am good at figuring out math problems. |
| 40 | + | AP | I want to improve my math skills. |
| 41 | + | AS | School counselors are a real help. |
| 42 | + | CV | In my ethnic/racial group, we think highly of someone who succeeds in a field like engineering. |
| 43 | - | AP | I would like to spend less of my school time studying science. |

| | | | |
|---|---|---|---|
| 44 | - | AS | My high school counselors would have preferred that I had taken basic math rather than algebra. |
| 45 | + | CV | My family cares a lot about education. |
| 46 | - | AT | Scientists tend to be unfriendly people. |
| 47 | - | AX | I worry about being able to understand my science assignments. |
| 48 | + | RM | There is an adult I look up to who is a scientist. |
| 49 | - | EO | Women are not as good in science as men are. |
| 50 | + | LC | The things that happen to me are my own doing. |
| 51 | - | SC | Most science courses are too hard for me. |
| 52 | - | PS | I often feel like quitting school. |
| 53 | - | AX | I am afraid I am not going to know the answer when I am called on in my math class. |
| 54 | + | AT | Science is interesting to me. |
| 55 | - | SC | I am not very good at math. |

56. List below the occupations you have considered for yourself in the future.

    i. _____

    ii. _____

    iii. _____

57. Please write a short paragraph describing the work you feel scientists do. If you don't know, just use your imagination. What would it be like to work as a scientist? How do you think a scientist spends a typical work day?

# APPENDIX C

# SCALES AND CONSTRUCTS OF THE OPINION PROTOCOL

| | QUESTION NUMBERS (See Appendix B) |
|---|---|
| **SET GOALS (SG)** | |
| Value | 5, 6, 30, 38 |
| Cultural Value | 10, 18, 42, 45 |
| Self Concept | 3, 16, 35, 39, 51, 55 |
| Aspiration | 17, 23, 26, 40, 43 |
| **ENVIRONMENTAL SUPPORT (SP)** | |
| Academic Support | 13, 41, 44 |
| Career Awareness | 8, 32, 33 |
| Role Model | 25, 37, 48 |
| Equal Opportunity | 19, 22, 49 |
| **ATTITUDE (AT)** | |
| Attitude Toward Math and Science | 2, 12, 24, 28, 29, 46, 54 |
| Locus of Control | 7, 27, 50 |
| Persistence | 9, 20, 21, 52 |
| Study Habits | 1, 11, 15, 36 |
| Anxiety | 4, 14, 31, 34, 47, 53 |

# APPENDIX D

# PERCENT RESPONSE ON ITEMS OF

# THE COLLEGE STUDENT PROTOCOL

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 19 | CONTROL n = 19 |
| 1. Sex | | |
| Women | 63% | 63% |
| Men | 37% | 37% |
| 6. Class | | |
| .Freshmen | 100% | 100% |
| 7. Declared SET majors | 100% | 26%[a] |
| 8. Students taken an advanced placement test | 11% | 11% |
| 9. Higher education expected: | | |
| .Two years of college | 0% | 5% |
| .Four years of college | 16% | 26% |
| .One or more years after college | 84% | 68% |
| 10. Studies most influenced by | | |
| .Parents | 79% | 79% |
| .Another family member | 0% | 5% |
| .Teacher | 0% | 0% |
| .Counselor | 5% | 0% |
| .Minister | 0% | 0% |
| .Friend | 0% | 0% |
| .Science professional | 5% | 0% |
| .Nonscience professional | 5% | 0% |
| .No one at all | 5% | 16% |
| 11. Sources of income | | |
| .Parents/guardians | 79% | 58% |
| .Spouse | 0% | 0% |
| .Work study | 58% | 74% |
| .Job other than work study | 5% | 21% |
| .Tuition or scholarship | 21% | 37% |
| .Loan | 63% | 47% |
| .Grant | 63% | 84% |
| .Personal savings | 16% | 11% |
| .GI Bill, ROTC, etc. | 0% | 0% |
| .Family trust, etc. | 0% | 0% |
| .Other | 5% | 5% |
| Number of sources of income * | 3.11 | 3.37 |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 19 | CONTROL n = 19 |
| 12. Student needs help in:[b] | | |
| .Counseling on educational plans | 37% | 11% |
| .Counseling on career plans | 47% | 47% |
| .Improving math ability | 58% | 58% |
| .Finding part-time work | 21% | 26% |
| .Counseling on personal problems | 0% | 0% |
| .Increasing reading ability | 21% | 21% |
| .Developing good study habits | 79% | 63% |
| .Improving writing ability | 53% | 42% |
| Number of areas needing help * | 3.16 | 2.68 |
| 13. Sources of outside income | | |
| .None | 5% | 26% |
| .One | 47% | 26% |
| .Two | 47% | 47% |
| 14. Family income: | | |
| .Below U.S. average | 37% | 16% |
| .About average | 32% | 26% |
| .Above average | 16% | 21% |
| .Unknown | 16% | 32% |
| 15. Birth order of student: | | |
| .Only child | 26% | 5% |
| .Oldest child | 21% | 26% |
| .Youngest child | 21% | 37% |
| .In-between child | 32% | 32% |
| 16. Number of siblings: | | |
| .None | 26% | 5% |
| .One | 16% | 42% |
| .Two | 21% | 21% |
| .Three or more | 37% | 32% |
| 17. Father's education: | | |
| .Grade school or less | 5% | 5% |
| .Some high school | 5% | 5% |
| .High school graduate | 53% | 26% |
| .Some college | 11% | 21% |
| .College degree or more | 21% | 32% |
| .Missing | 5% | 11% |
| 18. Mother's education: | | |
| .Grade school or less | 0% | 5% |
| .Some high school | 5% | 0% |
| .High school graduate | 26% | 26% |
| .Some college | 21% | 16% |
| .College degree or more | 47% | 47% |
| .Missing | 0% | 5% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 19 | CONTROL n = 19 |
| 19. Language spoken most at home: | | |
| .English | 95% | 100% |
| .Spanish | 0% | 0% |
| .Language of tribe | 0% | 0% |
| .Other | 0% | 0% |
| .Missing | 5% | 0% |
| 20. Parents involvement during student's years in school:[b] | | |
| .Attend PTA meetings | 68% | 47% |
| .Attend parent-teacher conferences | 84% | 68% |
| .Visit student's class | 53% | 53% |
| .Phone/visit if there's a problem | 68% | 63% |
| .Do volunteer work | 26% | 42% |
| .Assist student in course selection | 42% | 53% |
| .Assist in student's homework | 79% | 79% |
| Number of parental involvements * | 4.21 | 4.05 |
| 21. Parent(s) read: | | |
| .Not at all | 0% | 0% |
| .Sometimes | 5% | 32% |
| .A lot | 95% | 58% |
| .Missing | 0% | 11% |
| 22. Student reads: | | |
| .Not at all | 0% | 11% |
| .Sometimes | 58% | 63% |
| .A lot | 42% | 26% |
| 23. Items in student's home:[b] | | |
| .Desk | 90% | 58% |
| .Daily newspaper | 95% | 79% |
| .Encyclopedia | 100% | 95% |
| .Typewriter | 94% | 74% |
| .Calculator | 100% | 95% |
| .Television | 100% | 100% |
| .Computer | 37% | 37% |
| .Video Cassette Recorder (VCR) | 90% | 79% |
| Number of support items[c] * | 7.00 | 6.16[a] |
| t (26.39) = 2.00 | (0.82) | (1.64) |
| 24. Type of high school attended | | |
| .Public | 74% | 84% |
| .Private | 21% | 16% |
| .No formal high school | 5% | 0% |
| 25. Member math/science club in high school | 21% | 37% |

| PROTOCOL ITEM | PERCENT RESPONSE | |
|---|---|---|
| | INTERVENTION n = 19 | CONTROL n = 19 |
| 26. All activities student took part in:[b] | | |
| .Math/science club | 16% | 21% |
| .Field trip | 74% | 63% |
| .Watching science programs on TV | 58% | 53% |
| .Listen to talk by scientist | 32% | 32% |
| .Science/math fair | 38% | 47% |
| .Other science/math competition | 11% | 5% |
| .Play/work in computer lab | 84% | 68% |
| Number of activities * | 3.32 | 2.89 |

[a] Significant at $p \leq .10$
[b] Students selected all applicable responses.
[c] $t$ (26.39) = 2.00, Intervention SD = 0.82, Control SD = 1.64

* Mean value reported in lieu of percent responses

# APPENDIX D

# SUMMARY OF ALL CONSORTIUM INTERVENTIONS

CASET CONSORTIUM COLLEGES

| COLLEGE | TARGET POPULATION | COMPONENTS | GOALS |
|---|---|---|---|
| ALABAMA STATE UNIVERSITY<br>915 South Jackson Street<br>Montgomery, AL 36195<br>(205) 293-4465<br>Dr. Wallace Maryland, Chair<br>Math and Physical Science | Black freshmen ASU students with declared SET majors.<br>High ability males & females. | Role modeling, counseling, instruction, tutoring, skills training, peer support, career information workshops. | Increased enrollment & graduation in SET majors, improvement in grades in SET courses. |
| BENEDICT COLLEGE<br>Harden and Blanding Streets<br>Columbia, SC 29204<br>(803) 256-4220 x253<br>Dr. Kenneth Alston<br>Director, C-MAS | Women and minority freshmen & sophomore students at Benedict. | On-Line instruction using a computer network called MASON. This consists of tutoring and monitoring students' performance with electronic mailing. | Increased motivation to pursue careeers in vital SET fields, measured by a continued enrollment in SET majors. |
| COMMUNITY COLLEGE OF PHIL.<br>1700 Spring Garden St.<br>Philadelphia, PA 19130<br>(215) 751-8000<br>Mr. Geoffrey Schulz<br>Mathematics Department | Black & Hispanic CCP students having a HS diploma/GED who are eligible for the Math Placement tests. | Algebra review, hands-on exp., science careers awareness, role modeling. | Elimination of unnecessary math review, increased enrollment and competence, increased awareness of SET careers. |
| EDWARD WATERS COLLEGE<br>1658 Kings Road<br>Jacksonville, FL 32209<br>(904) 366-2504<br>Dr. James Kerr<br>Chair, Division of Education | Black 7th and 8th grade students, males and females.<br>Students must demonstrate aptitude for math and science. | Role modeling, counseling, field trips, instruction. | Enrollment in academic college prep program, increased interest in math and science, improvement in grades and communications skills, increased awareness of SET careers. |
| FISK UNIVERSITY<br>17th Avenue North<br>Nashville, TN 37203<br>(615) 329-8678<br>Dr. George Neely, Jr.<br>Executive Vice President | Black 4th, 5th, and 6th grade students, males and females. | Saturday-Summer Academy (hands-on experience, instruction, role modeling, field trips). | Improvement of math and science grades, increased confidence, increased awareness of SET careers, change in attitude toward math and science. |

CASET CONSORTIUM COLLEGES

| COLLEGE | TARGET POPULATION | COMPONENTS | GOALS |
|---|---|---|---|
| HUSTON-TILLOTSON COLLEGE<br>1820 East 8th Street<br>Austin, TX 78702<br>(512) 476-7421<br>Dr. Charles E. Urdy<br>Chemistry Department | Black and Hispanic 9th-12th grade students, males and females. | Saturday Science Academy (role modeling, mentoring, tutoring, skill enrichment). | Improvement of math and science grades, increased awareness of SET careers, increase retention of students on SET track. |
| LANEY COLLEGE<br>900 Fallon Street<br>Oakland, CA 94607<br>(415) 464-3226<br>Dr. Eugene Long<br>Assistant Dean for Math, Sci. and Related Technologies<br>Mr. Blas Guerrero | Black, Hispanic, American Indian 10th grade students, males and females.<br>Second-tier, economically disadvantaged students with strong interest in math and science. | Academic enrichment, tutoring, counseling, career awareness workshop, involvement with UC-Berkeley MESA program. | Improvement of math grades, 80% completion rate for Laney program, enrollment in SET academic track at the college level. |
| MARY HOLMES COLLEGE<br>Highway 50W<br>West Point, MS 39779<br>(601) 494-6820<br>Dr. JoAnn Vicks, Dean of Math and Science<br>Ms. Fannie Gibson, Dean of Buisiness/Computer Science | Black college freshman and sophomore students, males and females.<br>High ability students with interest in math, science, and/or computer science | Saturday College (instruction, field trips, role modeling, career awareness). | Improvement of skills, increased awareness of SET careers, increased academic motivation. |
| METROPOLITAN STATE COLLEGE<br>Campus Box 23,<br>1006 Eleventh Street<br>Denver, CO 80204<br>(303) 556-4570<br>Dr. Gwendolyn Thomas<br>Asst. Vice President, Student Affairs. | Black and Hispanic 6th grade students, males and females.<br>Second-tier, economically disadvantaged students. | Counseling, instruction/tutoring (Summer Academy), hands-on exp., role modeling. | Improvement of math and science grades, increased enrollment in SET courses, increased awareness of SET careers. |

CASET CONSORTIUM COLLEGES

| COLLEGE | TARGET POPULATION | COMPONENTS | GOALS |
|---|---|---|---|
| MOREHOUSE COLLEGE<br>830 Westview Drive, SW<br>Atlanta, GA 30314<br>(404) 681-2800<br>Dr. Arthur Jones<br>Director, Software Group | Black college freshman students, males only.<br>In Dual-Degree Engineering Program. | Counseling, tutoring, role modeling, skills seminars. | Improvement of math grades, increased number of engineering graduates, rapid progression thru Morehouse College (Dual-Degree Program). |
| NAVAJO COMMUNITY COLLEGE<br>P.O. Box 580<br>Shiprock, NM 87420<br>(505) 368-5164<br>Dr. Mark C. Bauer<br>Chair, Mathematics and Science | American Indian 4th-8th grade students, males and females. | Instruction, hands-on exp. (Summer Academy). | Improvement of performance in math and science, increased interest in SET careers. |
| NEW MEXICO HIGHLANDS UNIVERSITY<br>Las Vegas, NM 87701<br>(505) 425-7511<br>Dr. Gilbert Rivera<br>Vice President, Academic Affairs | Hispanic 11th and 12th grade students, males and females.<br>High ability students. | Instruction, hands-on exp., role modeling. | Increased awareness of SET careers, increased enrollment and graduation in SET studies. |
| OUR LADY OF THE LAKE UNIVERSITY<br>411 Southwest 24th Street<br>San Antonio, TX 78207-4466<br>(512) 434-6711 x240<br>Sister Isabel Ball<br>Dean, College of Arts & Sciences | Hispanic freshman and sophomore college students, males and females.<br>Precalculus and calculus students. | Study teams as a "lab," accompanying precalculus and calculus. | Improvement of academic/study skills, increased understanding of language of math, increased academic motivation |
| PAUL QUINN COLLEGE<br>1020 Elm Street<br>Waco, TX 76704<br>(817) 753-6415 ext. 258<br>Dr. Dennis Strete | Black 11th and 12th grade students, males and females. | Summer program and Saturday workshops (instruction, tutoring, field trips). | Improvement of academic skills, increased knowledge of math and science, increased awareness of SET careers. |

CASET CONSORTIUM COLLEGES

| COLLEGE | TARGET POPULATION | COMPONENTS | GOALS |
|---|---|---|---|
| RUST COLLEGE<br>One Rust Avenue<br>Holly Springs, MS 38635<br>(601) 252-4661<br>Ms. Cheryl Ann Richards<br>Computer Science Instructor | Black 10th-12th grade students, males and females.<br>Students show promise in SET fields. | Saturday Academy, tutoring,role modeling, field trips. | Improvement of performance, increased interest in SET fields, increased motivation. |
| TALLADEGA COLLEGE<br>627 West Battle<br>Talladega, Alabama 35160<br>(205) 362-5152<br>Dr. Arthur L. Bacon<br>Chair, Natural & Computational Sciences | Black freshman and sophomore college students, males and females. | Tutoring, counseling, skills workshops, role modeling, field trips, general academic support. | Reduction in attrition rate, increased numbers of science graduates. |
| TEXAS A&I UNIVERSITY<br>P.O. Box 101<br>Kingsville, TX 78363<br>(512) 595-2111<br>Dr. Lionel D. Hewett<br>Department of Physics | Hispanic college students, males and females.<br>Enrolled in physics lab course. | Development and implementation of instructional system (4MAT) using four learning styles and both brain modalities. | Improvement of performance through new instructional system. |
| TEXAS SOUTHERN UNIVERSITY<br>3100 Cleburne Street<br>Houston, TX 77004<br>(713) 527-7836<br>Dr. Pearlie Fennell<br>Associate Professor of Chemistry | Black college students, males and females.<br>Science and math majors. | Lectures, mini-courses, field trips, audio-visual presentations, mentoring, and hands-on experience. | Increased retention of science and math majors, increased faculty involvement in student development, increased percentage of SET majors pursuing graduate studies. |

CASET CONSORTIUM COLLEGES

| COLLEGE | TARGET POPULATION | COMPONENTS | GOALS |
|---|---|---|---|
| WESTERN NEW MEXICO UNIVERSITY<br>P.O. Box 680<br>Silver City, NM 88061<br>(505) 538-6011<br><br>Dr. John E. Cunningham (505) 538-6352<br>Chairman, Natural Science.<br><br>Dr. Alfred Milligan (505) 538-6528<br>Associate Professor, Math/<br>Computer Science. | Hispanic 9th-11th grade students, males and females. | Summer field-oriented workshop: "Natural New Mexico." (collecting fossils, banding bats, seeing life zones and rock types, etc. | Increased interest and awareness of science activities and careers. |
| WILBERFORCE UNIVERSITY<br>226 Walker Center<br>Wilberforce, OH 45384<br>(513) 376-2911 x657<br>Ms. Jennie Hodges Sethna<br>Director, Engineering and<br>Computer Science | Black 7th grade students, males and females. | Summer Academy - math, science, computer literay, communications skills, study skills, career planning; fields trips every Friday: Wright Patterson AFB, Chevy Robotics Plant, etc.; role modeling. | Improvement of performance, increased awareness of SET careers. |

# APPENDIX E

# DATABASE ABSTRACT INDEXING FORM

# ABSTRACT FORM SHEET

DESCRIPTION OF THE PROGRAM:

1. Program Name

2. Geographic Location of program (institution or organization, college or university, city, and state)

3. Year of this study, and semester if available

4. Type of Program

   a. Saturday Academy  b. Study Groups
   c. Summer Residential  d. Summer Non-residential
   e. Other

DESCRIPTION OF THE PARTICIPANTS:

The purpose here is to place in the consumer's mind a picture of WHO was in the intervention program, so give as complete a description of the participants as possible. For example, "freshmen science majors," undergraduate students who were assessed as potentially underprepared in mathematics," "entering freshmen students who indicated they would like to participate."
BE SURE to tell the total number, sex, race/ethnicity, and academic level.

5. Enrollment (total number of participants)

6. Number or percentage of minority participants, by racial/ethnic group

7. Number or percentage of participants by sex

8. Educational level of intervention:

   a. Undergraduate  b. Graduate  c. High School
   d. Middle School (6-8th grade)  e. Elementary School
   f. Professional  g. Other

9. Selection process - how were the students chosen for this intervention; what class were they enrolled in; how were they recruited; any information which tells how these particular students came to be in this intervention

10. Year the program was started or how many years the program has gone on.

    In the CASET interventions, this space covers the semesters the intervention was repeated.

11. FOR THE CASET INTERVENTIONS ONLY, write in the following:

The (name of the institution) program is part of a research study being conducted by The Center for the Advancement of Science, Engineering, and Technology (CASET), of Huston-Tillotson College, Austin, Texas, under funding from the U.S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA)/Lyndon B. Johnson Space Center (JSC), and the Department of Labor.

DETAILS OF THE PROGRAM:

12. Objectives/goals.

13. Major components of program

14. Methodology (if there is one). In the simplest form, here you tell how the data were gathered - from a survey, questionnaire, protocol, test scores. Most interventions are not studies, therefore there will be no gathering of data.

FOR THE CASET INTERVENTIONS THERE WILL ALWAYS BE A METHODOLOGY, WHICH WILL BE A VERSION OF THE FOLLOWING:

"The research design for the intervention was quasi-experimental; however, intervention and control groups were not formed by random assignment.

All of the participants furnished demographic data through the CASET College Student Protocol. All participants were administered pre- and post-CASET Opinion Protocols. Other data collected were from college transcripts, national standardized test scores, and Calculus I and Physics I semester grades. Demographic, performance, and opinion data were analyzed within the context of a nonequivalent control group design; through analyses of preintervention measures, it appeared that the intervention and control groups were comparable."

15. Results

a. Positive b. Negative c. None d. Not available

IN THE CASET INTERVENTIONS, THIS SECTION WILL BE CALLED "FINDINGS" and will give information on how well the intervention achieved success as determined by the statistical procedures carried out to evaluate the outcome measures.

In the other interventions, we wish to used the key word "success" (or "successful") in some way so that a person searching for "success" will find those interventions who in some way were measured and found to be "successful." For example, significant statistical findings are a measure of success; Dr. Berriozabal's high percentage of participants who are majoring in SET fields is a measure of success. Here you have to make a decision as to whether or not the intervention is successful, but you must have something to back up your decision and tell what it is. Another key word is "evaluation" or "evaluate." If the program was evaluated, tell whether it was external or internal and what the criteria were (briefly).

If no information is given to show that the intervention was successful, that does not automatically make the result a negative one. If there are negative results, say so. Otherwise, say "no results of effectiveness were reported" or say nothing about results at all.

16. Follow-up studies of this intervention have shown that the effect of the intervention was:

a. Positive. b. Negative c. None d. Not available

THE FOLLOW-UP MAY BE CONSIDERED AN EVALUATION. IF YOU DO, THEN BE SURE TO USE THE WORD "EVALUATION" SO THAT A SEARCH BY THIS WORD WILL FIND THIS INTERVENTION

<u>PROJECT DIRECTOR</u>:

17. Name

18. Title

19. Institution

20. Address and Telephone Number

ON CASET INTERVENTIONS, USE ONLY THE NAME AND TITLE OF THE PROJECT DIRECTOR.

# APPENDIX F

# INTERVIEW SCHEDULE

STUDY TO DETERMINE FACTORS 3-24-89
IMPACTING ON THE SUPPLY OF MINORITY AND WOMEN
SCIENTISTS, ENGINEERS, AND TECHNOLOGISTS

INTERVIEW SCHEDULE

**********

DEMOGRAPHIC CHARACTERISTICS

1. Name: _____

2. Date of birth (month/day/year): _____

   Place of birth: _____

3. Sex: _____ Male _____ Female

4. Citizenship:

   _____ U.S. Native-born
   _____ U.S. Naturalized

5. Ethnicity/race:

   _____ Anglo
   _____ Black
   _____ Asian American
   _____ American Indian ..... Please specify the tribe which best describes your heritage. _____

   _____ Hispanic ..... Which of the following best describes your heritage?
   _____ Cuban-American
   _____ Mexican-American
   _____ Puerto Rican
   _____ Other _____

   _____ Other _____

6. Marital status:

   _____ Never married
   _____ Married
   _____ Separated, divorced
   _____ Widowed

7. Do you have children living with you?

_____ No

_____ Yes ..... Are these children:
_____ Under 6 years of age?
_____ Between 6 and 17 years of age?

**********

FAMILY INFORMATION

8. How many brothers and/or sisters do you have?

_____ None
_____ One
_____ Two
_____ Three
_____ Four
_____ Five
_____ Six or more

9. What was the highest level of education achieved by your mother and your father?

| Mother | Father | |
|---|---|---|
| _____ | _____ | Less than high school diploma |
| _____ | _____ | High school diploma or GED |
| _____ | _____ | Vocational, trade, or business school degree |
| _____ | _____ | Baccalaureate degree in SET field |
| _____ | _____ | Baccalaureate degree in non-SET field |
| _____ | _____ | Master's or Ph.D. degree in SET field |
| _____ | _____ | Master's or Ph.D. degree in non-SET field |

10. How do you expect that your achievements will compare to your parents' achievements in the following areas?

| | Exceed | Same | Fall short |
|---|---|---|---|
| Academic | _____ | _____ | _____ |
| Professional | _____ | _____ | _____ |
| Financial | _____ | _____ | _____ |

11. What was your parents' employment status while you were in school?

| Mother | Father | |
|---|---|---|
| _____ | _____ | Employed in SET field |
| _____ | _____ | Employed in non-SET field |
| _____ | _____ | Not employed |

12. Which of the following did your parent(s)/guardian(s) do during your years in school? (Check all that apply)

_____ Attend PTA meetings
_____ Attend parent-teacher conferences
_____ Visit your classes
_____ Phone or visit your teacher, counselor, or principal when you had a problem
_____ Do volunteer work such as fund-raising or assisting on school projects
_____ Assist you in course selection
_____ Help you with your homework

13. While you were in high school, did your parents emphasize the importance of ... (Check if important)

_____ Taking mathematics and science courses?
_____ Developing good verbal and reading skills?
_____ Getting good grades?

14. Which of the following did you have in your family home during your high school years? (Check all that apply)

_____ A specific place for study
_____ A daily newspaper
_____ Encyclopedia or other reference books
_____ Typewriter
_____ Electric dishwasher
_____ Two or more cars or trucks that run
_____ More than 50 books
_____ A room of your own
_____ Pocket calculator
_____ Color TV
_____ Personal computer
_____ Video cassette recorder (VCR)
_____ Stereo

15. Which of the following best describes your high school program?

_____ General
_____ Academic or college preparatory
_____ Vocational (occupational preparation)
_____ Other _____

16. How did you decide in which high school program you would enroll?

_____ You were assigned it
_____ You selected it after talking to your counselor or teacher
_____ You selected it after talking to your parents
_____ You selected it after talking to your friends
_____ You selected it without consulting anyone
_____ Other _____

17. Which of the following courses did your high school offer? Which of the following did you take? (Check all that apply)

| Offered | Taken | |
|---|---|---|
| _____ | _____ | Algebra I |
| _____ | _____ | Algebra II |
| _____ | _____ | Geometry |
| _____ | _____ | Trigonometry |
| _____ | _____ | Calculus |
| _____ | _____ | Computer programming |
| _____ | _____ | Physics |
| _____ | _____ | Chemistry |
| _____ | _____ | Biology |
| _____ | _____ | Other _____ |

18. Why did you not take more mathematics courses in high school?

_____

_____

_____

Why did you not take more science courses in high school?

_____

_____

_____

19. What did you think of your first high school mathematics class?
(Identify class) _____

_____

What did you think of your first high school science class?
(Identify class) _____

_____

20. In general, how well did you do in your mathematics and science courses?

| Mathematics | Science | |
|---|---|---|
| _____ | _____ | Very well |
| _____ | _____ | Above average |
| _____ | _____ | Average |
| _____ | _____ | Below average |
| _____ | _____ | Poorly |

21. Which of the following best describes your grades in high school?

_____ Mostly A's
_____ A's and B's
_____ Mostly B's
_____ B's and C's
_____ Mostly C's
_____ C's and D's
_____ Mostly D's
_____ Below D

22. How intelligent do you think you were in high school compared with others in your class?

_____ Far above average
_____ Above average
_____ Average
_____ Slightly below average
_____ Below average
_____ Far below average

23. How would you rate the quality if your mathematics and science high school teachers?

| | Excellent | Good | Average | Poor |
|---|---|---|---|---|
| Mathematics teachers | _____ | _____ | _____ | _____ |
| Science teachers | _____ | _____ | _____ | _____ |

24. Do you think you were prepared adequately in high school for a SET curriculum in college?

_____ No

_____ Yes

Please elaborate. _____

_____

25. Have you ever taken part in any of these activities? (Check all that apply)

_____ Mathematics and/or science clubs
_____ Field trip to a science museum, laboratory, or other place where scientists work
_____ Watching science programs on TV
_____ A talk by a scientist
_____ Science/mathematics fair
_____ Other science/mathematics competition
_____ Play or work in a computer lab
_____ Enrichment program such as Upward Bound, Saturday Academy, etc. Please name the program(s): _____

_____

_____

26. Were there high school academic achievements that played an important role in your decision to pursue a SET program in college?

_____ No

_____ Yes ..... What were they? _____

_____

_____

_____

27. How much influence did each of the following people have on your post-high school educational/career plans?

| | Very great influence | Great influence | Little influence | No influence |
|---|---|---|---|---|
| A. Your father | _____ | _____ | _____ | _____ |
| B. Your mother | _____ | _____ | _____ | _____ |
| C. Guidance counselor | _____ | _____ | _____ | _____ |
| D. Mathematics teachers | _____ | _____ | _____ | _____ |
| E. Science teachers | _____ | _____ | _____ | _____ |
| F. Friends | _____ | _____ | _____ | _____ |
| G. Relatives (Who? _____) | _____ | _____ | _____ | _____ |
| H. Military recruiters (Who? _____) | _____ | _____ | _____ | _____ |
| I. College recruiters | _____ | _____ | _____ | _____ |
| J. Other (Who? _____) | _____ | _____ | _____ | _____ |

28. What did the aforementioned individuals think you should do following high school? (Enter alpha letters A to J that correspond to aforementioned individuals in appropriate spaces below)

_____ Go to 4/5-year college/university majoring in SET field
_____ Go to 4/5-year college/university majoring in non-SET field
_____ Go to 2-year college
_____ Enter a trade school or an apprenticeship
_____ Get a full-time job
_____ Enter the military service
_____ Get married
_____ Expressed no specific preference

29. Did you participate in ROTC in high school?

_____ No

_____ Yes ..... Which branch of the service? _____

**********

## POSTSECONDARY EDUCATION

30. What is the highest degree you have received?

_____ High school diploma or GED
_____ Associate degree
_____ Baccalaureate degree in SET field
_____ Baccalaureate degree in non-SET field
_____ Master's or Ph.D. degree in SET field
_____ Master's or Ph.D. degree in non-SET field
_____ Other _____

31. What college or university are you now attending?

_____

In what year of study are you? (freshman, sophomore, junior, senior, graduate student, special student)

_____

What other colleges/universities have you attended?

_____

If you received a degree, specify school and degree received.

_____

32. What were your SAT/ACT scores? _____

33. Academically, how well did you do in college during your first and last years?

| First year | Last or current year |
|---|---|
| _____ Very well | _____ Very well |
| _____ Above average | _____ Above average |
| _____ Average | _____ Average |
| _____ Below average | _____ Below average |
| _____ Poorly | _____ Poorly |

34. What is (was) your grade point average in college? _____
(Note: A = 4.0, B = 3.0, C = 2.0, D = 1.0)

35. How intelligent do you think you are (were) compared with others in your college program?

_____ Far above average
_____ Above average
_____ Average
_____ Slightly below average
_____ Below average
_____ Far below average

36. How do you rate your academic performance in college compared with the following groups? My performance is (was) ...

| | Much better than | Better than | Same as | Worse than |
|---|---|---|---|---|
| All students | _____ | _____ | _____ | _____ |
| All SET students | _____ | _____ | _____ | _____ |
| SET students of your own sex | _____ | _____ | _____ | _____ |
| SET students of the opposite sex | _____ | _____ | _____ | _____ |
| SET students of your own race/ethnic background | _____ | _____ | _____ | _____ |

37. What is your major? _____

What was your major when you entered college? _____

(If changed) Why did you change majors? _____

_____

_____

Had you thought of a career in SET?

_____ No

_____ Yes

Why or why not? _____

_____

_____

38. How much influence did your parents/guardians have on your choice of the following?

| | Very great influence | Great influence | Little influence | No influence |
|---|---|---|---|---|
| College/university | _____ | _____ | _____ | _____ |
| Major field of study | _____ | _____ | _____ | _____ |
| Career goals | _____ | _____ | _____ | _____ |

39. Are your academic achievements rewarded, recognized, or appreciated by your ...

| | Yes | No |
|---|---|---|
| Teachers? | _____ | _____ |
| Peers? | _____ | _____ |
| Parents? | _____ | _____ |

40. What academic honors or awards have you (did you) receive in college?

_____

_____

_____

41. What has been your greatest source of concern in college?

_____

_____

_____

42. Reflecting on your college experience,

have you enjoyed ...

| | Yes | No |
|---|---|---|
| The college/university? | _____ | _____ |
| Your academic program? | _____ | _____ |
| The social environment? | _____ | _____ |

have you had the opportunity for ...

| | Yes | No |
|---|---|---|
| Close student-teacher relationships? | _____ | _____ |
| Friendships with students in your academic program with whom you could socialize? | _____ | _____ |
| Friendships with students in your academic program with whom you could study or discuss academic problems? | _____ | _____ |

have you had ...

| | Yes | No |
|---|---|---|
| Family support of your academic interests and career goals? | _____ | _____ |
| Encouragement from family/teachers to continue in your academic program? | _____ | _____ |

43. While in college, did you participate (are you participating) in any enrichment program such as Women in Engineering, MESA, etc.?

_____ No

_____ Yes ..... Please name the program(s)._____

_____

_____

44. While in college, did you participate (are you participating) in ROTC?

_____ No

_____ Yes ..... Which branch of the service? _____

45. In retrospect, was the college/university you selected the the right one for you ...

| | Yes | No |
|---|---|---|
| Academically? | _____ | _____ |
| Socially? | _____ | _____ |
| Economically? | _____ | _____ |

46. What kind of relationship do you (did you) have with most of your professors? (Check only one)

_____ Excellent
_____ Good
_____ Fair
_____ Poor

Does (did) this differ from your expectations?

_____ No

_____ Yes

47. Are (were) you satisfied with the support faculty demonstrate(d) in the following areas?

| | Yes | No |
|---|---|---|
| Interest in me as a person | _____ | _____ |
| Interest in my career plans | _____ | _____ |
| Assistance in locating and obtaining summer jobs and internships | _____ | _____ |
| WHERE APPLICABLE: | | |
| Assistance in locating and obtaining first career-related job | _____ | _____ |
| Making me feel professionally competent | _____ | _____ |

48. As a college student, how much of the following do you (did you) receive from individuals at your college/university?

| | Great deal | Some | A little | None |
|---|---|---|---|---|
| Remedial instruction in mathematics as needed | _____ | _____ | _____ | _____ |
| Remedial instruction science as needed | _____ | _____ | _____ | _____ |
| Counseling on personal problems | _____ | _____ | _____ | _____ |
| Counseling on academic problems | _____ | _____ | _____ | _____ |
| Tutoring by faculty | _____ | _____ | _____ | _____ |
| Tutoring by students | _____ | _____ | _____ | _____ |

49. How satisfied are you (were you) with the following?

| | Greatly satisfied | Satisfied | Neutral | Dis-satisfied | Greatly dis-satisfied |
|---|---|---|---|---|---|
| Ability, knowledge, and personal qualities of your teachers | _____ | _____ | _____ | _____ | _____ |
| Development of your work skills | _____ | _____ | _____ | _____ | _____ |
| Your intellectual growth | _____ | _____ | _____ | _____ | _____ |
| Counseling or job placement | _____ | _____ | _____ | _____ | _____ |
| The intellectual life of the school | _____ | _____ | _____ | _____ | _____ |
| Course curriculum | _____ | _____ | _____ | _____ | _____ |
| Quality of the instruction | _____ | _____ | _____ | _____ | _____ |
| Financial cost of attending school | _____ | _____ | _____ | _____ | _____ |
| Prestige of the school | _____ | _____ | _____ | _____ | _____ |

50. Have you (did you) change your career goals/ambitions after you entered college?

_____ No

_____ Yes ..... When and why did you change your goals? _____

_____

_____

_____

**********

ECONOMICS

51. While you were growing up, in which income bracket were your parents/guardians?

_____ Below U.S. average
_____ About average
_____ Above average
_____ Don't know

52. At what age did you begin your first job? _____

53. Was college delayed because of a lack of adequate funds?

_____ No

_____ Yes

54. How have you been financing your college education? (Check all that apply)

_____ Parent(s) or guardian(s)
_____ Husband or wife
_____ College work-study
_____ Job other than college work-study
_____ Tuition or other scholarship
_____ Loan
_____ Grant
_____ Previous personal earnings or savings
_____ GI Bill or other governmental assistance (other than scholarship or loan)
_____ Family trust fund, insurance plan, or other similar arrangement
_____ Other _____

55. How many hours a week do you work?

_____ Does not work
_____ Works ..... Hours worked _____

56. Do you feel that your working during college interferes (interfered) with your studies?

_____ No

_____ Yes

57. Were you provided information regarding scholarships, grants, etc., that were available to you for your college expenses?

_____ No

_____ Yes ..... Who provided this information? _____

_____

When was this information provided? _____

_____

58. Did you receive any of the following scholarships, fellowships, grants, or benefits (not a loan) that made it possible for you to attend college? (Check all that apply)

_____ Basic Educational Opportunity Grant (BEOG) or Pell Grant
_____ Supplemental Educational Opportunity Grant
_____ ROTC scholarship
_____ Social Security benefits for children of retired, disabled, or deceased parents
_____ Veteran's Educational Assistance Program (VEAP) or new GI Bill
_____ State scholarship program
_____ College or university scholarship
_____ Scholarships from private organizations
_____ Division of a Vocational Rehabilitation Education Benefits
_____ Financial assistance for which you do not know the source
_____ Tuition waiver, forgiveness, or reduction
_____ Other scholarship or grant
_____ Did not receive any of the above

59. If you borrowed money to attend college, how much of a debt do you now have as a result of your college expenses?

$ _____

60. If you received a loan to go to school, from which of the following sources did you receive the loan(s)? (Check all that apply)

_____ National Direct Student Loan
_____ Federal Guaranteed Student Loan Program
_____ State Student Loan Program
_____ College or University Loan Program
_____ Regular bank loan
_____ Parents/guardians, other relatives
_____ Friends
_____ Loan for which you do not know the exact source
_____ Other _____

61. Would you enlist in the Armed Forces if you were offered a program which would reduce the amount of money you owe on a Federal Loan for education assistance?

_____ No
_____ Yes
_____ Not sure

To which of the Armed Forces would you be most attracted?

_____ Army
_____ Navy
_____ Air Force
_____ Marines
_____ Coast Guard

**********

## SELF-IMAGE AND PERCEPTIONS

62. Please check those of the following with which, overall, you are satisfied.

_____ Life in general
_____ Family life
_____ Leisure activities
_____ Social life
_____ Geographic area in which you live
_____ Future prospects

63. Which of the following do you think apply to the way you are viewed by other students? (Check all that apply)

_____ As popular
_____ As athletic
_____ As socially active
_____ As a good student
_____ As important
_____ As a troublemaker
_____ As a leader
_____ As successful

64. Do you feel that society is prejudiced against you because of your ...

| | Yes | No |
|---|---|---|
| Race? | _____ | _____ |
| Sex? | _____ | _____ |
| Age? | _____ | _____ |
| Religion? | _____ | _____ |

65. Do you agree or disagree with the following statements?

| | Agree | Disagree | No Opinion |
|---|---|---|---|
| I have a positive attitude toward myself. | _____ | _____ | _____ |
| Good luck is more important than hard work for success. | _____ | _____ | _____ |
| I am a person of worth on an equal plane with others. | _____ | _____ | _____ |
| I am able to do things as well as most people. | _____ | _____ | _____ |
| Every time I try to get ahead, something or somebody stops me. | _____ | _____ | _____ |
| Planning only makes a person unhappy, since plans hardly ever work out anyway. | _____ | _____ | _____ |
| People who accept their condition in life are happier than those who try to change things. | _____ | _____ | _____ |
| On the whole, I am satisfied with myself. | _____ | _____ | _____ |
| What happens to me is a result of my own doing. | _____ | _____ | _____ |
| At times I think I am no good at all. | _____ | _____ | _____ |
| When I make plans I am almost certain I can make them work. | _____ | _____ | _____ |
| I feel that I do not have much to be proud of. | _____ | _____ | _____ |
| I know that my personal achievement advances the cause of my ethnic/ racial group. | _____ | _____ | _____ |

66. Do you think academic excellence is valued by ...

| | Yes | No |
|---|---|---|
| Our society? | _____ | _____ |
| Your circle of friends? | _____ | _____ |
| Your family? | _____ | _____ |

67. How far in school do you think you will get? How far do your parents/guardians want you to go? (Enter N/A if not applicable, i.e. if you are <u>beyond</u> level listed)

| You | Parents/ guardians | |
|---|---|---|
| _____ | _____ | Two-year college program |
| _____ | _____ | Four- or five-year college program |
| _____ | _____ | Master's degree or equivalent |
| _____ | _____ | Ph.D., M.D., or other advanced professional degree |
| _____ | _____ | No choice |

68. For what reason(s) would you go on for an advanced degree in your field?

_____ To increase potential earnings
_____ To take advantage of new career opportunities
_____ To take advantage of grants/fellowships
_____ To avoid a tight job market
_____ Other _____

69. What were your ambitions and goals upon entering college?

_____

_____

70. Have your current ambitions and goals changed from your previous ambitions and goals?

_____ No

_____ Yes ..... Why? _____

_____

_____

71. How important is each of the following to you in your life?

| | Very | Somewhat | Not at all |
|---|---|---|---|
| Being successful in my line of work | _____ | _____ | _____ |
| Finding the right person to marry and having a happy life | _____ | _____ | _____ |
| Having lots of money | _____ | _____ | _____ |
| Having strong friendships | _____ | _____ | _____ |
| Being able to find steady work | _____ | _____ | _____ |
| Being a leader in my community | _____ | _____ | _____ |
| Being able to give my children better opportunities than I had | _____ | _____ | _____ |
| Getting away from the geographic area in which I now live | _____ | _____ | _____ |
| Working to correct social and economic inequalities | _____ | _____ | _____ |
| Having children | _____ | _____ | _____ |
| Having leisure time to enjoy my own interests | _____ | _____ | _____ |

72. If there were no limitations on your choice of career, what would you most like to do? Why?

_____

_____

_____

**********

CAREER OR JOBS

73. What is your current status?

_____ Employed full-time ..... What is your present job?

_____

_____ Employed part-time ..... What is your present job?

_____

_____ Unemployed and seeking employment
_____ Unemployed and <u>not</u> seeking employment
_____ Student, full-time
_____ Student, part-time
_____ Unable to work for physical, mental, or emotional reasons
_____ Other _____

74. If you are now unemployed and looking for a job, how long have you been unemployed? _____

75. What kind of a job are you looking for? _____

_____

76. If you are unemployed and seeking employment, what have been the major difficulties in finding employment? (Check all that apply)

_____ Finding a suitable job in your field
_____ Lack of geographic mobility
_____ Finding adequate child care
_____ Lack of skills now considered vital in desired job area
_____ Inadequate educational background
_____ Salary offers too low to be acceptable
_____ Anti-nepotism rules
_____ Job market too tight, not enough jobs available
_____ Lack of required work experience
_____ Employers are reluctant to hire you because of your sex
_____ Employers are reluctant to hire you because of your race
_____ Employers are reluctant to hire you because of your age
_____ Employers are reluctant to hire you because you have too much education
_____ Spouse discourages employment
_____ Other _____

77. How many employers have you had since you started working professionally (part-time as well as full-time)?

_____

78. How important do you think the following features of an occupation have been or will be in influencing your choice of occupation?

| | Very important | Somewhat important | Not very important | Not at all important |
|---|---|---|---|---|
| Occupation has high prestige | _____ | _____ | _____ | _____ |
| Involves work with people rather than things | _____ | _____ | _____ | _____ |
| Provides freedom from close supervision | _____ | _____ | _____ | _____ |
| Has prospect of high income | _____ | _____ | _____ | _____ |
| Provides predictably secure future | _____ | _____ | _____ | _____ |
| Suits parents' wishes/ideas | _____ | _____ | _____ | _____ |
| Allows combining career and family | _____ | _____ | _____ | _____ |
| Allows establishing roots in community | _____ | _____ | _____ | _____ |
| Leaves a lot of time for other things in your life | _____ | _____ | _____ | _____ |
| Allows flexible or part-time hours | _____ | _____ | _____ | _____ |
| Makes use of your best talents | _____ | _____ | _____ | _____ |
| Requires use of your intellect | _____ | _____ | _____ | _____ |
| Involves helping others | _____ | _____ | _____ | _____ |
| Is respected by your friends and peers | _____ | _____ | _____ | _____ |
| Previous work experience in the area | _____ | _____ | _____ | _____ |
| Freedom to make your own decisions | _____ | _____ | _____ | _____ |
| Provides challenge | _____ | _____ | _____ | _____ |

79. To what extent have the following factors had a negative effect on your career development?

| | Major impact | Moderate impact | Little or no impact | Not applicable |
|---|---|---|---|---|
| Inadequate funds for education | _____ | _____ | _____ | _____ |
| Attitude of family regarding your career choice | _____ | _____ | _____ | _____ |
| Attitude of friends regarding your career choice | _____ | _____ | _____ | _____ |
| Unsatisfactory job opportunities | _____ | _____ | _____ | _____ |
| Demands of spouse's career | _____ | _____ | _____ | _____ |
| Other demands on time (i.e., family, social) | _____ | _____ | _____ | _____ |
| Personal health | _____ | _____ | _____ | _____ |
| Sex discrimination | _____ | _____ | _____ | _____ |
| Race discrimination | _____ | _____ | _____ | _____ |
| Age discrimination | _____ | _____ | _____ | _____ |
| Geographic location of job | _____ | _____ | _____ | _____ |
| Travel demands of job | _____ | _____ | _____ | _____ |
| One or more children at home | _____ | _____ | _____ | _____ |
| Inadequate household help | _____ | _____ | _____ | _____ |
| Little financial incentive to work | _____ | _____ | _____ | _____ |

80. How have you found your job(s)?

_____ School employment or placement service
_____ Campus recruiter; identify _____
_____ Public employment service
_____ Private employment service
_____ Newspaper advertisement
_____ Checked with employer directly
_____ Through the assistance of a relative
_____ Through the assistance of a friend
_____ Through the assistance of a faculty member
_____ Other _____

81. What kind of job(s) have you held in the past?

_____

_____

_____

82. Do you consider yourself to be ...

| | Yes | No |
|---|---|---|
| Professionally employed? | _____ | _____ |
| Professionally underemployed (you hold a job <u>below</u> your level of professional competence)? | _____ | _____ |

83. How satisfied are (were) you with the following aspects of your present (most recent) job?

| | Very satisfied | Satisfied | Dis-satisfied | Very dis-satisfied |
|---|---|---|---|---|
| Pay and fringe benefits | _____ | _____ | _____ | _____ |
| Importance and challenge of work | _____ | _____ | _____ | _____ |
| Working conditions | _____ | _____ | _____ | _____ |
| Opportunity for promotion and advancement with this employer | _____ | _____ | _____ | _____ |
| Opportunity for promotion and advancement with this line of work | _____ | _____ | _____ | _____ |
| Opportunity to use past training and experience | _____ | _____ | _____ | _____ |
| Security and permanence | _____ | _____ | _____ | _____ |
| Supervisor(s) | _____ | _____ | _____ | _____ |
| Opportunity for developing new skills | _____ | _____ | _____ | _____ |
| Pride and respect you receive from family and friends by being in this line of work | _____ | _____ | _____ | _____ |
| Relationships with co-workers | _____ | _____ | _____ | _____ |
| Job as a whole | _____ | _____ | _____ | _____ |

84. Have (had) you been promoted in your present (most recent) job?

_____ No

_____ Yes ..... Did the promotion give you ...

_____ More pay?
_____ More challenging work?
_____ More authority over other workers?
_____ More responsibility?
_____ Other _____

_____ Not applicable

85. If you were educated in the SET areas and are now employed in a non-SET position, what was the most important reason for accepting a position (or positions) unrelated to SET?

_____ Preferred non-SET position
_____ Promoted out of SET position
_____ Pay was better in non-SET position
_____ Preferred the location of non-SET position
_____ SET position not available
_____ Other _____

86. In general, do you think that you have progressed, moved backward, or just about held your own in your professional career?

_____ Progressed
_____ Moved backward
_____ Held your own

87. Specifically, right now, what is your career goal?

_____

_____

_____

_____

88. To reach your career goal, what do you <u>most</u> need?

_____ Further training or education
_____ Better opportunity
_____ A mentor to guide you
_____ The feeling you are equipped to reach your career goal
_____ Other _____

**********

Proposed open-ended interview to be administered after 88-item "Impact Interview Schedule." Interview is designed to elicit relevant data that may fall outside purview of Interview Schedule.

I am interested in anything you have to tell me about your involvement with science/engineering/technology. I'll ask you a few questions, just to help you recall some of the experiences or people who may in some way have shaped your interest. Mainly, we would value very greatly any insights you can offer as to how other women/minority groups might profit from what you know. If things occur to you, beyond or different from what I ask, please feel free to bring them up at any time.

1. Can you recall when you first felt any interest whatsoever in these areas: science, engineering, technology? Whatever comes to mind.

2. (If subject has not mentioned childhood) What about as a child? Earliest recall. (Probe.) In the home? Influences? Your parents, school, books read, toys, presents received or asked for, TV programs (kid shows), friends, activities.

3. As you were growing up, were there people you admired who were in some way a part of this area of interest? Early models? Mentors--people who encouraged you, allowed you to watch them, be a part of their activities. Tell me about them.

4. Can you recall any point of definitive insight, like "I'd really like to study about the stars," or "Maybe I'll be a chemist when I get older," or something like that? Did you discuss this insight or interest with anyone?

5. Do you recall any discouragement along the way? When was that? Why was that, do you think?

6. Did being a woman (Black, Mexican-American, American Indian, etc.) affect your interest or development or enthusiasm in the sciences in any way, do you think?

7. Now that you <u>are</u> involved in science/engineering/technology, what do you find most exciting about it? What do you least like about it?

8. Are there educational changes you would recommend in the training of scientists/engineers/technologists?

9. Have men been of help or hindrance along the way to career decisions and training? (If the subject is male minority, ask re women.) Can you give me an example? Have you ever purposefully sought a man's advice about a career decision?

10. How about other women? Help or hindrance? (Probe.)

11. Tell me a little about your own experience in combining college and personal life and work.

12. Have Mexican-Americans (or Blacks, etc.)been doing what they should to help other Mexican-Americans (or Blacks, etc.) get themselves into these fields? To help on another once they are <u>in</u> these fields? (Probe.)

13. What do you think can be done (by the community, government, business) to help further the presence and advance of women and minorities in SET?

14. Do you have a very concrete image of what you see yourself doing in SET, say, in five years? 20 years? What contribution would you like to make?

15. Would you like to marry (to have married) a scientist? Why or why not?

16. Looking back, are there things that you would have done differently in terms of your own educational development in SET?

# APPENDIX G

## EDUCATING TOMORROW'S ENGINEERS
## A GUIDE TO PRECOLLEGE MINORITY ENGINEERING PROGRAMS

# Educating Tomorrow's Engineers

## A Guide to Precollege Minority Engineering Programs

The National Action Council for Minorities in Engineering, Inc.
3 West 35th Street
New York, New York 10001
212/279-2626

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# Introduction

*Educating Tomorrow's Engineers, A Guide to Precollege Minority Engineering Programs* lists educational initiatives throughout the country that are working to increase the number of African American, Hispanic and Native American students with the academic and motivational preparation to enter engineering and other technical fields of study. While the programs all share an emphasis on mathematics and science achievement, they represent a wide variety of service delivery models for students. Collectively, these efforts demonstrate a unique alliance between the public and private sectors to enhance the quality of education for minority youth.

For the most part, precollege programs are community-based and supported by industry or university-administered with some degree of industry support. There are 107 such programs listed in this directory. They show a total student enrollment of more than 60,000: 52% African American; 14% Hispanic; 3% American Indian; and 31% comprised of others as well as students for whom ethnic distribution has not been provided. The state with the largest number of programs is California, with 14, while Michigan, New Jersey, New York, and Texas each has seven. The predominant form of intervention is the summer program, offered by 87% of the listed organizations. The activities most frequently offered are: guest speakers/instructors, career counseling, field trips/tours, follow-up/evaluation, hands-on experience, instructional materials, and academic counseling.

## Organization of Precollege Program Descriptions

The information contained in this directory describes the range and extent of intervention efforts in mathematics and science for minority students. The directory is organized to provide a brief narrative summary of each program and a tabular view of selected features across all programs.

Descriptions are arranged alphabetically by state and, within states, alphabetically by program. The Table of Contents provides a page reference for both states and programs.

The Reference Guide presents a tabular listing of all programs with indications for program activities and format, as well as students served.

# Section A

## Precollege Program Descriptions

All listings in the directory are based on information provided by the programs themselves at the close of 1988. This information has been broken down as described below.

| | |
|---|---|
| Type of program | Categorizes programs as precollege, university or combined precollege and university. Precollege programs are local or regional, can operate independently, can be supported by an umbrella organization, or can be sponsored by a university. University programs are based at a university campus and often address the needs of college students as well as precollege students. |
| Total students/grades | Presents the number of students served during the 1987-88 academic year and their grade levels. |
| Staff | States the number of full-time and part-time personnel at each program, with full-time designation requiring a minimum of 75 percent of an individual's professional time. |
| Service period | Denotes the time periods during which services are delivered: Saturday, summer, school day, and/or after school. |
| Student contact | Describes how often students receive services and for how many hours during each contact. |

1

## Engineering Summer Institutes

College of Engineering and Applied Sciences
Arizona State University
Tempe, Arizona 85287

**Maria Lupe Durante,**
Director
602/965-5150

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 99 students in grades 9-10 |
| Staff | 1 full-time, 1 part-time |
| Service period | Summer |
| Student contact | Daily, for 2 weeks |

The Engineering Summer Institutes were founded in 1979 as four one-week sessions. They since have evolved into two-week sessions. The Institutes target Hispanics, Native Americans, African Americans, and women who are freshman and sophomore high school students. The objectives of the program are: to reinforce academic skills in mathematics, science, computer literacy, and English; to expose minorities and women to engineering and technology-related fields; and to provide college life experience.

### Program Activities

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | | | X | X | X | X | | X | X | X |

2

## Mathematics, Engineering, Science Achievement Program

MESA Arizona
Glendale Community College
6000 West Olive Avenue
Glendale, Arizona 85302

**Elizabeth K. Medrano,**
Director
602/435-3000

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 70 students in grades 9-12 |
| Staff | 1 full-time |
| Service period | Summer, school day |
| Student contact | Daily |

The Mathematics, Engineering, Science Achievement Program at Glendale Community College is currently working with three high schools: Dysart, Peoria, and Tolleson. A total of seventy students meet daily and learn study skills, work on science projects, listen to speakers in the field of engineering, science, or math, and go on field trips.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | | X | X | X | | X | | X | X | | | | X |

3

## Pre-Engineering Summer Workshops for Minorities and Women

Department of Nuclear and Energy Engineering
University of Arizona
Tucson, Arizona 85721

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 96 students in grades 7-11 |
| Staff | 1 part-time |
| Service period | Summer |
| Student contact | Daily, 3-10 days |

**Prof. Morris Farr,**
Coordinator
602/621-2446

The Pre-Engineering Summer Workshops for Minorities and Women Program of the University of Arizona began operation in 1978 to encourage young people to prepare for a career in engineering by enrolling in as many high school mathematics and science courses as possible. The workshops consist of four summer programs varying from three days to ten days in duration, depending on the age of the students. Students participate in engineering demonstrations, tours, lectures, experiments, and games designed to introduce them to engineering careers.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | | X | | X | | X | X | X | X | X | X |

4

## Minority Introduction to Engineering

MITE
University of Arkansas
Fayetteville, Arkansas 72701

**Thomas Carter III,**
Director
501/575-6015

| | |
|---|---|
| Type of program | University |
| Total students/grades | 14 students in grade 11 |
| Staff | 2 full-time |
| Service period | Summer |
| Student contact | Daily for one week |

The University of Arkansas Minority Introduction to Engineering Program (MITE) was founded in 1976 as a one-week summer residential program designed to increase the awareness of engineering as a profession among minority students. The program offers activities that include hands-on experience in computer fundamentals, robotics, and field trips to corporations that employ engineers. Students also attend seminars to learn about the various engineering disciplines offered at the University of Arkansas.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | X | | | X | X | | | X | X | X |

## Engineering Summer Residency Program

ESRP
College of Engineering
University of California, Davis
Davis, California 95616

5

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 48 students in grades 11-12 |
| Staff | 13 full-time |
| Service period | Summer |
| Student contact | Daily for one week |

**Jane C. Elliott,**
Manager,
Minority Services
and Programs
916/752-7761

The University of California's Engineering Summer Residency Program was founded in 1975 by Dow Chemical and the Chemical Engineering Department at Davis but has expanded to all five disciplines in the School of Engineering. Through laboratories, lectures, design projects, and field trips, this one-week summer residential program introduces eleventh and twelfth graders to the challenges of an engineering education and the engineering profession. Campus staff provide workshops on college admissions and financial aid. Students live in university dormitories with minority engineering students as resident advisors/counselors.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | | X | | | X | | X | X | X | | X | | X |

6

## Interface Institute

8500 A Street
Oakland, California 94621

**Ann Bouie Wilson,**
Director
415/635-1755

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 60 students in grades 7-10 |
| Staff | 3 full-time, 10 part-time |
| Service period | Saturday, summer, after school |
| Student contact | Weekly, more than 6 hours/week |

Interface Institute (formerly Project Interface) was founded in 1982 through a joint effort of the Northern California Council of Black Professionals and the Allen Temple Baptist Church. Its purpose is to increase the pool of intermediate school students who are capable and prepared to go on to college, and to monitor and groom college students to attend and graduate from a four-year college, enter graduate school, or obtain full-time employment. Interface serves two populations: students in grades seven to ten who demonstrate academic potential but are underachievers; and college students majoring in mathematics and science.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X |

7

## Mathematics, Engineering, Science Achievement Program

MESA California
California State University
Bakersfield, California 93311

**J.R. Scott,**
Director
805/837-1215

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 531 students in grades 7-12 |
| Staff | 1 part-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Twice weekly, 3-5 hours/week |

The MESA program on the Bakersfield campus was founded in 1983 for the purpose of increasing the quantity and quality of underrepresented minority students who pursue mathematics-based professional careers. It is a part of the statewide MESA system based at the Lawrence Hall of Science at the University of California, Berkeley. The program serves over 500 junior and senior high school students with activities that include tutoring, high-tech industry field trips, role models, university tours, and academic competition. Each year the program offers $1,000 scholarships to several qualified students.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

8

## Mathematics, Engineering, Science Achievement Program/Minority Engineering Program

MESA/MEP California
University of California, Berkeley
Lawrence Hall of Science
Berkeley, California 94720

**Wilfred O. Easter,**
MESA Statewide
Director
415/642-5064

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 4,232 students in grades 7-12 at 16 sites* |
| Staff | 45 full-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Twice weekly, 3-5 hours/week |

The MESA program was created in 1970 by a group of Oakland public school teachers, faculty of the University of California at Berkeley, and staff of the State Department of Education. Its primary objective is to increase the number of underrepresented minority students who graduate from a four-year college or university with a degree in a mathematics or science-related field. The university program, MEP, is designed to recruit and retain minority students enrolled in engineering disciplines. The two programs serve nearly 8,000 students statewide from seventh grade through university graduation and are administered through colleges of engineering and physical sciences on twenty-two campuses.

MESA selects students with an aptitude and interest in mathematics and provides them with academic and enrichment activities such as study groups, field trips to industry, scholarship incentive awards, summer enrichment programs, freshman orientation, academic and career counseling, summer employment, and professional development training.

*Individual listings of nine of these sites are included in this directory. The necessary numerical adjustments have been made when providing the statistical information in Sections B and C.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Mathematics, Engineering, Science Achievement Program

MESA California
Harvey Mudd College
Claremont, California 91711

**Linda Dell'Osso,**
Director
714/621-8240

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 506 students in grades 7-12 |
| Staff | 1 full-time, 1 part-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Weekly, 1-2 hours/week |

The MESA Program at Harvey Mudd College is part of the statewide MESA Program based at the Lawrence Hall of Science at the University of California, Berkeley. For fifteen years, the MESA Program at Harvey Mudd has worked with students from historically underrepresented groups — African American, Mexican American, Native American and Puerto Rican — to help them meet their goals to enter a mathematics or science college program. MESA participants are an important source of future engineers, scientists, and mathematics professionals.

### Program Activities

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

10

## Mathematics, Engineering, Science Achievement Program

MESA California
School of Engineering
University of Southern California
Los Angeles, California 90089-1455

**Larry Lim,**
Director
213/743-2127

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 322 students in grades 7-12 |
| Staff | 1 full-time, 1 part-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Weekly, 1-2 hours/week |

The University of Southern California MESA Program was established in 1977 as part of the expansion of MESA in California. The USC-MESA Program currently works with eight high schools and three junior high schools and more than 300 students. Its objective is to increase the number of underrepresented minority students entering a mathematics-based major in college. Activities include: field trips, speakers, college and career advisement, mathematics and science activities, mathematics/science competitions, summer programs, tutoring, incentive awards, and teacher training.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Mathematics, Engineering, Science Achievement Program

MESA California
California State University, Northridge
Engineering 109
18111 Nordhoff Street
Northridge, California 91330

**Belinda A. Acuna,**
Director
818/885-2753

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 312 students in grades 7-12 |
| Staff | 2 full-time |
| Service period | Summer, school day, after school |
| Student contact | Weekly, 1-2 hours/week |

Part of the statewide MESA Program based at the Lawrence Hall of Science at the University of California, Berkeley, the mission of the California State University MESA Program is to increase the number of students from ethnic groups historically underrepresented in mathematics and science professions who complete a four-year university degree in a mathematics-based field. Program activities include organized study, summer enrichment programs, academic advising, scholarship incentive awards, MESA meetings, career exploration, and family involvement.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| x | x | x | | x | x | x | x | x | x | x | x | x | x | x | x |

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## Mathematics, Engineering, Science Achievement Program

MESA California
Capitol Center MESA
University of California, Sacramento
655 University Avenue
Sacramento, California 95825

**James Harold,**
Director
916/923-0844

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 725 students in grades 7-12 |
| Staff | 3 full-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Daily, 3-5 hours/day |

MESA is a public service program based at the Lawrence Hall of Science at the University of California, Berkeley. The purpose of MESA is to increase the number of historically underrepresented minority students — African American, Mexican American, Native American, and Puerto Rican — who have sound academic preparation, giving them the background necessary to complete a post-secondary education in mathematics and scientific disciplines.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | | | | | | | |

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## Mathematics, Engineering, Science Achievement Program

MESA California
College of Engineering, Room 403J
California State University, San Diego
San Diego, California 92182

**Susan Dixon,**
Director
619/265-4197

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 188 students in grades 7-12 |
| Staff | 1 full-time, 1 part-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Daily, 50 minutes<br>Weekly, 1-2 hours/week |

MESA is a public service program based at the Lawrence Hall of Science at the University of California, Berkeley. The purpose of MESA is to increase the number of historically underrepresented minority students — African American, Mexican American, Native American, and Puerto Rican — who have sound academic preparation, giving them the background necessary to complete a post-secondary education in mathematics and scientific disciplines.

The San Diego Regional MESA Center has been operating at San Diego State University since 1979. MESA is a collaborative effort involving students, teachers, parents, school districts, universities, industries, engineering societies, and professional and minority organizations. MESA's work enriches the educational program of junior and senior high school students in mathematics, science, and English, and prepares them for college matriculation.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |

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## MESA/Math Science Program

MESA/MSP
California State University, San Jose
School of Engineering, Room 491 B
1 Washington Square
San Jose, California 95192

**Roberto P. Chavez,**
Director
408/924-3835

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 354 students in grades 9-12 |
| Staff | 1 full-time, 1 part-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Weekly, 3-5 hours/week |

The Mathematics, Engineering, Science Achievement Program (MESA) is a public service program based at the Lawrence Hall of Science at the University of California, Berkeley. The purpose of MESA is to increase the number of historically underrepresented minority students — African American, Mexican American, Native American, and Puerto Rican — who have sound academic preparation, giving them the background necessary to complete a post-secondary education in mathematics and scientific disciplines.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

## Mathematics, Engineering, Science Achievement Program/Minority Engineering Program

MESA/MEP California
College of Engineering
University of California, Santa Barbara
Santa Barbara, California 93106

| | |
|---|---|
| Type of program | Combined precollege, university, and bridge |
| Total students/grades | 121 students in grades 7-12 |
| Staff | 4 full-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Weekly, 1-2 hours/week |

Part of the statewide MESA Program based at the Lawrence Hall of Science at the University of California, Berkeley, the MESA program at the University of California at Santa Barbara currently offers programs at the precollege and university levels. The precollege program, MESA, provides academic and career assistance to junior and high school students interested in pursuing careers in mathematics, science and engineering. The university program, MEP, is designed to recruit and retain minority students enrolled in engineering disciplines.

**Oscar J. Perez,**
Assistant to the Dean
805/961-4026

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Mathematics, Engineering, Science Achievement Program

MESA California
Stanford University
Building 530
Stanford, California 94305

**Harold Bannerman,**
Center Director
415/723-0550

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 200 students in grades 7-12 |
| Staff | 4 full-time |
| Service period | Saturday, summer, school day |
| Student contact | Weekly, 3-5 hours/week |

A part of the statewide MESA Program based at the Lawrence Hall of Science at the University of California, Berkeley, the MESA Program at Stanford has worked for fifteen years with students from historically underrepresented groups — African American, Mexican American, American Indian, and Puerto Rican — to help them enter a mathematics-based college program. MESA participants are an important source of future professional engineers, scientists, and mathematicians. MESA provides support through organized study, academic advising, summer enrichment programs, Saturday programs, scholarship incentive awards, MESA meetings, career exploration, and family involvement.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | | | | | | | |

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## Minority Engineering Program

MEP
Pre-Engineering Summer Program
University of California, Los Angeles
3161 Engineering 1
Los Angeles, California 90024-1600

**Rick Ainsworth,**
Director
213/206-6493

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 38 students in grades 9-11 |
| Staff | 5 full-time |
| Service period | Saturday, summer, school day |
| Student contact | Weekly, more than 9 hours/week<br>Monthly, 7-9 months/year |

The purpose of the UCLA Pre-Engineering Summer Program is to increase the pool of minority students who are prepared and motivated to enter the School of Engineering at UCLA. Students are chosen on the basis of their interest, ethnic group and gender, school location, and enrollment in appropriate mathematics and science courses. Qualified students participate in a seven-week instructional program that includes mathematics, English, introduction to computers, career/college planning seminars, and visits to industry. Nine UCLA faculty members sponsor students in research projects for six weeks.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |

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## Secondary School Science Project

SSSP
California Institute of Technology
10-63 Caltech
Pasadena, California 91125

**Lee F. Browne,**
Director and
Lecturer
818/356-6207

| | |
|---|---|
| Type of program | Combined precollege, university, and bridge |
| Total students/grades | 546 students in grades 7-12 |
| Staff | 2 part-time |
| Service period | Saturday, summer |
| Student contact | Daily, during the summer<br>5 hours/week, during the school year |

The California Institute of Technology's Secondary School Science Project (SSSP) was founded in 1969 for the academic enrichment of junior and senior high school minority students in mathematics, science, and engineering. Classes meet from October through May on Saturdays, and for seven weeks during the summer.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | | X | X | X | X | X | X | X | X | X | X | X | X | X |

## American Indian Science and Engineering Society

Summer Math Camps
Suite 1506
1085 14th Street
Boulder, Colorado 80302-7309

**Norbert Hill,**
Executive Director
**Cathy Abeita,**
Precollege Director
303/492-8658

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 127 students in grades 7-9 |
| Staff | 3 part-time |
| Service period | Summer |
| Student contact | Weekly, more than 9 hours/week |

Founded in 1977, the American Indian Science and Engineering Society (AISES) seeks to increase the number of American Indian scientists and engineers in the nation and develop technological leaders within the Indian community. The objective of AISES is to help American Indians become self-reliant and self-determined members of society.

AISES provides training for teachers serving American Indian students in order to improve the quality of mathematics and science instruction. Since 1981, AISES has provided teacher training for approximately 10,000 teachers.

In 1988, AISES launched a national network of summer mathematics camps for students in grades seven to nine. These camps offer experientially based, culturally sensitive mathematics instruction; field trips to colleges and industries; guest speakers such as American Indian mathematicians, engineers, and other role models; and parent counseling.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | | | X | | X | | X |

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## Colorado Minority Engineering Association

CMEA, MESA Colorado
College of Engineering
University of Colorado, Denver
1200 Larimer Street, Campus Box 104
Denver, Colorado 80204-5300

**Gloria Nelson,**
Acting Executive Director
303/556-2344

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 1,381 students in grades 7-12 |
| Staff | 2 full-time |
| Service period | Summer, after school |
| Student contact | Weekly, 1-2 hours/week |

The Colorado Minority Engineering Association, Inc. (CMEA) was formed in 1978 to provide educational support services to minority high school students in the state of Colorado in order to increase their representation in the fields of engineering, science, and technology. The MESA precollege program begins in the seventh grade and continues through the twelfth grade.

Activities for middle school students concentrate on enhancing mathematics, science, and communication skills in preparation for their college preparatory curriculum in high school. MESA also encourages parents to join the MESA Concerned Parents, Inc. group to reinforce support for the MESA program at school and their child's participation and work at home. At the high school level, MESA provides tutoring, design and science projects, role models, summer enrichment programs, field trips, speakers, and other motivation incentives.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

## Denver Educational Excellence Program

DEEP
c/o Denver Public Schools
3800 York Street Unit B
Denver, Colorado 80205

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 219 students in grades 7-12 |
| Staff | 4 full-time |
| Service period | School day, after school |
| Student contact | Weekly, 1-2 hours/week<br>Monthly, 1-3 months/year |

**Clementine Pigford,**
Program Manager
303/837-1000, Ext. 2817

The Denver Educational Excellence Program (DEEP), formerly known as the Denver Educational Entry to Energy Program (DEEEP) was implemented in 1980 by a group of educators and administrators who were concerned about the underrepresentation of minorities in the field of engineering and other technical areas. It is a not-for-profit organization designed to assist students in attaining the skills necessary to enter scientific fields such as engineering, medicine, and other technical professions. While the program is open to all students in the Denver public schools, DEEP gives special consideration to female and minority students to maximize their potential for achievement in the areas of mathematics, science, and English.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | | X | X | X |

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## Summer Minority Engineering Training Program

SUMMET
Colorado School of Mines
Golden, Colorado 80401

**Harold Cheuvroat,**
Dean of Student Affairs
303/273-3234

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 54 students in grade 11 |
| Staff | 1 part-time |
| Service period | Summer |
| Student contact | Weekly, more than 9 hours/week |

Founded in 1970, the Summer Minority Engineering Training Program (SUMMET) is an intensive four-week summer program that gives qualified minority students the opportunity to live on the campus of the Colorado School of Mines and explore the fields of engineering, science, and mathematics. The goal of the program is to encourage minority students to attend college and to consider engineering and the sciences as a career.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | X | X | X | | X | | X | X | X | X | | X | X | X |

## Connecticut Pre-Engineering Program

CPEP
950 Trout Brook Drive
West Hartford, Connecticut 06119

**Glenn A. Cassis,**
Executive Director
203/236-2961

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 221 students in grades 7-12 |
| Staff | 2 full-time, 16 part-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Twice weekly, 3-5 hours/week |

The Connecticut Pre-Engineering Program (CPEP) was initiated in 1986 by the director of the Science Museum of Connecticut with forty-seven students in one middle school in Hartford. It has since expanded to over 200 students in twelve schools in Hartford, Bridgeport, and New Haven. The goal of CPEP is to identify minority students in the upper elementary grades who have the potential for college-level work in the technical areas and then to prepare them for college entrance by providing a strong foundation in mathematics, the sciences, and engineering.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | | | |

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## Engineering for Deserving Youth Program

EDY
University of Bridgeport
Bridgeport, Connecticut 06601

**Richard A. Strand,**
Director
203/576-4712

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 76 students in grades 10-12 |
| Staff | 8 part-time |
| Service period | Summer |
| Student contact | Daily, for 6 weeks |

Engineering for Deserving Youth (EDY) offers a six-week precollege summer enrichment program designed to give minority high school students and graduates a chance to explore career opportunities and prepare for college. Initiated by the College of Science and Engineering at the University of Bridgeport in 1971, the program offers study skills building and instruction in mathematics, physics, chemistry, computers, and communication on the university campus. Special seminars with engineering faculty and industrial representatives, as well as visits to industry, are part of the curriculum.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | | | | | X | X | X |

## Forum to Advance Minorities in Engineering

FAME, Inc.
Suite 4-3
Montchanin Building
100 West 10th Street
Wilmington, Delaware 19801

**Guizelous O. Molock,**
Executive Director
302/773-5806

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 254 students in grades 7-12 |
| Staff | 2 full-time, 20 part-time |
| Service period | Saturday, summer |
| Student contact | Daily, during the summer<br>Twice monthly, more than 10 months/year |

The Forum to Advance Minorities in Engineering (FAME) began in 1977 with a six-week program for sixty-nine minority middle school students. Today FAME prepares more than 200 students in grades seven to twelve to enter college and complete a science degree. FAME exposes minority students to cultural, academic, and industrial environments, provides minority role models in the engineering and technical fields, and encourages the cooperation and support of local industry, education, government, and community organizations.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Resources to Insure Successful Engineers

RISE
College of Engineering
University of Delaware
135 DuPont Hall
Newark, Delaware 19716

**Frank A. Wells, Jr.,**
Director
302/451-6315

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 62 students in grades 11-12 |
| Staff | 4 full-time |
| Service period | Summer |
| Student contact | Daily, for 6 weeks |

Resources to Insure Successful Engineers (RISE) was established in 1977 by the University of Delaware as a summer academic enrichment program for talented minority high school students who demonstrate abilities for success in applied science and engineering. Its goal is to encourage participants to pursue an engineering degree at the University of Delaware.

During the six-week program, students receive intensive supplemental course work in mathematics (calculus, pre-calculus, algebra II), physics, chemistry, computer orientation, communication skills, and an engineering design seminar, as well as guidance in preparing for college entrance. RISE requires students to live in dormitories on the campus for the duration of the program.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | X | X | X | X | X | X | | X | | X |

## District of Columbia Metropolitan Consortium for Minorities in Engineering

METCON
The School of Engineering
Howard University
2300 Sixth Street, N.W.
Washington, DC 20059

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 841 students in grades 7-12 |
| Staff | 2 full-time |
| Service period | Summer, school day, after school |
| Student contact | Weekly, 1-2 hours/week<br>Monthly, 7-9 months/year |

**Dr. Elbert L. Cox,**
Associate Dean/
Executive Director
202/636-6638

METCON was established with an initial grant from Exxon to Howard University to deliver technical information and technology-oriented resources to junior and senior high school students in the D.C. metropolitan area. The primary objective of METCON is to increase the interest and enrollment in engineering of students from the area's minority groups. The consortium is composed of junior and senior high schools, engineering schools, industrial firms, government agencies, professional societies, and community groups.

At the junior high school level, METCON's academic year program is focused on monthly classroom presentations to selected students. At the senior high school level, the focus is on engineering clubs. These clubs, under the supervision of engineers and scientists, provide students with an opportunity to apply science and engineering principles to practical projects and to visit engineering facilities. Summer programs provide a follow-up to the academic year activities and an opportunity, in some cases, for students to gain work experience in a technical environment.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | | X | X | X | | X | X | X | X | X | X | X | X |

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## Minority Engineering Program

MEP
University of Central Florida
P.O. Box 25000
Orlando, Florida 32816-0450

**Jacqueline A. Smith,**
Coordinator
407/281-5740

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 274 students in grades 9-12 |
| Staff | 1 full-time, 1 part-time |
| Service period | Summer, school day |
| Student contact | Weekly, more than 9 hours/week<br>Monthly, more than 10 months/year |

The University of Central Florida's Minority Engineering Program (MEP) was founded in 1986 to increase the number of minority students interested and prepared to pursue the study of engineering. The precollege program encourages high school students to follow an academic curriculum, to enroll in advanced mathematics, science, and language arts courses, and to improve their grades. The university program is designed to assist students majoring in the field of engineering to remain in college and graduate as engineers. It provides a center for academic assistance, individual career and personal counseling, employment referrals, peer counseling, and a mentor program.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | | X | | X | X | X | X | |

## Freshman Engineering Workshop

FEW
College of Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332-0360

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 35 students in grades 8-9 |
| Staff | 2 part-time |
| Service period | Summer |
| Student contact | Daily for one week |

**Dr. Lytia R. Howard,**
Director of Special Programs
404/894-3354

The Freshman Engineering Workshop (FEW), founded in 1983, provides an opportunity for students in the Atlanta area to explore the engineering profession and the Georgia Institute of Technology. For one week, ninth grade students from minority backgrounds visit the campus daily and learn about careers in engineering. The objective is to encourage students to begin planning early in their education for college and a career in technology or engineering. Activities include field trips, film presentations, and demonstrations conducted by the Schools of Mathematics, Chemistry, and Physics, and discussions with Georgia Tech students, faculty, and practicing minority engineers.

### Program Activities

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | | | X | | X | | | X | X | | | | | X |

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## Minority Introduction to Engineering

MITE
College of Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332-0360

**Dr. Lytia R. Howard,**
Director of Special Programs
404/894-3354

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 57 students in grade 11 |
| Staff | 3 part-time |
| Service period | Summer |
| Student contact | Daily for one week |

Minority Introduction to Engineering (MITE) is a summer program sponsored by the Georgia Institute of Technology's College of Engineering with the assistance of undergraduate minority students. The program is designed to motivate able high school minority students in fourteen states and Puerto Rico to consider careers in engineering. Since MITE is funded primarily by corporate contributions, students participate at no cost, except for transportation to and from the program. Through the MITE program, students receive six nights of dormitory lodging, all meals at campus dining facilities, transportation to field trip sites, and paid admission to group recreational activities.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | | X | X | X | | | X | | X |

## Precollege Engineering Program

PREP
College of Engineering
Georgia Institute of Technology
Atlanta, Georgia 30332-0360

**Dr. Lytia R. Howard,**
Director of Special Programs
404/894-3354

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 60 students in grades 10-12 |
| Staff | 3 part-time |
| Service period | Summer |
| Student contact | Daily for one week |

The Precollege Engineering Program (PREP) is a summer residential program on the Georgia Tech campus sponsored by the College of Engineering with the assistance of undergraduate students. The program is designed to motivate high school juniors and seniors across the country and Puerto Rico to consider careers in engineering. The activities include film and slide presentations, participation in engineering-related experiments, visits to the university's engineering schools, panel discussions with current engineering students, a mini-career fair, and workshops with industrial representatives.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | | | X | X | | | X | X | | | | X | X |

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## Southeastern Consortium for Minorities in Engineering

SECME
c/o Georgia Institute of Technology
Atlanta, Georgia 30332-0270

**R. Guy Vickers,**
Executive Director
404/894-3314

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 24,354 students in grades 7-12 |
| Staff | 7 full-time, 4 part-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Twice weekly, 6-8 hours/week |

The Southeastern Consortium for Minorities in Engineering (SECME) was established in 1975 by the deans of engineering from six universities for the purpose of increasing the number of underrepresented minorities in engineering professions. Today SECME's network links twenty-seven universities and sixty corporations to serve more than 24,000 students in 225 schools throughout seven southeastern states.

SECME programs operate within the existing educational structure at the middle and secondary school levels. Students identified as achievers and those with potential to achieve are nominated by teachers or counselors to participate. The programs are administered by a school-based team of principal, counselor, and mathematics and English teachers. This team is trained at SECME's Summer Institute to use new methods for curriculum enrichment, to use the microcomputer as an instructional tool, to explain the opportunities available in engineering, and to describe the prerequisites for engineering school.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

## Early Identification Program

EID
Illinois Institute of Technology
3200 South Wabash Avenue
Chicago, Illinois 60616

**Carmen Suarez**
Associate Director,
Pre-University and
Minority Program
312/567-5111

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 110 students in grades 10-11 |
| Staff | 5 full-time |
| Service period | Saturday, summer |
| Student contact | Weekly, more than 9 hours/week |

The Early Identification Program (EID) sponsored by the Illinois Institute of Technology began in 1974 as part of a national effort to increase the number of minorities in the field of engineering. EID offers both academic enrichment and hands-on engineering projects, as well as a communication skills and a business component. The primary objective of the program is to provide students with information, resources, and motivational support that help them translate promising academic ability into academic credentials.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | | X | | | X | X | X | X | X | | | X | | X |

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## Math Counts Tutorial Program

4510 South Michigan Avenue
Chicago, Illinois 60653

**Michael Hyatt,**
Education Specialist
312/285-5800,
Ext. 439

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 200 students in grades 9-12 |
| Staff | 23 part-time |
| Service period | School day, after school |
| Student contact | Weekly, 2 hours/week |

Math Counts is a tutorial program that began in Chicago in 1981 when it became apparent that few minority students from the inner-city high schools were competing in regional and state mathematics contests. Beginning in October, Math Counts selects eight high achieving mathematics students at each participating high school and offers them two hours of tutoring a week in algebra, geometry, algebra/trigonometry, and pre-calculus to prepare them to compete in the regional contest and go on to compete at the state level. Not only does Math Counts furnish minority students with competitive skills, it also improves classroom performance, encourages students to pursue mathematics-related occupations and hard sciences, improves standardized test scores, and enhances self-esteem.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | X | | X | X | X | | | | | | | | |

## Midtown Achievement Program

MAP
Midtown Center
718 South Loomis Street
Chicago, Illinois 60607

**Arthur B. Thelen**
Executive Director
312/733-1016

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 235 male students in grades 7-11 |
| Staff | 6 full-time |
| Service period | Saturday, summer, after school |
| Student contact | Daily, during the summer<br>Twice weekly, 3-5 hours/week, during the school year |

A group of Chicago businessmen founded the Midtown Center in 1965 as a tutoring, sports, and vocational program for low-income youths in a local neighborhood. By 1985, the program had shifted its focus to academic and character enrichment. Through a balanced and carefully planned academic program, the Midtown Achievement Program (MAP) provides supplementary education to junior high and high school minority students to improve their ability to get into better colleges and prepare them for professions.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Planning Ahead for Science and Engineering

PASE
School of Engineering
Southern Illinois University, Edwardsville
Edwardsville, Illinois 62026-1804

**Janet McReynolds,**
Assistant to the President
618/692-2829

| | |
|---|---|
| Type of program | University |
| Total students/grades | 54 students in grade 12 |
| Staff | 2 part-time |
| Service period | Saturday, summer |
| Student contact | Daily, for 6 weeks, during the summer<br>Twice monthly, 4-6 months/year |

Planning Ahead for Science and Engineering (PASE) at Southern Illinois University assists selected minority and female high school seniors who are interested in entering the fields of engineering and science. Students qualify for participation on the basis of their academic performance on standardized tests, their high school records, and recommendations from two teachers or counselors. PASE offers a six-week summer session before senior year, twelve Saturday sessions during senior year, and money and tuition for a summer session before college entrance. Students learn about careers in science and engineering, visit minority and women scientists at work, prepare for standardized tests, and acquire a basic knowledge of microcomputers.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | X | X | | X | X | X | | X | X | X |

## Pre-Freshman Program in Engineering and Science

Chicago State University
95th Street at King Drive
Chicago, Illinois 60628-1598

**Terri Jones Young,**
Director
312/995-2357

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 30 students in grades 7-8 |
| Staff | 1 full-time |
| Service period | Summer |
| Student contact | Weekly, more than 9 hours/week |

The Chicago State University Office of Engineering Studies held its first Pre-Freshman Program in Engineering and Science in 1988. The purpose of the program is to stimulate the interest of elementary and junior high school students in engineering as a profession, and encourage them to take more mathematics and science courses in high school. The program offers activities that highlight the courses required to pursue a career in engineering and demonstrates that these areas of study are exciting and within the students' capabilities.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | X | X | | | X | | X | | X |

38

## Role Model Experiences/Engineering Mentoring Program

School of Engineering
Southern Illinois University
Edwardsville, Illinois 62025-1804

**Sandra M. English,**
Director
618/692-2829

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 40 students in grades 8 and 11 |
| Staff | 2 part-time |
| Service period | Saturday, school day |
| Student contact | Monthly, 7-9 months/year |

Beginning in the 1986-87 academic year, Southern Illinois University, in collaboration with the St. Louis Public Schools, established the Role Model Experiences/Engineering Mentoring Program. Monthly seminars introduce junior and senior high school minority students to role models in the field of engineering and include trips to engineering workshop sites. The seminars help motivate and prepare students academically for careers in engineering. In Saturday sessions, volunteer engineering mentors from local industry work with small teams of students on special projects.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | | X | X | X | | | X | X | X |

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## Engineering Preview

Minority Engineering Program
ENAD, Room 211
Purdue University
West Lafayette, Indiana 47907

**Marion W. Blalock,**
Director
317/494-3974

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 70 students in grade 12 |
| Staff | 2 full-time |
| Service period | School day |
| Student contact | Daily, 2-day program |

Engineering Preview, designed for minority students who have been offered admission to the Purdue School of Engineering, is an annual program sponsored jointly by the Department of Freshman Engineering and the Purdue chapter of the National Society of Black Engineers. The program's purpose is to provide students with information about Purdue before they make their final college selection. The program provides tours of the Engineering School and outlines the educational and social services available at the university. Applicants have the opportunity to discuss their questions and concerns with faculty, staff, and engineering students.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | | | X | | X | | | | X |

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## Minority Engineering Advancement Program

MEAP
Purdue University at Indianapolis
799 West Michigan Street
Indianapolis, Indiana 46202

**Karen Parrish Baker,**
Director of Minority Affairs
317/274-2943

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 131 students in grades 6-12 |
| Staff | 1 full-time, 1 part-time |
| Service period | Saturday, summer |
| Student contact | Weekly, more than 9 hours/week<br>Monthly, 4-6 months/year |

The Minority Engineering Advancement Program (MEAP) was founded in 1974 at the Purdue University School of Engineering and Technology at Indianapolis to increase the number of African Americans, Hispanics, and American Indians entering engineering and engineering-related fields. This goal is achieved through early identification and encouragement of academically promising minority students in grades six to twelve. During the students' junior and senior years, they participate in summer workshops, which include industry tours, mathematics competitions, and recreation. They also attend monthly workshops on Saturdays during the school year. Their precollege experiences culminate in jobs provided by local industry. On the college level, MEAP provides minority scholarships, employment and personal counseling, and referral services.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | X | X | X | X | X | X | X | X | X | X | X | X | | |

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## Minority Introduction to Engineering

MITE
ENAD. Room 211
Purdue University
West Lafayette, Indiana 47907

**Marion W. Blalock,**
Director
317/494-3974

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 58 students in grade 11 |
| Staff | 5 full-time, 8 part-time |
| Service period | Summer |
| Student contact | Daily, for 2 weeks |

Purdue University's Minority Introduction to Engineering (MITE) is a two-week summer residential program designed to give minority high school rising seniors an opportunity to sample the various engineering fields. The program offers instruction in the use of the computer for solving engineering problems, lectures by faculty and other professionals, hands-on laboratory experience, and guidance not only in planning and preparing for college but also in successfully completing an engineering degree.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | | X | X | | X | | | | X |

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## Purdue's Recruitment of Minorities Interested in Schools of Engineering

PROMISE
Minority Engineering Program
ENAD, Room 211
Purdue University
West Lafayette, Indiana 47907

**Marion W. Blalock,**
Director
317/494-3974

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 38 students in grades 11-12 |
| Staff | 2 full-time |
| Service period | School day |
| Student contact | Daily, 2-day program |

Purdue's Recruitment of Minorities Interested in Schools of Engineering (PROMISE) is a special two-day program on the Purdue University campus organized by the university's Minority Engineering Program. The program is offered to minority students in grades eleven and twelve who are interested in investigating career possibilities in the field of engineering. The purpose of the program is to provide information about college admission and financial aid procedures, and the freshman engineering curriculum. Activities include a campus tour, visits to engineering laboratories, social events, and an opportunity to meet faculty, staff, and students.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | | X | X | X | X | | | X | X |

## Purdue University Pre-Freshman and Cooperative Education

PREFACE
Minority Engineering Program
ENAD. Room 211
Purdue University
West Lafayette, Indiana 47907

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 25 students in grades 9-10 |
| Staff | 5 full-time, 7 part-time |
| Service period | Summer |
| Student contact | Daily for one week |

**Marion W. Blalock,**
Director
317/494-3974

Purdue University's Pre-Freshman and Cooperative Education Program (PREFACE) is a special summer program available to minority students who are about to enter sophomore or junior year in high school and are interested in investigating career possibilities in the field of engineering. The program is designed to give students an early opportunity to sample engineering courses on the Purdue campus. PREFACE also provides participants with a unique chance to look into education and career opportunities in engineering, to work on engineering-related projects, and to develop new study skills and learning habits.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | | | X | X | X | X | | | X | X |

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## 7th and 8th Grade Summer Engineering Workshop

SEW
Minority Engineering Program
ENAD, Room 211
Purdue University
West Lafayette, Indiana 47907

**Marion W. Blalock,**
Director
317/494-3974

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 97 students in grades 7-8 |
| Staff | 5 full-time, 7 part-time |
| Service period | Summer |
| Student contact | Daily, for 2 weeks |

Each summer, Purdue University's Minority Engineering Program holds two one-week engineering workshops on the West Lafayette campus for minority students who have completed seventh or eighth grade. The workshops consist of hands-on engineering projects, tours of engineering laboratories and facilities, and discussions with engineering students and professionals. Purdue's admissions staff discuss the importance of high school studies to later success in college, and suggest the courses necessary to prepare for a college degree in the technical fields.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | | X | X | | X | | X | | X |

## Mid-America Consortium for Engineering and Science Achievement

MACESA
Kansas State University
144 Durland Hall
Manhattan, Kansas 66506

**Tom Cummings,**
Director
913/532-5949

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 304 students in grades 7-12 |
| Staff | 1 full-time, 1 part-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Weekly, 1-2 hours/week |

The Mid-America Consortium for Engineering and Science Achievement (MACESA) was founded in 1985 at Kansas State University in collaboration with five other universities. MACESA serves seventeen high schools in eight school districts in Kansas, Nebraska, and Missouri. The program selects middle and high school minority students to participate based on their potential to succeed in a college preparatory program. MACESA guides these students through college preparatory classes and enrichment activities in order to enhance their ability to complete college degrees in science, mathematics, and engineering.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## University of Kansas Summer Early Entry Program

INROADS
University of Kansas
4010 Learned Hall
Lawrence, Kansas 66044

**Florence E. Boldridge,**
Director
913/864-3620

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 20 students in grade 11 |
| Staff | 2 full-time |
| Service period | Summer |
| Student contact | Daily, for 8 weeks |

INROADS is a career development organization established in Kansas City in 1979 for the purpose of recruiting high school students and preparing them for the business and technical world. INROADS offers an eight-week summer residential program at the University of Kansas for students who have completed their junior year in high school with a minimum grade point average of 2.7. Participants take college classes and are given a taste of college life. They receive internships at one of INROADS's fifty member corporations for four consecutive summers before they graduate.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | X | | X | X | X | | | | | X |

## Increasing Career Opportunities for Minorities in Engineering

INCOME, Inc.
c/o DuPont
4200 Camp Ground Road
Louisville, Kentucky 40216

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 85 students in grades 6-11 |
| Staff | 6 part-time |
| Service period | Summer, school day, after school |
| Student contact | Daily, during the summer<br>Twice monthly, during the school year |

Increasing Career Opportunities for Minorities in Engineering (INCOME) was founded in 1977 to increase representation of minorities in the high technology engineering professions and related fields. The highlight of INCOME's activities are INCREASE and INSPIRE, two five-week summer enrichment programs for middle and high school students. INCOME also offers an advanced INSPIRE program for enrolling college freshmen, who earn college credit for their participation.

During the school year, as many as 5,000 additional students may participate in programs providing career information, field trips, and an annual Engineering Exposition, which includes project and academic competition.

**Wade Campbell,**
Chairman of the Board
**Karl Turner**,
Secretary
502/569-3261

### Program Activities

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | x | x | x | x | x | x | | x | x | | x | x | | x | x |

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## Engineering Summer Institute

ESI
College of Engineering
Southern University
Baton Rouge, Louisiana 70813

**Prof. Thomas L. Henderson,**
Assistant Dean
504/771-3798

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 155 students in grades 7-12 |
| Staff | 23 part-time |
| Service period | Summer |
| Student contact | Daily, for 4 weeks |

The Engineering Summer Institute (ESI) began in 1975 to focus on increasing the pool of minority students prepared to enter the fields of engineering, science, and technology. It is a four-week residential program on the campus of Southern University. Students are selected on the basis of academic achievement, recommendations, test scores, and an interest in engineering. The institute has five components: course work, laboratories, project design, field trips, and counseling.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

## Louisiana Engineering Advancement Program for Minorities

LEAP
c/o Xavier University of Louisiana
7325 Palmetto Street
New Orleans, Louisiana 70125

**George W. Baker,**
Executive Director
504/483-7645

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 433 students in grades 6-12 |
| Staff | 3 full-time |
| Service period | School day, after school |
| Student contact | Weekly, 1-2 hours/week<br>Monthly, 7-9 months/year |

Louisiana Engineering Advancement Program for Minorities (LEAP) was initiated in 1980 in three high schools and three middle schools in the city of New Orleans for the purpose of fostering an interest in engineering and science-related careers among minority students. The program accomplishes this goal through activities that focus on motivation, career counseling, and curriculum enhancement.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Recruitment into Engineering of High Ability Minority Students

REHAMS
College of Engineering
3304 CEBA
Louisiana State University
Baton Rouge, Louisiana 70803-6401

**Forrest Smith,**
Coordinator
504/388-5701

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 10 students in grade 11 |
| Staff | 1 part-time |
| Service period | Summer |
| Student contact | Daily, for 4 weeks |

Since 1978, the Louisiana State University College of Engineering has conducted a precollege summer program for minority students between their junior and senior years in high school. The four-week residential program, REHAMS-Phase 1 (Recruitment into Engineering of High Ability Minority Students), offers qualified students an opportunity to develop a realistic concept of the kinds of activities and thinking that characterize the engineering profession. The program challenges and stimulates students to develop their interest, creativity, and talent in solving problems using engineering design methodologies. On field trips to local industries, students see the accomplishments of the engineering profession in the past and opportunities for the future.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | | | | | X |

## Mathematics, Engineering, Science Achievement Program

MESA Maryland
Applied Physics Laboratory
Johns Hopkins University
Johns Hopkins Road
Laurel, Maryland 20707

**Robert H. Willis,**
Director
301/953-5382

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 203 students in grades 7-12 |
| Staff | 2 full-time |
| Service period | After school |
| Student contact | Twice weekly, 3-5 hours/week |

The Maryland Mathematics, Engineering, Science Achievement Program (MESA) began in 1976 at two high schools and expanded to five by 1986. The long-range goal is for expansion to a statewide Maryland MESA Program. The purpose of MESA is to increase the number of minorities and women in mathematics, engineering, and science-related professions, at both the technical and management levels. Participating middle and high school students meet after school on a weekly basis to receive the educational enrichment and practical assistance they need to prepare them for university-level programs.

Once selected for the MESA Program, students participate in a wide variety of experiences aimed at improving their academic skills, especially in the areas of mathematics and science, broadening their understanding of these fields, and increasing their awareness of opportunities in college.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Engineering Career Orientation

ECO
Minority Engineering Program
University of Massachusetts
128 Marston Hall
Amherst, Massachusetts 01003

**Dwight L. Tavada,**
Associate Director
413/545-2030

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 35 students in grades 8-12 |
| Staff | 2 part-time |
| Service period | Summer |
| Student contact | Daily, for 2-3 weeks |

Engineering Career Orientation (ECO) is a summer residential program at the University of Massachusetts that runs for two weeks for minority students in grades eight and nine, and three weeks for students in grades ten through twelve. Initiated in 1974 to stimulate interest among minority students in engineering, science and related technical fields, ECO's goal is to acquaint young students with the learning process and to reinforce the notions that success and the setting and achievement of personal goals are available to them only through dedication and persistence. Activities focus on hands-on laboratory experience, chemistry, writing, computer proficiency, and presentations by recent college graduates.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | X | | X | X | X | X | | X | X | X |

## Massachusetts Pre-Engineering Program, Inc.

MASSPEP, Inc.
553 Huntington Avenue
Boston, Massachusetts 02115

**Robert C. Hayden,**
Executive Director
617/427-7227

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 513 students in grades 7-12 |
| Staff | 4 full-time, 2 part-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Weekly, 3-5 hours/week |

The Massachusetts Pre-Engineering Program (MASSPEP) was founded in 1979 by Boston area industries, university engineering schools, and the Boston and Cambridge school districts to improve the mathematics and science skills of high school minority students and prepare them for successful entrance into undergraduate engineering programs. The program has expanded from 150 students in five high schools to over 500 students in nine high schools and twelve middle schools. MASSPEP offers opportunities for students to apply mathematics and science skills in independent research projects, and provides contact with professional engineers who act as role models and introduce students to the engineering environment. MASSPEP also provides education in communication skills, writing and speaking, and interpersonal skills.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | | X | | X | X | X | X | X | |

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## Accelerate Students Potentially Interested in Research and Engineering

ASPIRE
2421 Corunna Road
Flint, Michigan 48503

**Ron Knox,**
Director
313/762-1952

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 508 students in grades 8-12 |
| Staff | 2 full-time |
| Service period | Summer, after school |
| Student contact | Weekly, 6-8 hours/week |

The Flint Public Schools conceived Accelerate Students Potentially Interested in Research and Engineering (ASPIRE) for the purpose of developing and implementing early intervention strategies to increase the number of minority high school students entering the engineering profession. Professors from local universities teach enrichment courses in science, chemistry, physics, bio-engineering, and robotics to students in grades eight to twelve who have high academic potential or good academic potential but poor motivation. Through role models, after-school class assignments, and field trips, ASPIRE exposes students to the engineering field and encourages and prepares them for college.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | | X | | | | X | X | | X | X | X | X | | X | X |

## Detroit Area Precollege Engineering Program

DAPCEP
Rackham Memorial Building
60 Farnsworth
Detroit, Michigan 48202-1226

**Kenneth Hill,**
Executive Director
313/831-3050

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 1,780 students in grades 7-12 |
| Staff | 5 full-time, 2 part-time |
| Service period | Saturday, summer, school day |
| Student contact | Varies from school to school |

The Detroit Area Precollege Engineering Program (DAPCEP) was founded in 1976 with a commitment to increase the number of minority students motivated and prepared to pursue a science or engineering education. DAPCEP operates programs in twenty middle and ten high schools for 1,780 students in conjunction with Michigan State University, the University of Michigan-Ann Arbor, University of Michigan-Dearborn, University of Detroit, Oakland University, and Wayne State University.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | | X | | | X | | | X | X |

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## Detroit Area Precollege Engineering Program

DAPCEP
Michigan State University
G54 Wilson Hall
East Lansing, Michigan 48824-1208

**Bertha Green Roach,**
MSU DAPCEP
Director
517/355-8310

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 30 students in grades 10-12 |
| Staff | 10 part-time |
| Service period | Summer |
| Student contact | Daily, for 6 weeks |

The Detroit Area Precollege Engineering Program (DAPCEP) offers a six-week summer session at Michigan State University for thirty minority juniors and seniors who have expressed an interest in engineering and have already taken a number of mathematics and science courses. The program offers course work in algebra, computer science, and communication skills (writing, reading, and speaking) taught by College of Engineering faculty and professional engineers. The purpose is to introduce students to the more rapid and rigorous pace of college courses. Structured evening study sessions are held four evenings per week for three hours each during which tutors assist students with class assignments. Students also participate in workshops on stress management and study skills, and a minimum of four field trips, as well as a tour of the university campus and library.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | X | X | X | | | | | X | X | X |

## Engineering Industrial Support Program

EISP
2316 EECS Building
1301 Beal Avenue
Ann Arbor, Michigan 48109-2116

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 146 students in grades 7-12 |
| Staff | 1 full-time |
| Service period | Saturday, summer, after school |
| Student contact | Twice monthly, 7-9 months/year |

**Derrick E. Scott,**
Director
313/764-6497

The Engineering Industrial Support Program (EISP) was founded in 1977 by the University of Michigan College of Engineering and two divisions of Ford Motor Company. The program is targeted at Washtenaw County students and is designed to introduce and prepare minority students for the field of engineering. EISP works with students in grades seven to twelve and beyond with Ford summer internship and scholarship programs. Program activities include science fair projects and competitions, field trips, academic and industrial presentations, career exposure, Saturday classes, and summer academic and research apprentice programs.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | | | X | | X | X | X | X | X | X | X | | X | | |

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## Mid-Michigan Minority Pre-Engineering Program

M³PEP
P.O. Box 1382
Midland, Michigan 48640

**Arthur Priestley,**
President
517/757-7261
517/781-0203

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 350 students in grades 6-11 |
| Staff | 16 part-time |
| Service period | Saturday, summer |
| Student contact | Weekly, 6-8 hours/week |

The superintendent of Midland Public Schools and the manager of the Office of Equal Employment Opportunity for the Dow Corning Company organized mid-Michigan area businesses, professional organizations, and educational institutions in 1982 to set up the Mid-Michigan Minority Pre-Engineering Program (M³PEP). It provides enrichment courses in mathematics and science for minority and low-income youth from grades six to eleven.

The program offers field trips and summer workshops in writing, problem solving, career exploration, hands-on application of physical science, engineering, technology, mathematics, science, and physics. M³PEP also provides assistance in curriculum development for secondary schools to prepare students for college engineering programs, disseminates information about technical career opportunities to educational institutions, students, and parents, and encourages local industry to create job opportunities in engineering and science.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | | X | | | X | | X | | | X | X | X | X | X |

## Project Technical and Business

TAB
Lawrence Institute of Technology
21000 West Ten Mile Road
Southfield, Michigan 48075

**Oliver S. Coleman,**
Director
313/356-0200

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 517 students in grades 10-12 |
| Staff | 1 full-time, 1 part-time |
| Service period | Summer, school day |
| Student contact | Daily, for 8 weeks, during the summer<br>Twice monthly, more than 10 months/year |

The principal objective of Project Technical and Business (TAB), founded in 1976 at the Lawrence Institute of Technology, is to increase the number of minorities and women in the fields of business, engineering, science, and technology. The program operates in two phases: the Summer Careers and Leadership Institute, and the In-School Clubs. In the first phase, forty selected students spend eight weeks in the summer acquiring organizational and leadership skills needed to lead the In-School Clubs. The school clubs offer additional qualified students vocational exploratory experiences, educational and career guidance, role models and mentors, college admission and financial aid counseling, and instruction in communication skills.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X |

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## Project Technology Power

Institute of Technology
339 Walter Library
117 Pleasant Avenue, S.E.
University of Minnesota
Minneapolis, Minnesota 55455

**Don Birmingham,**
Director
612/626-0219

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 280 students in grades 8-10 |
| Staff | 2 full-time |
| Service period | Saturday, summer |
| Student contact | Daily, for 7 weeks, during the summer<br>Monthly, 4-6 months/year |

Project Technology Power's precollege program is designed to enhance the academic foundation of minority students so that they are prepared to succeed at the University of Minnesota's Institute of Technology. The program objectives are to: encourage and guide students toward technical careers; direct them to college preparatory courses such as physics and pre-calculus; refine problem-solving skills; increase self-esteem; strengthen parental involvement; and reward goal achievement, teamwork, discipline, and creativity. With these same objectives, Project Technology Power's college program helps students complete an engineering degree and obtain employment by providing summer internships, guidance in resume writing, and audiovisual practice interviews.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | | X | | X | X | X |

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## ChIME Workshops

New Jersey Institute of Technology
Newark, New Jersey 07102

**Prof. Reginald P.T. Tomkins,**
Coordinator
201/596-3424

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 47 students in grades 7-11 |
| Staff | 3 part-time |
| Service period | Summer |
| Student contact | Weekly, more than 9 hours/week |

ChIME (Chemical Industry for Minority Engineers) Workshops at the New Jersey Institute of Technology offer three weeks of summer workshops for middle and high school minority students with high potential in science and mathematics. Activities encourage students to pursue college degrees in chemical engineering and related disciplines, and illustrate the diversity of employment opportunities in the chemical industry. Minority role models serve as teachers, career advisors, and field trip lecture guides.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | | X | X | X | | | X | X | X |

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## Experimental Mathematics, Science, and Communications Program

EMP
New Jersey Institute of Technology
Newark, New Jersey 07102

**Prof. Rose Dios,**
Coordinator
201/596-3424

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 19 students in grade 7 |
| Staff | 4 part-time |
| Service period | Summer |
| Student contact | Weekly, more than 9 hours/week |

Experimental Mathematics, Science and Communications (EMP) is a four-week summer program given at the New Jersey Institute of Technology for graduating seventh grade inner-city students. The program integrates mathematics, science, and language activities to sharpen students' reasoning powers and problem-solving abilities and to improve their oral and written communication skills. The program uses experiments, exercises, puzzles, and games to make learning enjoyable and to motivate students to enroll in mathematics and science courses in high school. The curriculum includes mapping and surveying, statistical probability, numerical cryptography, journal writing, and the publication of two newsletters.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | | X | | | X | | X | | X |

## Females in Engineering Methods, Motivation, and Experience

FEMME
New Jersey Institute of Technology
Newark, New Jersey 07102

**Prof. Lisa Novemsky,**
Coordinator
201/596-3424

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 24 students in grade 9 |
| Staff | 4 part-time |
| Service period | Summer |
| Student contact | Weekly, more than 9 hours/week |

Females in Engineering Methods, Motivation, and Experience (FEMME) was founded at the New Jersey Institute of Technology in 1980 as a summer program designed to encourage ninth grade females to enroll in advanced mathematics and science courses and to choose careers in engineering and related fields. The program is an intensive, rigorous four weeks of activities that introduce the young women to successful women engineers, explore career opportunities in science and technical fields, provide hands-on laboratory experience, and foster interaction with peers who have similar interests and aptitudes.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | | X | X | X | X | | X | X | X |

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## High School Scholars Program

New Jersey Institute of Technology
323 King Boulevard
Newark, New Jersey 07102

**Dr. Howard Kimmel,**
Director, Center for Precollege Programs
**Prof. J. Neidhardt,**
Coordinator
201/596-3574

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 36 students in grade 12 |
| Staff | 6 part-time |
| Service period | Saturday, school day |
| Student contact | Weekly, 3-5 hours/week |

The High School Scholars Program at the New Jersey Institute of Technology is designed to provide inner-city high school students the opportunity to enroll in college level courses and earn college credit. The program offers three courses: Integrated Calculus/Physics at college level to provide twelfth grade students a competitive edge in college admission; Advanced Placement Computer Science to prepare high school seniors to pass the ETS test for college advanced placement; and College Chemistry for students majoring in science and engineering, in which twelfth graders receive tutorial help as needed.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | X | | | | | X | | | | | | | X |

## Jersey Coast Explorers

New Jersey Institute of Technology
323 King Boulevard
Newark, New Jersey 07102

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 75 students in grades 4-7 |
| Staff | 6 part-time |
| Service period | School day |
| Student contact | Monthly, 7-9 months/year |

**Dr. Howard Kimmel,**
Director, Center for Precollege Programs
201/596-3574

The New Jersey Institute of Technology's Jersey Coast Explorers is a marine awareness project designed to educate inner-city elementary school students and teachers about the coastal environment. The program's objectives are: to educate young students about the importance of conserving our natural resources in the marine environment; to enhance inner-city students' interest in science by demonstrating that science is exciting, challenging, and useful; and to increase students' s0elf-esteem and confidence in their ability to succeed in science courses. Activities include hands-on experience in the salt marshes and ocean beaches of the Jersey coast.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | | | X | | | | | X | | | | | | | X |

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## Union County College Minorities in Engineering Program

UCCMEP
Union County College
1033 Springfield Avenue
Cranford, New Jersey 07016

**Elmer Wold,**
Executive Director
201/709-7559
201/709-7182

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 326 students in grades 7-12 |
| Staff | 2 part-time |
| Service period | Summer, after school |
| Student contact | Weekly, 1-2 hours/week |

The Union County College Minorities in Engineering Program (UCCMEP) was established in 1979 to assure that minority students are motivated and guided toward careers in engineering, are taking the appropriate high school courses to prepare for college engineering study, and are participating in supplementary courses in mathematics, science, and communication skills. The program offers these supplementary courses, the course curriculum and materials, and teacher training in facilities provided by the participating school districts.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | | X | X | X | X | X | X | X | X |

## Urban Engineering Programs

New Jersey Institute of Technology
323 King Boulevard
Newark, New Jersey 07102

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 170 students in grades 7-11 |
| Staff | 18 part-time |
| Service period | Summer |
| Student contact | Daily, for 4-6 weeks |

**Dr. Howard Kimmel,**
Director, Center for Precollege Programs
**Prof. Harold Deutschman,**
Coordinator
201/596-3424

Urban Engineering and Introduction to Urban Engineering are two summer programs conducted by the New Jersey Institute of Technology for inner-city students with an interest and aptitude in science and mathematics. One is a six-week program for high school students, the other a four-week program for junior high school students. The goal of these programs is to stimulate and encourage students to formulate college and career goals in the fields of science and engineering. Topics discussed in the programs include: water resources, waste water disposal, transportation systems, energy resources and generation, architectural design, urban planning, and computer science.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| x | x | x | x | | | x | | x | x | x | | | x | x | x |

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## Native American Mineral Engineering and Science Program

Minorities in Mineral Engineering and Science Program
NAMES, MIMES
Box 3527 C.S.
New Mexico Institute of Mining and Technology
Socorro, New Mexico 84801

**Bette Chavez-Holcomb,**
Coordinator/Academic Advising and Minority Study Program
505/835-5208

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 36 students in grades 10-11 |
| Staff | 12 part-time |
| Service period | Summer |
| Student contact | Daily, for 4 weeks |

The Native American Mineral Engineering and Science Program (NAMES) began in 1979 as a four-week residential course to prepare Native American students to study mathematics, science, and engineering in the challenging environment of New Mexico Tech. The program attempts to respond to the insufficient preparation of these students by exposing tenth and eleventh graders to college life in a precollege summer program where they study chemistry, physics, geology, mining, petroleum, mathematics, and English. NAMES was the model for Minority Students in Mineral Engineering and Science Program (MIMES), which operates concurrently but focuses on a wider minority population that includes African Americans, Hispanics, and women.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | | X | | X | X | X |

## New Mexico Mathematics, Engineering, Science Achievement Program

MESA New Mexico
Farris Engineering Center #137
University of New Mexico
Albuquerque, New Mexico 87131

**Patricia L. Chavez,**
Executive Director
505/227-5831

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 790 students in grades 7-12 |
| Staff | 2 full-time, 1 part-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Weekly, more than 9 hours/week |

The University of New Mexico MESA Program began in 1982 and was modeled after the University of California MESA Program to increase the number of underrepresented minorities in mathematics, engineering, and the sciences. Because these professions attract a disproportionately small percentage of African Americans, Hispanics, and Native Americans, New Mexico middle and high school students from these backgrounds are the target of the program. Participating students receive the educational enrichment experiences and practical help they need to prepare for university-level courses. Activities include academic tutorials, Saturday leadership workshops, summer enrichment and employment programs, and scholarship incentive awards.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Buffalo-Area Engineering Awareness for Minorities

BEAM
c/o State University of New York at Buffalo
412 Bonner Hall
Amherst, New York 14260

**James R. Legge,**
Executive Director
716/636-3066

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 289 students in grades 7-12 |
| Staff | 3 full-time |
| Service period | Summer, school day, after school |
| Student contact | Daily, 6-8 weeks, during the summer<br>Twice monthly, 7-9 months/year |

The Buffalo-Area Engineering Awareness for Minorities (BEAM) was initiated in 1982 by the Linde Division of Union Carbide Corporation, the State University of New York at Buffalo, and the Omega Psi Phi Fraternity, and now operates in twenty-two Buffalo area high schools.

BEAM currently provides three programs. The BEAM Clubs are in-school organizations that meet during the school year. The Precollege Engineering Program, a six-week summer program, is designed to identify promising Buffalo-area minority engineering students and motivate them to accept the challenge and responsibility of an engineering education. The Honors Program is an eight-week summer program sponsored by BEAM, the university engineering faculty and STEP (Science Technology Enrichment Program) for academically outstanding minority high school students interested in engineering. Students are given an opportunity to work, and be paid for their work, in an engineering research laboratory. Projects in the past have involved such fields as computer-aided design, thermoconductivity, and composite materials. At the end of the summer, students are required to present a project module paper describing their work in detail.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | | X | X | | X | X | X | X | X |

## Capital District Science and Technology Entry Program

STEP
Office of Minority Affairs
Rensselaer Polytechnic Institute
Troy, New York 12180-3590

**Mark D. Smith,**
Director of Academic Support Programs
518/276-6272

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 363 students in grades 7-12 |
| Staff | 7 full-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Weekly, 6-8 hours/week |

The Capital District Science and Technology Entry Program (STEP) is the product of a consortium of area colleges designed to assist minority and economically disadvantaged high school students gain access to scientific, technical, and health-related professions. The program prepares interested and motivated middle and high school students to improve their knowledge, thinking, and learning skills prior to college entrance. The summer program offers intensive academic course work to enhance success in school during the academic year. The school-year and Saturday programs focus on tutorial support services, counseling, test preparation, field trips, and employment opportunities.

### Program Activities

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X |

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## Comprehensive Mathematics and Science Program

CMSP
Schools of Engineering
The Cooper Union and Columbia University
51 Astor Place
New York, New York 10003

**Gilbert Lopez,**
Director
212/228-0950

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 3,640 students in grades 8-12 |
| Staff | 3 full-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Weekly, more than 9 hours/week |

Initiated in 1974, the Comprehensive Mathematics and Science Program (CMSP) is a field-based research and development program operating under the aegis of the Schools of Engineering at The Cooper Union and Columbia University to increase the pool of African American, Hispanic, and American Indian students who pursue science and engineering college study. CMSP focuses on: creating and test-implementing model mathematics programs to increase the pool of students who enroll and achieve in four years of precollege mathematics; establishing collaborative high school/college/industry programs to heighten student awareness of science and engineering careers; and explaining the factors that contribute to the successful completion of a college degree.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

## Dylan A. Thomas Memorial PREFACE Program

PREFACE
Rensselaer Polytechnic Institute
Troy, New York 12180

**Norman B. Burnett,**
Associate Dean of Students, Director of Minority Affairs
518/276-6272

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 28 students in grade 11 |
| Staff | 2 full-time |
| Service period | Summer |
| Student contact | Weekly, more than 9 hours/week |

The Dylan A. Thomas Memorial PREFACE Program is a two-week residential summer course on the Rensselaer Polytechnic Institute campus designed to enable talented minority high school students to explore career opportunities in engineering, sciences, and technology. Activities include an introduction to the various engineering disciplines, business management, technical writing, the health professions, architecture, laboratory experience in college level physics and chemistry, and intensive work with computer graphics and computing fundamentals. Students visit the facilities of the General Electric Company and the NASA Lewis Research Center to see and talk to engineers and scientists at work.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| x | x | x | x | x | x | x | | x | | x | | | | x | x |

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## Precollege Engineering Program

L.C. Smith College of Engineering
Syracuse University
Division of Summer Sessions
111 Waverly Avenue
Syracuse, New York 13244

**Dr. Samuel P. Clemence,**
Coordinator
315/423-4181

| | |
|---|---|
| Type of program | Precollege and bridge |
| Total students/grades | 28 students in grade 12 |
| Staff | 6 part-time |
| Service period | Summer |
| Student contact | Daily |

Syracuse University's Minority Precollege Engineering Program is designed for high school juniors and seniors to sample science and engineering courses during the summer on the Syracuse campus. Students enroll in two undergraduate courses. In one course, they become acquainted with various professions and the career opportunities available in engineering through a historical and contemporary overview. The second course provides instruction in basic skills that prepares students for the undergraduate engineering curriculum.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | X | X | X | | | | | | | |

## Program for Rochester to Interest Students in Science and Math

PRIS²M
The Hutchison House
930 East Avenue
Rochester, New York 14607-2241

**Nathaniel Brown, Jr.,**
Director
716/244-8596

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 372 students in grades 8-12 |
| Staff | 2 full-time, 11 part-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Daily, during the summer<br>Twice monthly, 7-9 months/year |

The Program for Rochester to Interest Students in Science and Math (PRIS²M) is an organization supported by Rochester industry to encourage students to prepare for professional and technical careers. Major program components include the PRIS²M Saturday Institute (PSI), PRIS²M teams, and summer internships.

PSI brings together eighth graders from groups traditionally underrepresented in the sciences to learn and apply basic principles in math, computers, science, communication, and leadership. PSI also includes a number of industrial, research, and museum visits during the school year.

Five of Rochester's City School District high schools have PRIS²M teams at each grade level that meet as after-school or in-school science clubs. Under the direction of two teachers, students work on college preparation, math/science career exploration, science projects, and motivational activities. Area professionals serve as role models, mentors, and tutors.

Each summer, PRIS²M offers its juniors and seniors, as well as some of its graduates, math/science or engineering internships with local companies. Students receive a one-week, intensive orientation to college life, engineering, and the world of work prior to their paid work assignments.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | | X | X | X | | X | X | X | X | | X | X | |

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## Science and Technology Entry Program

STEP
School of Engineering
Manhattan College
Riverdale, New York 10471

**Marilyn Carter Stevens,**
Director
212/920-0281

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 104 students in grades 7-12 |
| Staff | 1 full-time, 1 part-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Twice weekly, 6-8 hours/week |

Manhattan College established the Science and Technology Entry Program (STEP) in 1985 as a summer program for minority high school students to enhance their awareness of the science, technology, and engineering professions. The program helps students and secondary school personnel understand the requirements of a college degree in engineering and assists them in acquiring the requisite skills and courses necessary to pursue technical careers. Program activities include teacher workshops, student seminars, peer support networks, student clubs, and internships.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | | | X | X | | X | | | X | X | X | X | X |

## Engineering Special Programs and Minority Student Services

ESP, MSS
North Carolina State University
Box 7904
Raleigh, North Carolina 27695-7904

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 2,500 students in grades 9-12 |
| Staff | 6 full-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Daily, during the summer<br>Monthly, 7-9 months/year |

**Byard Houck,**
ESP Director
**Bobby D. Pettis,**
MSS Director
919/737-3264

The College of Engineering at North Carolina State University founded the Engineering Special Program (ESP) in the early 1970s to create a pool of high school minority students who would have an interest in, and prepare adequately for, careers in engineering and other technical fields. The North Carolina public high schools implement this process by supporting activities that increase student awareness of these professions and build up their academic skills.

The Minority Student Services (MSS) program was instituted in 1982 to recruit, retain, and graduate minority students. This program actively recruits qualified students, and offers counseling, an early warning academic monitoring system, and a summer transitional program for marginal students. It also locates summer cooperative or intern positions to help ease the financial burdens of a college education.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Mathematics and Science Education Network Precollege Program

MSEN
University of North Carolina
201 Peabody Hall, CB 3345
Chapel Hill, North Carolina 27599

**Dr. William Graves,**
Interim Director
919/966-3256

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 571 students in grades 6-11 |
| Staff | 10 full-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Weekly, more than 9 hours/week |

The Mathematics and Science Education Network Precollege Program (MSEN) at the University of North Carolina is aimed at increasing the number of minority students who graduate from high school with sufficient interest and preparation in mathematics, science, and English to pursue study in the technical fields at the college level. Established in 1986, MSEN operates in eighteen middle schools and three high schools. For middle school students, the program's goal is to increase the number of students who complete Algebra I in grade eight or nine and enroll in Geometry by grade ten. For high school students, the goal is to increase the students completing four years of mathematics, three years of science, and four years of college preparatory English courses.

MSEN also provides teacher training to assist teachers in acquiring instructional methods, curriculum planning techniques, and materials to attract and retain female and minority students in science and mathematics courses. The program organizes parent support through the Parents Involved for Excellence (PIE) clubs at each participating school. Parents attend mathematics and science workshops, learn communication skills, and discuss academic and career counseling.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

## Region 'O' Council for the Advancement of Minorities in Engineering

ROCAME
New Hanover County Schools
P.O. Box 390
Wilmington, North Carolina 28402

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 436 students in grades 7-12 (New Hanover) |
| Staff | 2 part-time |
| Service period | Summer, school day, after school |
| Student contact | Weekly, 1-2 hours/week |

In 1979, representatives from industry and education in North Carolina formed a nonprofit organization called Region 'O' Council for the Advancement of Minorities in Engineering (ROCAME) to stimulate and motivate minority students in the Wilmington area to consider careers in technical and scientific fields.

In addition to students in the New Hanover County Schools, ROCAME selects minority students in grades seven to twelve in Brunswick, Columbus, and Pender Counties, and the Whiteville City Schools, to participate in mathematics, science, and technological experiences that will encourage them to enter the engineering profession. ROCAME serves a total of approximately 1,000 students, including the 436 New Hanover students.

**Dianne Avery,**
Community Schools Coordinator
919/763-5431

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Pre-Engineering Program for Minorities

PEP
College of Engineering and Technology
Ohio University
Athens, Ohio 45701

**Joseph E. Essman,**
Associate Dean
614/593-1482

| | |
|---|---|
| Type of program | Combined precollege, university, and bridge |
| Total students/grades | 14 students completing grade 12 |
| Staff | 3 part-time |
| Service period | Summer |
| Student contact | Weekly, more than 9 hours/week |

The Pre-Engineering Program for Minorities (PEP) was initiated in 1981 as a five-week academic program to help minority students make the transition from high school to an engineering degree program at Ohio University. Activities include instruction in mathematics and engineering and good study skills. The program also provides personal counseling, guidance and follow-up.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | X | | X | X | | | | X | | X |

## University of Cincinnati National Technical Association Summer Enrichment Program

UC/NTA SEP
Office of Minority Affairs
College of Engineering, M.L. 18
University of Cincinnati
Cincinnati, Ohio 45221

**Phyllis A. Majors,**
Coordinator
513/556-1164

| | |
|---|---|
| Type of program | University |
| Total students/grades | 287 students in grades 7-12 |
| Staff | 2 part-time |
| Service period | Saturday, summer |
| Student contact | Weekly, 3-5 hours/week |

The University of Cincinnati National Technical Association Summer Enrichment Program (UC/NTA SEP) was founded in 1980 to tutor minority students in grades seven to twelve in mathematics and computer science. The objectives are: to continue the students' educational process over the summer; to help students who are falling behind in their courses to catch up; and to expose bright students to new concepts. In addition, the program offers seminars on choosing a college and planning and preparing for a college degree.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | X | X | | X | X | | | | X | X | | | X |

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## Women in Engineering

School of Engineering, 204 KL
University of Dayton
Dayton, Ohio 45469

**Prof. Carol Shaw,**
Assistant Dean
513/229-2736

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 97 students in grade 10 |
| Staff | 20 full-time |
| Service period | Summer |
| Student contact | Daily for one week |

A one-week residential summer program at the University of Dayton School of Engineering, Women in Engineering, offers women completing tenth grade the opportunity to learn about engineering as a profession. Lectures and seminars conducted by university faculty present the various engineering professions, the degree requirements for ten engineering disciplines, and college admissions and financial aid procedures. At the same time, women get a taste of college life. Hands-on experience in campus laboratories, a course in creative computer design, a dinner with women engineers, and an industrial mini-trade show are other activities offered during the program.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | X | X | X | X | | | | X | X |

## Portland Mathematics, Engineering, Science Achievement Program

Portland MESA
P.O. Box 751
Portland, Oregon 97207

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 253 students in grades 7-12 |
| Staff | 2 full-time |
| Service period | Saturday, summer, after school |
| Student contact | Weekly, 1-2 hours/week |

The Portland Mathematics, Engineering, Science Achievement (MESA) Program is a support program operating outside the classroom to encourage minority junior and senior high school students to enter mathematics, engineering, and physical science professions. Portland MESA promotes career awareness so that participating students and parents learn of employment opportunities in mathematics and science professions early enough to prepare for them. The program also offers educational enrichment activities and practical assistance for students preparing for university-level courses.

**Dr. Ernest Hartzog,** Associate Superintendent of Portland Public Schools
**Dr. H. Erzurmlu,** Dean, School of Engineering and Applied Science, Portland State University
503/464-4665

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## EMS Minority Recruitment

College of Earth and Mineral Sciences
Pennsylvania State University
University Park, Pennsylvania 16802

**Dr. John J. Cahir,**
Associate Dean for
Resident Instruction
814/865-7482

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 33 students in grades 10-11 |
| Staff | 26 part-time |
| Service period | Summer |
| Student contact | Weekly, during the summer<br>Monthly, during the school year |

Initiated during the 1986-87 academic year, the Earth and Mineral Sciences (EMS) Minority Recruitment Program at Pennsylvania State University is designed to alert minority students in grades ten and eleven to the educational and career opportunities available in the fields of science and engineering related to the earth. Activities consist of monthly lectures by College of Earth and Mineral Sciences faculty members at two Pittsburgh high schools with significant minority enrollments. These are followed by a summer program in which selected students either conduct field experiments or gain hands-on experience in laboratories on the university campus.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | | | | | | | | X | | | | | | | X |

## Philadelphia Regional Introduction for Minorities to Engineering

PRIME, Inc.
Suite 1201
1700 Walnut Street
Philadelphia, Pennsylvania 19103

**Dr. Alexander Tobin,**
Executive Director
215/893-8500

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 3,000 students in grades 7-12 |
| Staff | 6 full-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Twice monthly, 7-9 months/year |

Founded in 1973, Philadelphia Regional Introduction for Minorities to Engineering (PRIME) is a partnership of Philadelphia area businesses, government agencies, colleges and universities, professional associations, and parent groups working together to identify and prepare minority students for careers in engineering, pharmacy, and other mathematics and science professions. PRIME identifies interested and capable minority students in grade seven to participate for five years in specialized and supplementary activities in mathematics, science, and communication skills that will motivate and equip them to pursue successful careers in technology.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Pittsburgh Regional Engineering Program

PREP
1402 Investment Building
239 Fourth Avenue
Pittsburgh, Pennsylvania 15222

**Charles E. Vitale,**
Executive Director
412/562-9605

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 625 students in grades 7-12 |
| Staff | 3 part-time |
| Service period | Saturday, after school |
| Student contact | Monthly, more than 10 months/year |

In 1978, the National Alliance of Business and five Pittsburgh corporations — Alcoa, J&L Steel, Rockwell International, U.S. Steel, and Westinghouse Electric — established the Pittsburgh Regional Engineering Program (PREP). The objective of the program is to motivate minority youngsters to pursue careers in the engineering and science professions. The program functions in nine Pittsburgh high schools and twelve middle schools. Activities include hands-on experience, field trips to universities and corporate sites, counseling, guest speakers, and cooperative work experiences.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | | X | | X | X | | X | | X | X | |

## University Scholars Program

Summer Honors Academy
241 Willard Building
Pennsylvania State University
University Park, Pennsylvania 16802

**Suzanne Power,**
Assistant to the Director, University Scholars Program
814/863-2635

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 25 students in grades 9-11 |
| Staff | 8 part-time |
| Service period | Summer |
| Student contact | Daily, for 2 weeks |

The University Scholars Program at Pennsylvania State University developed its Summer Honors Academy in 1984 to provide a special opportunity for academically talented high school students to pursue college level work at the university during the summer preceding either their junior or senior year in high school. The academy introduces students to the analytical tools and methods of research used in the engineering profession. In the laboratory, students explore problem-solving, experimentation, technological imagination, and engineering design. Lectures and discussions focus on topics such as ethics in engineering, failures in engineering, and the role of science and technology in society.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | | X | | | X | | X | | | | | X | | X |

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## To Improve Mathematics, Engineering, and Science Studies

TIMES$^2$, Inc.
480 Charles Street
Providence, Rhode Island 02904

**Vanessa L. Cooley,**
Executive Director
401/421-8276

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 441 students in grades 7-12 |
| Staff | 2 full-time |
| Service period | Saturday, summer, school day |
| Student contact | Weekly, 3-5 hours/week |

Rhode Island business and industry, government, universities, and public school systems formed a partnership in 1979 to establish TIMES$^2$, To Improve Mathematics, Engineering, and Science Studies, a nonprofit organization to increase the number of minority students preparing for college degrees in engineering, science, and mathematics. TIMES$^2$ serves over 400 students in nine schools beginning in the seventh grade. Classroom instruction in mathematics, science, and English is supplemented by hands-on laboratory experience, lectures and demonstrations by practicing professionals, extracurricular activities such as field trips to industrial sites, museums, and educational institutions, and mentors from a variety of disciplines who meet with students regularly to help them plan their educational, career, and personal goals.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

## Precollege Summer Technical Program

Westinghouse Savannah River Plant
Building 719-4A
Aiken, South Carolina 29808

**Jackie Shields,**
Coordinator
803/725-4142

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 56 students in grades 7-10 |
| Staff | 11 part-time |
| Service period | Summer |
| Student contact | Weekly, 40 hours/week |

The Precollege Summer Technical Program was established in 1980 to provide summer work for precollege students as well as to foster their interest in engineering as a profession. Students are recruited by ten on-site counselors assigned to two or three schools, and are selected through interviews. In order to qualify, a student must maintain better than a 90 average in school and have a strong interest in engineering.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | X | X | | | X | | | X | | | | | X | | X |

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## Science and Technology Enrichment Program

STEP II
Westinghouse Savannah River Plant
Building 719-4A
Aiken, South Carolina 29808

**Hugh Hanlin,**
Director
803/648-6851

| | |
|---|---|
| Type of program | University |
| Total students/grades | 72 students in grades 9-12 |
| Staff | Information not available |
| Service period | Saturday |
| Student contact | Twice monthly, 7-9 months/year |

The Science and Technology Enrichment Program (STEP II) was designed in 1982 to increase the number of minority students and females who choose careers in engineering and the sciences. The program is based at the University of South Carolina at Aiken and structured for first-, second-, and third-year high school students. These students attend Saturday sessions that offer subjects such as biology, chemistry, physics, computer science, mathematics, artificial intelligence, and computer architecture.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | | X | X | X | X | | X | | | | | X | | |

## Summer Technical Enrichment Programs

STEP I, REAP
Westinghouse Savannah River Plant
Building 719-4A
Aiken, South Carolina 29808

**Estelle Muse,**
STEP Director
**Allen Forrest,**
REAP Director
803/725-4142

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 89 students in grades 8-10 |
| Staff | 16 part-time |
| Service period | Summer |
| Student contact | Weekly, 6-8 hours/week |

STEP and REAP were founded in 1978 with funding from the Savannah River Plant. The programs were established to provide an extra effort to encourage minority students in the areas of science, mathematics, and communication skills. A maximum of forty-five eighth and ninth graders, all high achievers, participate in each six-week summer program. The students go on field trips, listen to speakers, watch films, and work on projects designed to foster their interest in science and engineering.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | | X | X | | X | X | | | | | | X | | |

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## Early Identification Program for Minorities in Engineering

EIP
Christian Brothers College
650 East Parkway South
Memphis, Tennessee 38104

**Paul Palazolo,**
Director
901/722-0405

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 26 students in grades 11-12 |
| Staff | 7 part-time |
| Service period | Summer |
| Student contact | Daily, for 5 weeks, 5 1/2 hours/day |

The Early Identification Program (EIP) for Minorities in Engineering at Christian Brothers College was founded in 1976 for the purpose of making minority students aware of engineering as a career and assisting them in the transition from high school to college. Students completing grades eleven and twelve take two courses, engineering design and mathematics, for college credit during an intensive five-week summer residential program on the college campus. They attend lectures given by practicing engineers and visit engineers at work. Students also learn college survival skills such as note-taking, listening, assertiveness, and other interpersonal skills.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | | | X | | | | X | | X |

## Minority Engineering Scholarship Program

MESP
University of Tennessee, Knoxville
103 Estabrook Hall
Knoxville, Tennessee 37996-2360

**James T. Pippin,**
Director
615/974-4457

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 141 students in grades 7-12 |
| Staff | 5 full-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Weekly, 1-2 hours/week |

The Minority Engineering Scholarship Program was initiated in 1973 at the University of Tennessee, Knoxville. Its goal is to graduate African American engineers for assignment within industry. Students are provided an opportunity to learn from hands-on experience with industry how an engineer interacts in a free enterprise system. The program also helps provide financial aid for the students' education. Scholarship awardees must attend a one-week spring orientation, a summer session, and a two-week fall academic review prior to beginning freshman year classes.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Golden Crest Alliance for Minorities in Engineering

GCAME
c/o DuPont
P.O. Box 2626
Victoria, Texas 77902

**Mike Jackson,**
NACME Coordinator
512/572-1216

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 162 students in grades 7-12 |
| Staff | 4 part-time |
| Service period | Summer, after school |
| Student contact | Weekly, more than 9 hours/week, during the summer<br>Monthly, more than 10 months/year |

Golden Crest Alliance for Minorities in Engineering (GCAME) was organized in 1977 by a group of local school board members from the Independent School Districts of Victoria, Calhoun County, Bloomington, and Edna as well as industry and community leaders. The objectives of this program are to introduce minority students at the middle school level to engineering as a career, and to increase the number of minority students entering and graduating from college in the technical fields. To accomplish its goal, GCAME coordinates support from the community, education, and industry to provide challenging projects that encourage the development of students' problem solving, mathematics, science, and communication skills.

GCAME is a participating member of the Texas Alliance for Minorities in Engineering.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | | X | X | X | X | | X | | | X | |

## Minority Introduction to Engineering

MITE
Equal Opportunity in Engineering
ECJ 2.102
University of Texas, Austin
Austin, Texas 78712

**Tom Backus,**
Director
512/471-5953

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 50 students in grade 11 |
| Staff | 4 full-time |
| Service period | Summer |
| Student contact | Daily for one week, 8 hours/day |

The Minority Introduction to Engineering (MITE) program offers a one-week residential summer course at the University of Texas for minority students entering senior year in high school. Students qualify for entrance on the basis of their scholastic performance and interest. The program offers courses that provide information about a variety of engineering fields — electrical, mechanical, civil, aerospace, petroleum, architectural, and chemical — as well as orientation on college admissions, scholarships, and financial aid.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | | X | X | X | | X | | X | X | X | | | | | X |

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## San Antonio Pre-Freshman Engineering Program

San Antonio PREP
PREP Office
University of Texas, San Antonio
San Antonio, Texas 78285

**Prof. Manuel P. Berriozábal,**
Director
512/691-4496

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 419 students in grades 7-12 |
| Staff | 2 full-time, 1 part-time |
| Service period | Summer |
| Student contact | Weekly, more than 9 hours/week |

The San Antonio Pre-Freshman Engineering Program (PREP) was organized by the University of Texas in 1979 for the purpose of identifying high ability minority middle and high school students in order to provide them with academic enrichment to pursue careers in engineering and science. Over a period of three eight-week summer sessions, students study logic, problem-solving, algebraic structures, probability and statistics, physics, computer science, engineering, and technical writing. Students must maintain better than a 75 percent average to continue in the program in subsequent summers. Since 1986, PREP has been replicated in six other locations in the state.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | | X | X | X | X | X | X | | X | X | X |

## Summer Engineering Institute

College of Engineering
University of Texas, El Paso
El Paso, Texas 79968

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 130 students in grades 7-12 |
| Staff | 2 part-time |
| Service period | Summer |
| Student contact | Daily, for 2 weeks |

**Stephen W. Stafford,**
Assistant Dean and Professor
915/747-5460

The Summer Engineering Institute began in 1975 as a motivational summer program on the University of Texas campus for the purpose of identifying and encouraging low-income high school students to pursue the study of engineering in college. The Institute offers four two-week sessions conducted by faculty, staff, and students from the university, and volunteers from local industry. Students representing the top five percent of their classes attend lectures about chemical, civil, electrical, industrial, mechanical, and metallurgical engineering, and computer science. These lectures include descriptions of each profession, the curriculum required for completion of a college degree, the types of jobs available after graduation, and a tour of the appropriate laboratory facilities at the College of Engineering.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | | X | | X | X | | | | | X | X |

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## Summer Enrichment Experience in Engineering

SEE
204 Zachry Engineering Center
Texas A&M University
College Station, Texas 77843-3127

**Jeanne Rierson,**
Coordinator and
Assistant to the Dean
409/845-7265

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 110 students in grades 10-11 |
| Staff | 3 full-time |
| Service period | Summer |
| Student contact | Daily for one week |

The Summer Enrichment Experience in Engineering (SEE) was held for the first time in 1981 at Texas A&M University to give minority students who had completed their sophomore year in high school an opportunity to explore engineering as a career. The program has two six-day residential sessions each summer, which offer special courses in computer programming, engineering design, and visits to laboratories and other engineering facilities on the campus and at the NASA Space Center. Students attend lectures about different engineering disciplines, college admission procedures, and receive financial aid counseling.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | | | | | X | | X | | | | | | | X |

## Texas Alliance for Minorities in Engineering, Inc.

TAME
c/o Dean of Engineering
Box 19019 UTA Station
University of Texas, Arlington
Arlington, Texas 76019

| | |
|---|---|
| Type of program | Precollege and bridge |
| Total students/grades | 3,500 in grades 7-12 at 16 sites* |
| Staff | 1 full-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Varies by city and program |

**John S. Robottom,**
Assistant Dean of
Engineering
817/273-2571

Operating sixteen chapters that reach approximately 3,500 Texas students a year, the Texas Alliance for Minorities in Engineering, Inc. (TAME) has grown continually since it was founded in 1975 by Texas industrialists and educators to promote minority students' interest in the engineering profession. Each TAME chapter mobilizes the resources of local industries, universities, and public schools in the engineering and scientific fields. Among the programs TAME offers are: career conferences with leading engineers; summer jobs in sponsor companies; college scholarships; assistance to selected public schools; development and definition of pre-engineering curricula; and EXPO, a mobile trailer exhibit.

*TAME's decentralized administration does not permit a detailed breakdown of students by ethnicity and grade level. Therefore, TAME students are not represented in the charts in Sections B and C.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | | X | X | X | X | X | X | | | | |

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## World of Engineering

WOE
Equal Opportunity in Engineering
ECJ 2.102
University of Texas, Austin
Austin, Texas 78712

**Tom Backus,**
Director
512/471-5953

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 850 students in grades 10-11 |
| Staff | 4 full-time |
| Service period | Saturday |
| Student contact | One-day conference |

The College of Engineering Minority Program Office of the University of Texas, Austin offers a one-day conference called WOE, World of Engineering, for minority sophomore and junior high school students, their teachers, and guidance counselors to learn about engineering as a career. The program includes tours of engineering laboratories and facilities on the university campus conducted by Pi Sigma Pi, the minority student engineering service organization.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | | | X | X | | | | | X | X | | X | | | X |

## Mathematics, Engineering, Science Achievement Program

MESA Utah
Utah State Office of Education
250 East 500 South
Salt Lake City, Utah 84111

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 299 students in grades 6-12 |
| Staff | 2 full-time |
| Service period | School day, after school |
| Student contact | Weekly, 5 hours/week |

**Richard Gomez,**
Administrator
801/538-7643

The MESA Utah program began operating in 1984 under the auspices of the University of Utah College of Engineering and the Utah State Office of Education. The goals are to enrich the academic experience of junior and senior high school students in mathematics and science, to stimulate their interest in these fields, and to encourage students to graduate prepared for the challenge of university studies. A unique component of MESA Utah is the MESA Math Class, a pre-algebra class for seventh and ninth graders with a low student/teacher ratio. In this class, basic skills in mathematics are solidified, study skills enhanced, and students prepared to advance to the college level or accelerated tracks in mathematics.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | | X | X | X | X | | X | | X | X | X | | X |

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## Cooperating Hampton Roads Organizations for Minorities in Engineering

CHROME, Inc.
P.O. Box 1394
Norfolk, Virginia 23501-1394

**Dr. Lilian Bautista-Myers,**
Executive Director
804/683-2931

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 452 students in grades 7-12 |
| Staff | 1 full-time |
| Service period | Summer, school day, after school |
| Student contact | Monthly, 7-9 months/year |

Cooperating Hampton Roads Organizations for Minorities in Engineering (CHROME) was founded in 1983 by the Planning Council of Norfolk. It is a partnership of higher education institutions, individuals, school systems, business and industry, professional associations, and government agencies. The organization's mission is to increase the number of minorities and women entering advanced technical fields. CHROME provides training and program activities for teachers and counselors that enable them to identify, encourage, and motivate students from third grade through high school to pursue careers in engineering. Program activities include summer workshops for students, teachers, and counselors, Saturday sessions for middle school students taught by young Ph.D.s, a space workshop for various ages, computer workshops, field trips, guest speakers, summer internships, and college scholarships.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | | | | | X | | X | X | X | | X | X | X | X |

## Minority Introduction to Engineering

MITE
University of Virginia, Charlottesville
A 127 Thornton Hall
Charlottesville, Virginia 22901

**Ron Simmons,**
Assistant Dean for
Minority Affairs
804/924-6425

| | |
|---|---|
| Type of program | University |
| Total students/grades | 43 students in grade 11 |
| Staff | 6 full-time |
| Service period | Summer |
| Student contact | Weekly, more than 9 hours/week |

The focus of the University of Virginia Minority Introduction to Engineering (MITE) program is to provide the resources and academic support to recruit, enroll, retain, and graduate minority students in the field of engineering. Program activities include an introduction to engineering and a summer research assistantship program for students who have completed their junior year in high school, a summer bridge program for entering freshmen, undergraduate tutoring, advising, and counseling, an early warning system to provide resources for students having problems, a small cooperative program, minority scholarships and fellowships, and support programs for graduate students.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | X | X | X | X | X | | | X | X | X |

## Mathematics, Engineering, Science Achievement Program

MESA Washington
353 Loew Hall, FH-18
University of Washington
Seattle, Washington 98195

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 1,314 students in grades 7-12* |
| Staff | 7 full-time |
| Service period | Saturday, summer, school day, after school |
| Student contact | Daily, 3-5 hours/week |

**Patricia MacGowan,**
MESA Statewide Director
206/543-0562

Washington's Mathematics, Engineering, Science Achievement (MESA) Program began in 1982. Its mission is to assist the state and nation in achieving an educated citizenry that is globally competitive and individually competent in mathematics, engineering, and science, with full participation of African Americans, Hispanics, Native Americans, and women. MESA accomplishes this through a partnership of higher education, school districts, business and industry, and community organizations. The partnership is dedicated to providing these underrepresented students with an education process that increases their interest, effective participation, and contribution to mathematics, science, and engineering.

*These statewide figures include students served by the two local chapters that are also listed in this directory. The necessary numerical adjustments have been made when providing the statistical information in Sections B and C.

### Program Activities

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Seattle Mathematics, Engineering, Science Achievement Program

MESA Washington
353 Loew Hall, FH-18
University of Washington
Seattle, Washington 98195

**Dawnmarie A. Cooper,**
Director
206/543-0562

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 476 students in grades 10-12 |
| Staff | 7 full-time |
| Service period | Summer, school day |
| Student contact | Weekly, 6-8 hours/week |

The University of Washington Mathematics, Engineering, Science Achievement (MESA) Program began in 1982 with financial support from the state and from private industry, and volunteer support from school districts, universities, industry, and engineering professionals. Its purpose is to increase the number of underrepresented minorities — African Americans, Hispanics, and Native Americans — in the mathematics, engineering, and science-related professions. MESA's efforts are directed toward Washington high school students from these backgrounds. Through MESA's activities, participating students receive the educational enrichment and practical help they need to prepare for university-level programs in a variety of fields.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | X | X | X | X | X | X | X | X | X | X | X | X |

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## Yakima Valley/Tri-Cities MESA Center

MESA Washington
Tri-Cities University Center
100 Sprout Road
Richland, Washington 99352

**Patricia A. Wright,**
MESA Center Director
509/373-3176

| | |
|---|---|
| Type of program | Precollege |
| Total students/grades | 148 students in grades 10-12 |
| Staff | 1 full-time, 1 part-time |
| Service period | School day |
| Student contact | Weekly, 3-5 hours/week<br>Twice weekly, 1-2 hours/week |

The Yakima Valley Tri-Cities Mathematics, Engineering, Science Achievement (MESA) Program began in Washington in 1982 with 80 students. MESA's goal is to increase the pool of minority students currently underrepresented in engineering and science professions by fostering mathematics and science proficiency at the secondary school level and by heightening career awareness. MESA receives support from state funding, school districts, universities, industry, and community organizations.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | X | | X | X | X | X | X | X | X | X | X | X | X |

## Gateway to Engineering, Science and Technology

GEST
University of Wisconsin, Milwaukee
P.O. Box 784
Milwaukee, Wisconsin 53201

**Rose Daitsman,**
Director
414/229-5356

| | |
|---|---|
| Type of program | Combined precollege and university |
| Total students/grades | 211 students in grades 7-12 |
| Staff | 2 full-time, 1 part-time |
| Service period | Saturday, summer |
| Student contact | Daily, during the summer |

The Gateway to Engineering Science and Technology Program (GEST) under the aegis of the University of Wisconsin, Milwaukee helps minority middle and high school students in the Milwaukee area prepare for technical and scientific careers. GEST programs provide opportunities for precollege minority students to identify an interest in mathematics and science and learn about and prepare for a college engineering program. The program offers: a six-week summer session for eighth grade students entering high school; engineering-oriented summer courses for high school students; enrichment activities during the academic year following up the summer program; and assistance with science projects during the year.

**Program Activities**

| Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| X | X | X | | X | X | X | X | X | X | X | X | | X | X | X |

## Section B

## Reference Guide:
## Program Activities and Student Characteristics

## Program Activities

| | Page | State | Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H S Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Engineering Summer Institutes**<br>Arizona State University | 1 | AZ | x | x | x | x | | x | | | x | x | x | x | | x | x | x |
| **Mathematics, Engineering, Science Achievement Program**<br>Glendale Community College | 2 | AZ | x | x | x | | x | x | x | | x | | x | x | | | | x |
| **Pre-Engineering Summer Workshops for Minorities and Women**<br>University of Arizona | 3 | AZ | x | x | x | x | x | | x | | x | | x | x | x | x | x | x |
| **Minority Introduction to Engineering**<br>University of Arkansas | 4 | AK | x | x | x | x | | x | x | | | x | x | | | x | x | x |
| **Engineering Summer Residency Program**<br>University Of California, Davis | 5 | CA | x | x | x | | x | | | x | | x | x | x | | x | | x |
| **Interface Institute** | 6 | CA | x | x | | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Mathematics, Engineering, Science Achievement Program**<br>California State University Bakersfield | 7 | CA | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Mathematics, Engineering, Science Achievement Program/ Minority Engineering Program**<br>University of California, Berkeley | 8 | CA | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Mathematics, Engineering, Science Achievement Program**<br>Harvey Mudd College | 9 | CA | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Mathematics, Engineering, Science Achievement Program**<br>University of Southern California | 10 | CA | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |

| Program Format | | | | Students Served | | | | | | | | | Grade Levels/ Total # of Students Served 1987-1988 School Year | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saturday | Summer | School Day | After School | African American | American Indian | Mexican American | Puerto Rican | Other Hispanic | Non-Minority | Female | Male | Total Minority | 7 | 8 | 9 | 10 | 11 | 12 | Total Students |
| | x | | | 18 | 20 | 32 | | | 29 | 79 | 20 | 70 | | | 36 | 63 | | | 99 |
| | x | x | | Information not available | | | | | | | | | | | | | | | 70 |
| | x | | | 5 | 3 | | | 60 | 28 | 54 | 42 | 68 | 29 | 11 | 20 | 9 | 27 | | 96 |
| | x | | | 13 | | | | | 1 | 8 | 6 | 13 | | | | | 14 | | 14 |
| | x | | | 8 | 1 | | | 21 | 18 | 20 | 28 | 30 | | | | | 19 | 29 | 48 |
| x | x | | x | 60 | | | | | | 29 | 31 | 60 | 23 | 12 | 12 | 3 | | | 60 |
| x | x | x | x | 228 | 23 | 280 | | | | | | 531 | 115 | 147 | 86 | 69 | 70 | 44 | 531 |
| x | x | x | x | 1458 | 160 | 2567 | 47 | | | 2395 | 1837 | 4232 | 491 | 609 | 610 | 1087 | 1035 | 228 | 4232 |
| x | x | x | x | Breakdown not provided | | | | | | | | | | | | | | | 506 |
| x | x | x | x | 84 | 6 | 231 | 1 | | | 180 | 142 | 322 | 27 | 59 | 31 | 72 | 93 | 40 | 322 |

## Program Activities

| | Page | State | Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activites | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H S Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mathematics, Engineering, Science Achievement Program** California State University, Northridge | 11 | CA | x | x | x | | x | x | x | x | x | x | x | x | x | x | x | x |
| **Mathematics, Engineering, Science Achievement Program** University of California, Sacramento | 12 | CA | x | x | x | x | x | x | x | x | x | | | | | | | |
| **Mathematics, Engineering, Science Achievement Program** California State University, San Diego | 13 | CA | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **MESA/Math Science Program** California State University, San Jose | 14 | CA | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Mathematics, Engineering, Science Achievement Program/ Minority Engineering Program** University of California, Santa Barbara | 15 | CA | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Mathematics, Engineering, Science Achievement Program** Stanford University | 16 | CA | x | x | x | x | x | x | x | x | x | | x | x | x | x | x | x |
| **Minority Engineering Program** University of California, Los Angeles | 17 | CA | x | x | x | x | x | x | x | x | x | x | x | x | | x | x | x |
| **Secondary School Science Project** California Institute of Technology | 18 | CA | x | x | | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **American Indian Science and Engineering Society** Summer Math Camps | 19 | CO | x | x | x | x | x | x | x | x | x | | | x | | x | | x |
| **Colorado Minority Engineering Association** University of Colorado, Denver | 20 | CO | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |

| Program Format | | | | Students Served | | | | | | | | | Grade Levels/ Total # of Students Served 1987-1988 School Year | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saturday | Summer | School Day | After School | African American | American Indian | Mexican American | Puerto Rican | Other Hispanic | Non-Minority | Female | Male | Total Minority | 7 | 8 | 9 | 10 | 11 | 12 | Total Students |
| | x | x | x | 25 | 9 | 273 | 5 | | | 188 | 124 | 312 | 10 | 26 | 29 | 83 | 90 | 74 | 312 |
| x | x | x | x | | | | | | | | | 725 | 100 | 125 | 150 | 125 | 110 | 115 | 725 |
| x | x | x | x | 73 | 8 | 104 | 3 | | | 98 | 90 | 188 | 5 | 7 | 24 | 56 | 68 | 28 | 188 |
| x | x | x | x | 84 | 13 | 252 | 5 | | | 202 | 152 | 354 | | | 116 | 94 | 76 | 68 | 354 |
| x | x | x | x | 15 | 5 | 101 | | | | 57 | 64 | 121 | 15 | 15 | 17 | 23 | 30 | 21 | 121 |
| x | x | x | | 150 | | | | 50 | | | | 200 | | | | | | | 200 |
| x | x | x | | 21 | | 17 | | | | 15 | 23 | 38 | | | 1 | 13 | 24 | | 38 |
| | x | | | 58 | 2 | 56 | | | | | | | 74 | 78 | 74 | 121 | 106 | 93 | 546 |
| | x | | | | 127 | | | | | | | 127 | 66 | 43 | 18 | | | | 127 |
| | x | | x | 218 | 24 | | | 697 | 442 | 735 | 646 | 939 | 328 | 385 | 211 | 150 | 192 | 115 | 1381 |

## Program Activities

| | Page | State | Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H S Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Denver Educational Excellence Program** | 21 | CO | x | x | x | x | x | x | x | x | x | x | x | x | | x | x | x |
| **Summer Minority Engineering Training Program** Colorado School of Mines | 22 | CO | | x | x | x | x | | x | | x | x | x | x | | x | x | x |
| **Connecticut Pre-Engineering Program** | 23 | CT | x | x | x | x | x | x | x | x | x | x | x | x | x | | | |
| **Engineering for Deserving Youth Program** University of Bridgeport | 24 | CT | x | x | x | x | x | x | x | x | x | | | | | x | x | x |
| **Forum to Advance Minorities in Engineering** FAME, Inc. | 25 | DE | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Resources to Insure Successful Engineers** University of Delaware | 26 | DE | x | x | x | x | | x | x | x | x | x | x | x | | x | | x |
| **District of Columbia Metropolitan Consortium for Minorities in Engineering** Howard University | 27 | DC | x | x | x | | x | x | x | | x | x | x | x | x | x | x | x |
| **Minority Engineering Program** University of Central Florida | 28 | FL | x | x | x | x | x | x | x | x | | x | | x | x | x | x | |
| **Freshman Engineering Workshop** Georgia Institute of Technology | 29 | GA | x | x | | | x | | x | | | x | x | | | | | x |
| **Minority Introduction to Engineering** Georgia Institute of Technology | 30 | GA | x | x | x | x | | | x | | x | x | x | | | x | | x |

| Program Format | | | | Students Served | | | | | | | | | Grade Levels/ Total # of Students Served 1987-1988 School Year | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saturday | Summer | School Day | After School | African American | American Indian | Mexican American | Puerto Rican | Other Hispanic | Non-Minority | Female | Male | Total Minority | 7 | 8 | 9 | 10 | 11 | 12 | Total Students |
| | | x | x | 132 | 1 | 15 | | | 71 | 136 | 83 | 148 | 48 | 71 | 34 | 24 | 30 | 12 | 219 |
| | x | | | 11 | 6 | 22 | | | 15 | 3 | | 39 | | | | | 54 | | 54 |
| x | x | | x | 128 | 11 | | 68 | | 14 | 107 | 114 | 207 | 62 | 55 | 42 | 27 | 16 | 19 | 221 |
| | x | | | 47 | 1 | | 8 | 2 | 18 | 35 | 41 | 58 | | | | 22 | 42 | 12 | 76 |
| x | x | | | 211 | | | 7 | | 36 | 150 | 104 | 218 | 79 | 50 | 35 | 31 | 32 | 27 | 254 |
| | x | | | 52 | | | 1 | 3 | 6 | 32 | 30 | 56 | | | | | 32 | 30 | 62 |
| | x | x | x | 809 | 6 | | | 21 | 5 | 391 | 450 | 836 | 167 | 174 | 206 | 131 | 87 | 76 | 841 |
| | x | x | | 181 | 1 | 2 | 18 | | 72 | | | 202 | | | 41 | 54 | 74 | 105 | 274 |
| | x | | | | | 35 | | | | | | 35 | | 25 | 10 | | | | 35 |
| | x | | | 49 | | | 8 | | | 24 | 33 | 57 | | | | | 57 | | 57 |

| | Program Activities | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Page | State | Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
| **Precollege Engineering Program**<br>Georgia Institute of Technology | 31 | GA | x | x | x | | | x | x | | | x | x | | | | x | x |
| **Southeastern Consortium for Minorities in Engineering**<br>c/o Georgia Institute of Technology | 32 | GA | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Early Identification Program**<br>Illinois Institute of Technology | 33 | IL | x | x | | x | | | x | x | x | x | x | | | x | | x |
| **Math Counts Tutorial Program** | 34 | IL | | | | x | | x | x | x | | | | | | | | |
| **Midtown Achievement Program** | 35 | IL | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Planning Ahead for Science and Engineering**<br>Southern Illinois University, Edwardsville | 36 | IL | x | x | x | x | | x | x | x | | x | x | x | | x | x | x |
| **Pre-Freshman Program in Engineering and Science**<br>Chicago State University | 37 | IL | x | x | x | x | | | x | x | x | | | x | | x | | x |
| **Role Model Experiences/ Engineering Mentoring Program**<br>Southern Illinois University, Edwardsville | 38 | IL | x | x | x | x | | | x | | x | x | x | | | x | x | x |
| **Engineering Preview**<br>Purdue University, West Lafayette | 39 | IN | x | x | x | x | | | x | | | x | | x | | | | x |
| **Minority Engineering Advancement Program**<br>Purdue University at Indianapolis | 40 | IN | | x | x | x | x | x | x | x | x | x | x | x | x | x | | |

| Program Format | | | | Students Served | | | | | | | | | Grade Levels/ Total # of Students Served 1987-1988 School Year | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saturday | Summer | School Day | After School | African American | American Indian | Mexican American | Puerto Rican | Other Hispanic | Non-Minority | Female | Male | Total Minority | 7 | 8 | 9 | 10 | 11 | 12 | Total Students |
| | x | | | 21 | | 6 | | | 33 | | | 27 | | | | 14 | 28 | 18 | 60 |
| x | x | x | x | 15,456 | 937 | 104 | 64 | 37 | 7756 | 10,058 | 6834 | 16,598 | 1566 | 2336 | 4513 | 5325 | 5523 | 5091 | 24,354 |
| x | x | | | 85 | | | 2 | 16 | 7 | 64 | 46 | 103 | | | | 62 | 48 | | 110 |
| | | x | x | Information not available | | | | | | | | | | | | | | | 200 |
| x | x | | x | 47 | | 149 | 6 | 4 | 29 | | 235 | 206 | 75 | 85 | 45 | 25 | 5 | | 235 |
| x | x | | | 27 | | | | | 27 | | | 27 | | | | | | 54 | 54 |
| | x | | | 30 | | | | | | 15 | 15 | 30 | 15 | 15 | | | | | 30 |
| x | | x | | 40 | | | | | | | | 40 | | 20 | | | 20 | | 40 |
| | | x | | 56 | | | | 13 | 1 | 23 | 47 | 69 | | | | | | 70 | 70 |
| x | x | | | 127 | | 1 | 2 | | 1 | 74 | 57 | 130 | 6th + 7th 20/20 | 21 | 21 | 21 | 20 | 8 | 131 |

## Program Activities

| | Page | State | Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H S Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Minority Introduction to Engineering**<br>Purdue University, West Lafayette | 41 | IN | x | x | x | x | | | x | | x | x | | x | | | | x |
| **Purdue's Recruitment of Minorities Interested in Schools of Engineering**<br>Purdue University, West Lafayette | 42 | IN | x | x | x | x | | | x | | x | x | x | x | | | x | x |
| **Purdue University Pre-Freshman and Cooperative Education**<br>Purdue University, West Lafayette | 43 | IN | x | x | x | x | | | | | x | x | x | x | | | x | x |
| **7th and 8th Grade Summer Engineering Workshop**<br>Purdue University, West Lafayette | 44 | IN | x | x | x | x | | | x | | x | x | | x | | x | | x |
| **Mid-America Consortium for Engineering and Science Achievement**<br>Kansas State University | 45 | KS | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **University of Kansas Summer Early Entry Program**<br>University of Kansas | 46 | KS | x | x | x | x | | x | x | | x | x | x | | | | | x |
| **Increasing Career Opportunities for Minorities in Engineering** | 47 | KY | | x | x | x | x | x | x | | x | x | | x | x | | x | x |
| **Engineering Summer Institute**<br>Southern University | 48 | LA | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Louisiana Engineering Advancement Program for Minorities**<br>c/o Xavier University of Louisiana | 49 | LA | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Recruitment into Engineering of High Ability Minority Students**<br>Louisiana State University | 50 | LA | x | x | x | x | x | x | x | x | x | x | x | | | | | x |

| Program Format | | | | Students Served | | | | | | | | | Grade Levels/ Total # of Students Served 1987-1988 School Year | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saturday | Summer | School Day | After School | African American | American Indian | Mexican American | Puerto Rican | Other Hispanic | Non-Minority | Female | Male | Total Minority | 7 | 8 | 9 | 10 | 11 | 12 | Total Students |
| | x | | | 41 | 2 | 7 | | 6 | 2 | 24 | 34 | 56 | | | | | 58 | | 58 |
| | | x | | 32 | | 1 | 4 | 1 | | 17 | 21 | 38 | | | | | 4 | 34 | 38 |
| | x | | | 17 | | 5 | 2 | | 1 | 15 | 10 | 24 | | | 13 | 12 | | | 25 |
| | x | | | 88 | | | | 8 | 1 | 55 | 42 | 96 | 24 | 73 | | | | | 97 |
| x | x | x | x | 267 | 2 | 34 | | | 1 | 180 | 124 | 303 | 2 | | 86 | 82 | 79 | 55 | 304 |
| | x | | | 18 | | | | 2 | | 10 | 10 | 20 | | | | | | | 20 |
| | x | x | x | | | | | | 20 | | | 65 | | | | | | | 85 |
| | x | | | | | | | | 1 | 78 | 77 | 154 | 12 | 20 | 13 | 2 | 47 | 61 | 155 |
| | | x | x | 422 | 1 | | | 1 | 9 | 293 | 140 | 424 | 6th + 7th 5/37 | 97 | 100 | 55 | 48 | 91 | 433 |
| | x | | | 8 | | | | | 2 | 7 | 3 | 8 | | | | | 10 | | 10 |

## Program Activities

| | Page | State | Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H S Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mathematics, Engineering, Science Achievement Program** Johns Hopkins University | 51 | MD | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Engineering Career Orientation** University of Massachusetts, Amherst | 52 | MA | x | x | x | x | | x | x | | x | x | x | x | | x | x | x |
| **Massachusetts Pre-Engineering Program, Inc.** | 53 | MA | x | x | x | x | x | x | x | | x | | x | x | x | x | x | |
| **Accelerate Students Potentially Interested in Research and Engineering** | 54 | MI | x | | x | | | | x | x | | x | x | x | x | | x | x |
| **Detroit Area Precollege Engineering Program** | 55 | MI | x | x | x | x | x | x | x | | x | | | x | | | x | x |
| **Detroit Area Precollege Engineering Program** Michigan State University | 56 | MI | x | x | x | x | | x | x | x | x | | | | | x | x | x |
| **Engineering Industrial Support Program** | 57 | MI | x | | | x | | x | x | x | x | x | x | x | | x | | |
| **Mid-Michigan Minority Pre-Engineering Program** | 58 | MI | x | x | | x | | | x | | x | | | x | x | x | x | x |
| **Project Technical and Business** Lawrence Institute of Technology | 59 | MI | x | x | x | x | | x | x | x | x | x | x | x | x | x | x | x |
| **Project Technology Power** University of Minnesota | 60 | MN | x | x | x | x | x | x | x | x | x | x | | x | | x | x | x |

| Program Format | | | | Students Served | | | | | | | | | Grade Levels/ Total # of Students Served 1987-1988 School Year | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saturday | Summer | School Day | After School | African American | American Indian | Mexican American | Puerto Rican | Other Hispanic | Non-Minority | Female | Male | Total Minority | 7 | 8 | 9 | 10 | 11 | 12 | Total Students |
| | | | x | 150 | 3 | | | 1 | 49 | 129 | 74 | 154 | 6th + 7th 31/28 | 58 | 17 | 33 | 14 | 22 | 203 |
| | x | | | 25 | | | 8 | | 2 | 11 | 24 | 33 | | 8 | 5 | 6 | 5 | 11 | 35 |
| x | x | x | x | 237 | 3 | | 151 | 85 | 37 | 252 | 261 | 476 | 131 | 60 | 39 | 56 | 119 | 108 | 513 |
| | x | | x | 475 | | 2 | | 5 | 26 | | | 482 | | 134 | 143 | 83 | 91 | 57 | 508 |
| x | x | x | | Information not available | | | | | | | | | | | | | | | 1780 |
| | x | | | 29 | | | 1 | | | 16 | 14 | 30 | | | | 1 | 20 | 9 | 30 |
| x | x | | x | 139 | | | | | 7 | 60 | 86 | 139 | 10 | 30 | 30 | 30 | 34 | 12 | 146 |
| x | x | | | Information not available | | | | | | | | | | | | | | | 350 |
| | x | x | | 431 | | | 53 | | 33 | 335 | 182 | 484 | | | | 224 | 158 | 135 | 517 |
| x | x | | | 184 | 16 | 80 | | | | 112 | 168 | 280 | | 150 | 70 | 60 | | | 280 |

## Program Activities

| | Page | State | Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H S Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ChIME Workshops**<br>New Jersey Institute of Technology | 61 | NJ | x | x | x | x | | | x | | x | x | x | | | x | x | x |
| **Experimental Mathematics, Science, and Communications Program**<br>New Jersey Institute of Technology | 62 | NJ | x | x | x | x | | | x | | x | | | x | | x | | x |
| **Females in Engineering Methods, Motivation, and Experience**<br>New Jersey Institute of Technology | 63 | NJ | x | x | x | x | | | x | | x | x | x | x | | x | x | x |
| **High School Scholars Program**<br>New Jersey Institute of Technology | 64 | NJ | | | | x | | | | | x | | | | | | | x |
| **Jersey Coast Explorers**<br>New Jersey Institute of Technology | 65 | NJ | x | | | x | | | | | x | | | | | | | x |
| **Union County College Minorities in Engineering Program**<br>Union County College | 66 | NJ | x | x | x | x | | | x | | x | x | x | x | x | x | x | x |
| **Urban Engineering Program**<br>New Jersey Institute of Technology | 67 | NJ | x | x | x | x | | | x | | x | x | x | | | x | x | x |
| **Native American Mineral Engineering and Science Program**<br>New Mexico Institute of Mining and Technology | 68 | NM | x | x | x | x | x | x | x | x | x | x | | x | | x | x | x |
| **New Mexico Mathematics, Engineering, Science Achievement Program**<br>University of New Mexico | 69 | NM | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Buffalo-Area Engineering Awareness for Minorities**<br>c/o State University of New York at Buffalo | 70 | NY | x | x | x | x | x | x | x | | x | x | | x | x | x | x | x |

| Program Format | | | | Students Served | | | | | | | | Grade Levels/ Total # of Students Served 1987-1988 School Year | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saturday | Summer | School Day | After School | African American | American Indian | Mexican American | Puerto Rican | Other Hispanic | Non-Minority | Female | Male | Total Minority | 7 | 8 | 9 | 10 | 11 | 12 | Total Students |
| | x | | | 31 | | | | 15 | 1 | 22 | 25 | 46 | 7 | 17 | | 5 | 18 | | 47 |
| | x | | | 17 | | | | 2 | | 13 | 6 | 19 | 19 | | | | | | 19 |
| | x | | | 8 | N/A | | | 9 | 7 | 24 | | 17 | | | 24 | | | | 24 |
| x | | x | | Information not available | | | | | | | | | | | | | | 36 | 36 |
| | | x | | 61 | | | 14 | | | 35 | 40 | 75 | 4th 10 | 5th 10 | 6th 10 | 7th 45 | | | 75 |
| | x | | x | 203 | | 1 | 5 | 27 | 90 | 193 | 133 | 236 | 87 | 77 | 46 | 35 | 38 | 43 | 326 |
| | x | | | 89 | 1 | | | 19 | 61 | 82 | 88 | 109 | 47 | 51 | 26 | 12 | 34 | | 170 |
| | x | | | | 19 | 10 | | | 7 | 25 | 11 | 29 | | | | 20 | 16 | | 36 |
| x | x | x | x | 41 | 42 | 672 | | | 35 | 458 | 332 | 755 | 15 | 20 | 210 | 225 | 181 | 139 | 790 |
| | x | x | x | 91 | | | | 9 | 67 | 94 | 73 | 100 | 57 | 39 | 26 | 24 | 16 | 5 | 167 |

## Program Activities

| | Page | State | Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H S Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Capital District Science and Technology Entry Program**<br>Rensselaer Polytechnic Institute | 71 | NY | x | x | x | x | | x | x | x | x | x | x | x | x | x | x | x |
| **Comprehensive Mathematics and Science Program**<br>The Cooper Union and Columbia University | 72 | NY | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Dylan A. Thomas Memorial PREFACE Program**<br>Rensselaer Polytechnic Institute | 73 | NY | x | x | x | x | x | x | x | | x | | x | | | | x | x |
| **Precollege Engineering Program**<br>Syracuse University | 74 | NY | x | x | x | x | | x | x | x | x | | | | | | | |
| **Program for Rochester to Interest Students in Science and Math** | 75 | NY | x | x | x | | x | x | x | | x | x | x | x | | x | x | |
| **Science and Technology Entry Program**<br>Manhattan College | 76 | NY | x | x | x | | | x | x | | x | | | x | x | x | x | x |
| **Engineering Special Programs and Minority Student Services**<br>North Caroiina State University | 77 | NC | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Mathematics and Science Education Network Precollege Program**<br>University of North Carolina | 78 | NC | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Region 'O' Council for the Advancement of Minorities in Engineering**<br>New Hanover County Schools | 79 | NC | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Pre-Engineering Program for Minorities**<br>Ohio University | 80 | OH | x | x | x | x | | x | x | | x | x | | | | x | | x |

| Program Format | | | |
|---|---|---|---|
| Saturday | Summer | School Day | After School |
| x | x | x | x |
| x | x | x | x |
| | x | | |
| | x | | |
| x | x | | x |
| x | x | x | x |
| x | x | x | x |
| x | x | x | x |
| | x | x | x |
| | x | | |

| Students Served | | | | | | | | | Grade Levels/ Total # of Students Served 1987-1988 School Year | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| African American | American Indian | Mexican American | Puerto Rican | Other Hispanic | Non-Minority | Female | Male | Total Minority | 7 | 8 | 9 | 10 | 11 | 12 | Total Students |
| 338 | | | | 19 | 6 | 230 | 133 | 357 | 50 | 63 | 91 | 85 | 48 | 26 | 363 |
| 1980 | | | 1400 | | 260 | 1915 | 1725 | 3380 | | 220 | 1630 | 945 | 505 | 340 | 3640 |
| 13 | 2 | | 2 | 4 | 7 | 18 | 10 | 21 | | | | | 28 | | 28 |
| 12 | 1 | | 4 | 4 | 7 | 14 | 14 | 21 | | | | | | 28 | 28 |
| | | | | | | 266 | 106 | | | 53 | 54 | 92 | 70 | 103 | 372 |
| 39 | | 1 | 51 | 11 | | 24 | 78 | 102 | 9 | 4 | 12 | 29 | 27 | 21 | 102 |
| 1150 | 165 | 20 | 22 | 73 | 1070 | 1040 | 1460 | 1430 | | | 718 | 677 | 598 | 507 | 2500 |
| 485 | 5 | 2 | | | 79 | 353 | 218 | 492 | 6th + 7th 238 | 206 | 106 | 18 | 3 | | 571 |
| 436 | | | | | | 263 | 173 | 436 | 92 | 78 | 72 | 18 | 78 | 98 | 436 |
| 13 | | | | 1 | | 4 | 10 | 14 | | | | | | 14 | 14 |

## Program Activities

| | Page | State | Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H S Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **University of Cincinnati National Technical Association Summer Enrichment Program**<br>University of Cincinnati | 81 | OH | | | | x | x | | x | x | | | | x | x | | | x |
| **Women in Engineering**<br>University of Dayton | 82 | OH | x | x | x | x | | | x | x | x | x | x | | | | x | x |
| **Portland Mathematics, Engineering, Science Achievement Program** | 83 | OR | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **EMS Minority Recruitment**<br>Pennsylvania State University | 84 | PA | x | | | | | | | | x | | | | | | | x |
| **Philadelphia Regional Introduction for Minorities to Engineering** | 85 | PA | | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Pittsburgh Regional Engineering Program** | 86 | PA | x | x | x | x | | | x | | x | x | | x | | x | x | |
| **University Scholars Program Summer Honors Academy**<br>Pennsylvania State University | 87 | PA | x | x | | x | | | x | | x | | | | | x | | x |
| **To Improve Mathematics, Engineering, and Science Studies** | 88 | RI | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Precollege Summer Technical Program** | 89 | SC | | x | x | | | x | | | x | | | | | x | | x |
| **Science and Technology Enrichment Program** | 90 | SC | x | x | | x | x | x | x | | x | | | | | x | | |

| Program Format | | | | Students Served | | | | | | | | Grade Levels/ Total # of Students Served 1987-1988 School Year | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saturday | Summer | School Day | After School | African American | American Indian | Mexican American | Puerto Rican | Other Hispanic | Non-Minority | Female | Male | Total Minority | 7 | 8 | 9 | 10 | 11 | 12 | Total Students |
| x | x | | | 282 | 3 | | | | 2 | 153 | 134 | 285 | 187 | 34 | 34 | 17 | 12 | 3 | 287 |
| | x | | | 10 | | 1 | | | 86 | 97 | | 11 | | | | 97 | | | 97 |
| x | x | | x | 137 | 4 | | | 10 | 102 | 151 | 102 | 151 | 97 | 91 | 24 | 15 | 20 | 6 | 253 |
| | x | | | 29 | | | | 1 | 3 | 19 | 14 | 30 | | | | 25 | 8 | | 33 |
| x | x | x | x | 2265 | | | | 310 | 425 | 1845 | 1155 | 2575 | 900 | 995 | 425 | 305 | 200 | 175 | 3000 |
| x | | | x | 532 | | | | | 93 | 322 | 303 | 532 | 51 | 92 | 90 | 122 | 161 | 109 | 625 |
| | x | | | 5 | | | | | 20 | 13 | 12 | 5 | | | 1 | 6 | 18 | | 25 |
| x | x | x | | 175 | 1 | 50 | 40 | | 175 | 248 | 193 | 266 | | | | | | | 441 |
| | x | | | 54 | 1 | | | 1 | | | | 56 | 16 | 17 | 9 | 14 | | | 56 |
| x | | | | | 63 | | | 1 | 8 | 37 | 35 | 64 | | | 15 | 20 | 24 | 13 | 72 |

| | Program Activities | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Page | State | Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H S Graduates | Follow-up or Evaluation |
| **Summer Technical Enrichment Programs** | 91 | SC | x | x | | x | x | | x | x | | | | | | x | | |
| **Early Identification Program for Minorities in Engineering**<br>Christian Brothers College | 92 | TN | x | x | x | x | x | x | x | | | x | | | | x | | x |
| **Minority Engineering Scholarship Program**<br>University of Tennessee, Knoxville | 93 | TN | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Golden Crest Alliance for Minorities in Engineering** | 94 | TX | x | x | x | x | x | | x | x | x | x | | x | | | x | |
| **Minority Introduction to Engineering**<br>University of Texas, Austin | 95 | TX | x | | x | x | x | | x | | x | x | x | | | | | x |
| **San Antonio Pre-Freshman Engineering Program**<br>University of Texas, San Antonio | 96 | TX | x | x | x | x | x | | x | x | x | x | x | x | | x | x | x |
| **Summer Engineering Institute**<br>University of Texas, El Paso | 97 | TX | x | x | x | x | x | | x | | x | x | | | | | x | x |
| **Summer Enrichment Experience in Engineering**<br>Texas A&M University | 98 | TX | x | x | | | | | x | | x | | | | | | | x |
| **Texas Alliance for Minorities in Engineering, Inc.**<br>University of Texas, Arlington | 99 | TX | x | x | x | x | x | | x | x | x | x | x | x | | | | |
| **World of Engineering**<br>University of Texas, Austin | 100 | TX | x | | | x | x | | | | | x | x | | x | | | x |

| Program Format | | | | Students Served | | | | | | | | | Grade Levels/ Total # of Students Served 1987-1988 School Year | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Saturday | Summer | School Day | After School | African American | American Indian | Mexican American | Puerto Rican | Other Hispanic | Non-Minority | Female | Male | Total Minority | 7 | 8 | 9 | 10 | 11 | 12 | Total Students |
| | x | | | 86 | | | | | 3 | 58 | 31 | 86 | | 57 | 31 | 1 | | | 89 |
| | x | | | 24 | | | | | 2 | 6 | 20 | 24 | | | | | 16 | 10 | 26 |
| x | x | x | x | 141 | | | | | | 83 | 58 | 141 | 25 | 20 | 18 | 30 | 26 | 22 | 141 |
| | x | | x | | | | | | | | | | | | | | | | 162 |
| | x | | | 10 | | 40 | | | | 20 | 30 | 50 | | | | | 50 | | 50 |
| | x | | | 28 | 5 | 314 | | | 72 | 251 | 168 | 347 | 89 | 105 | 114 | 60 | 46 | 5 | 419 |
| | x | | | 6 | 1 | | | 90 | 33 | 63 | 67 | 97 | 1 | 17 | 67 | 35 | 7 | 3 | 130 |
| | x | | | 35 | | 75 | | | | 46 | 64 | 110 | | | | 58 | 52 | | 110 |
| x | x | x | x | Breakdown not provided | | | | | | | | | | | | | | | 3500 |
| x | | | | Information not provided | | | | | | | | | | | | | | | 850 |

## Program Activities

| | Page | State | Field Trips/Tours | Career Counseling | Academic Counseling | Instructional Material | Contest/Science Fair | Tutoring | Guest Speakers/Instructors | Test Preparation Activities | Hands-on Experience | Financial Aid | College Application | Parental Involvement | Teacher Training Workshop | Student Records Maintained | Tracking H.S. Graduates | Follow-up or Evaluation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Mathematics, Engineering, Science Achievement Program** | 101 | UT | x | x | x | | x | x | x | x | | x | | x | x | x | | x |
| **Cooperating Hampton Roads Organizations for Minorities in Engineering** | 102 | VA | x | x | | | | | x | | x | x | x | | x | x | x | x |
| **Minority Introduction to Engineering** University of Virginia, Charlottesville | 103 | VA | x | x | x | x | | x | x | x | x | x | x | | | x | x | x |
| **Seattle Mathematics, Engineering, Science Achievement Program** Washington MESA | 104 | WA | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **Mathematics, Engineering, Science Achievement Program** Seattle Mesa Program, University of Washington | 105 | WA | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x | x |
| **YakimaValley/Tri-Cities MESA Center** Tri-Cities University Center | 106 | WA | x | x | x | x | | x | x | x | x | x | x | x | x | x | x | x |
| **Gateway to Engineering, Science and Technology** University of Wisconsin, Milwaukee | 107 | WI | x | x | x | | x | x | x | x | x | x | x | x | | x | x | x |

| Program Format | | | |
|---|---|---|---|
| Saturday | Summer | School Day | After School |
| | | x | x |
| x | x | x | x |
| | x | | |
| | x | x | |
| x | x | x | x |
| | | x | |
| x | x | | |
| | | | |
| | | | |
| | | | |

| Students Served | | | | | | | | | Grade Levels/ Total # of Students Served 1987-1988 School Year | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| African American | American Indian | Mexican American | Puerto Rican | Other Hispanic | Non-Minority | Female | Male | Total Minority | 7 | 8 | 9 | 10 | 11 | 12 | Total Students |
| 28 | 18 | 117 | 4 | 17 | 115 | 202 | 97 | 184 | 6th + 7th 7/94 | 55 | 42 | 56 | 30 | 15 | 299 |
| 355 | 1 | 6 | | | 90 | 254 | 198 | 362 | 97 | 84 | 49 | 69 | 58 | 95 | 452 |
| 35 | 2 | 3 | 3 | | | 28 | 15 | | | | | | 43 | | 43 |
| 970 | 95 | | 249 | | | | | 1314 | 84 | 68 | 129 | 408 | 320 | 305 | 1314 |
| 411 | 18 | | | 47 | | | | 476 | | | | 238 | 121 | 117 | 476 |
| 18 | 17 | 111 | | | 2 | | | 148 | | | | 43 | 61 | 44 | 148 |
| 147 | 32 | 8 | | | 24 | 136 | 75 | 187 | 26 | 74 | 49 | 38 | 20 | 4 | 211 |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |

# Section C

# Appendices

## Regional Distribution of Precollege Programs

| State | Number of Programs | State | Number of Programs |
|---|---|---|---|
| **West** | 18 | **Southwest** | 17 |
| California | 14 | Arizona | 3 |
| Oregon | 1 | Colorado | 4 |
| Washington | 3 | New Mexico | 2 |
| | | Texas | 7 |
| | | Utah | 1 |
| **Midwest** | 23 | **Southeast** | 18 |
| Arkansas | 1 | Florida | 1 |
| Illinois | 6 | Georgia | 4 |
| Indiana | 6 | Louisiana | 3 |
| Kansas | 2 | North Carolina | 3 |
| Michigan | 6 | South Carolina | 3 |
| Minnesota | 1 | Tennessee | 2 |
| Wisconsin | 1 | Virginia | 2 |
| **Mideast** | 8 | **Northeast** | 23 |
| Kentucky | 1 | Connecticut | 2 |
| Ohio | 3 | Delaware | 2 |
| Pennsylvania | 4 | District of Columbia | 1 |
| | | Maryland | 1 |
| | | Massachusetts | 2 |
| | | New Jersey | 7 |
| | | New York | 7 |
| | | Rhode Island | 1 |

## Distribution of Precollege Programs by State

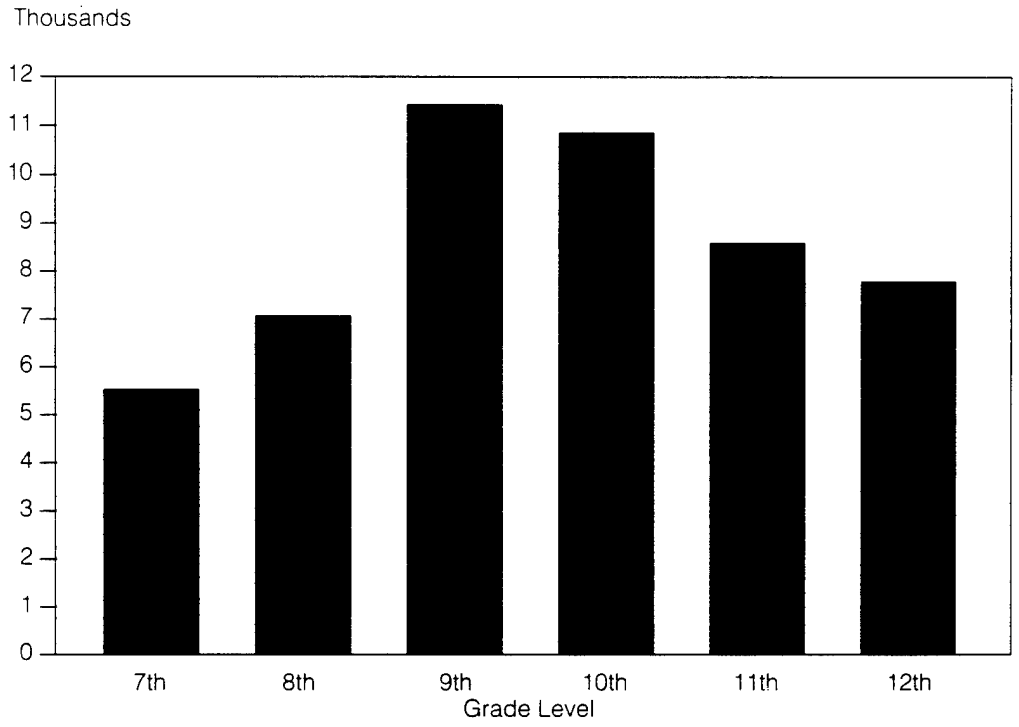
| State | Programs | Students |
|---|---|---|
| Arizona | 3 | 265 |
| Arkansas | 1 | 14 |
| California | 14 | 4,924 |
| Colorado | 4 | 1,781 |
| Connecticut | 2 | 297 |
| Delaware | 2 | 316 |
| District of Columbia | 1 | 841 |
| Florida | 1 | 274 |
| Georgia | 4 | 24,506 |
| Illinois | 6 | 669 |
| Indiana | 6 | 419 |
| Kansas | 2 | 324 |
| Kentucky | 1 | 85 |
| Louisiana | 3 | 598 |
| Maryland | 1 | 203 |
| Massachusetts | 2 | 548 |
| Michigan | 6 | 3,331 |
| Minnesota | 1 | 280 |
| New Jersey | 7 | 697 |
| New Mexico | 2 | 826 |
| New York | 7 | 4,700 |
| North Carolina | 3 | 3,507 |
| Ohio | 3 | 398 |
| Oregon | 1 | 253 |
| Pennsylvania | 4 | 3,683 |
| Rhode Island | 1 | 441 |
| South Carolina | 3 | 217 |
| Tennessee | 2 | 167 |
| Texas | 7 | 5,221 |
| Utah | 1 | 299 |
| Virginia | 2 | 495 |
| Washington | 3 | 1,314 |
| Wisconsin | 1 | 211 |
| | 107 | 62,104 |

## Program Participation by Grade Level, Ethnicity and Gender

| | | | |
|---|---|---|---|
| **Program Participation by Grade Level** | | | |
| Grade 7 | | 5,655 | 9.1% |
| Grade 8 | | 7,190 | 11.6% |
| Grade 9 | | 10,586 | 17.0% |
| Grade 10 | | 11,416 | 18.4% |
| Grade 11 | | 10,985 | 17.7% |
| Grade 12 | | 8,721 | 14.0% |
| Distribution not available | | 7,551 | 12.2% |
| | | 62,104 | 100.0% |
| **Program Participation by Ethnicity** | | | |
| African American | | 32,333 | 52.1% |
| American Indian | | 1,788 | 2.9% |
| Hispanic (Total) | | 8,406 | 13.5% |
| • Mexican American | 4,556 | | 7.3% |
| • Puerto Rican | 2,244 | | 3.6% |
| • Other Hispanic | 1,606 | | 2.6% |
| Others | | 12,200 | 19.6% |
| Distribution not available | | 7,377 | 11.9% |
| | | 62,104 | 100.0% |
| **Program Participation by Ethnicity** | | | |
| Female | | 25,513 | 41.1% |
| Male | | 19,790 | 31.9% |
| Distribution not available | | 16,801 | 27.0% |
| | | 62,104 | 100.0% |

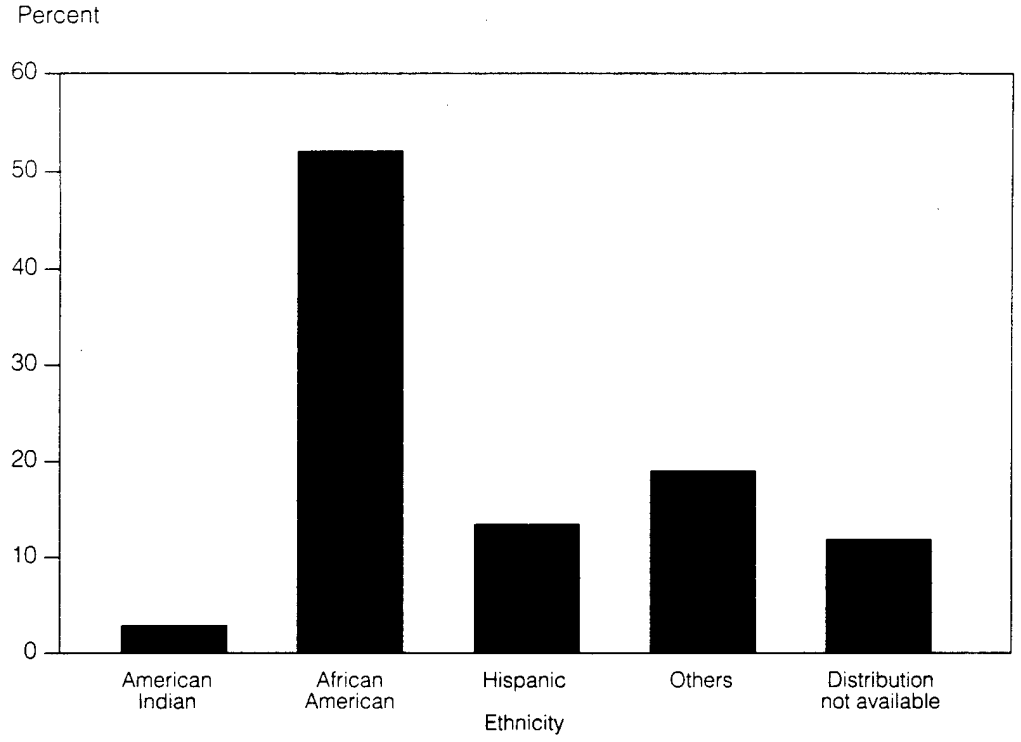
## Program Participation by Grade Level

1987-1988



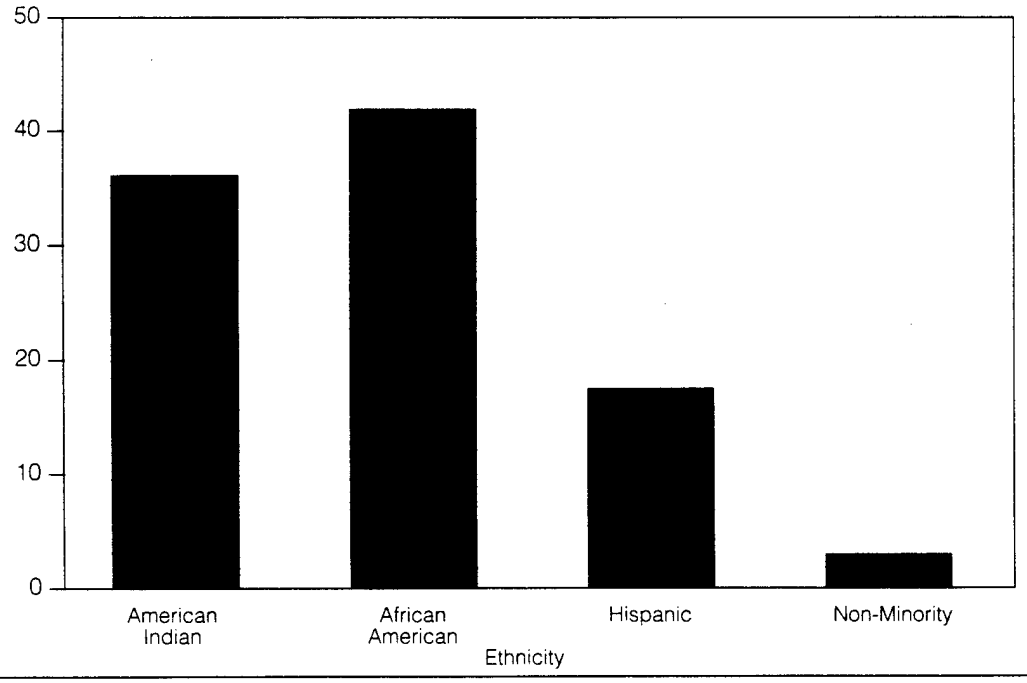
## Program Participation by Ethnicity

1987 - 1988



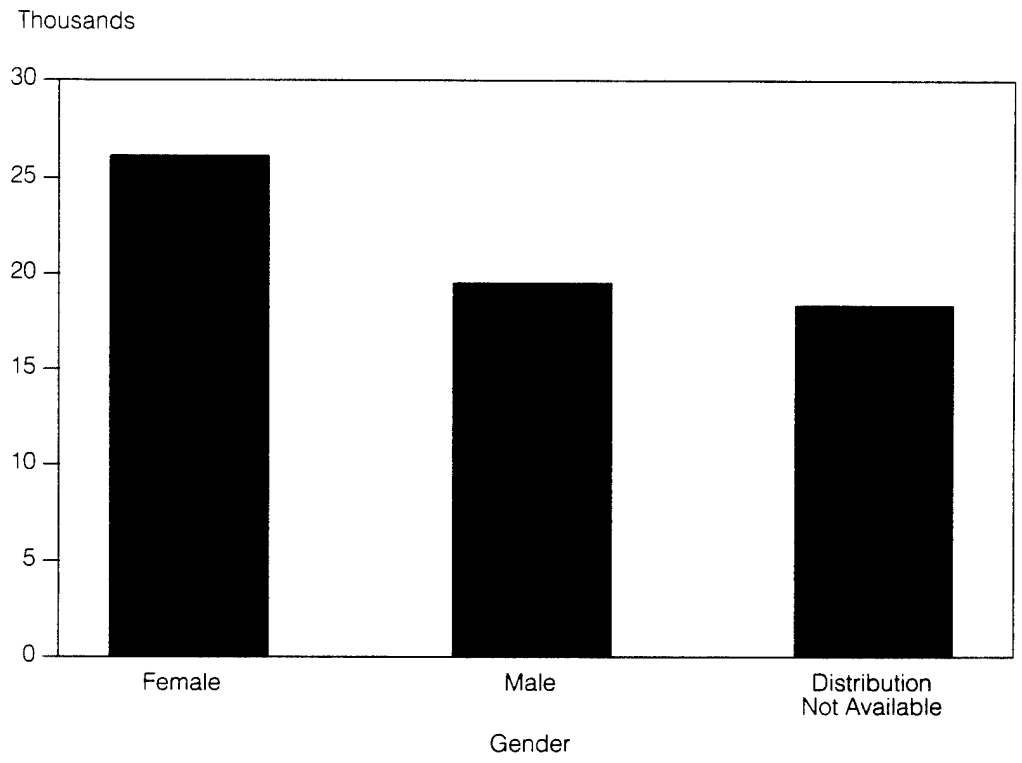

## Program Participation by Ethnicity

Normalized to the Population Distribution 1987 - 1988



## Program Participation by Gender

1987-1988




(Note: Based on programs providing gender data)

## Frequency of Program Activity Offerings

| Program Activity | Programs | Percentage |
|---|---|---|
| Guest Speakers/Instructors | 99 | 93% |
| Field Trips/Tours | 99 | 93% |
| Career Counseling | 98 | 92% |
| Follow-up or Evaluation Conducted | 93 | 87% |
| Hands-on Experience | 93 | 87% |
| Instructional Materials | 92 | 86% |
| Academic Counseling | 90 | 84% |
| Financial Aid Counseling | 82 | 77% |
| Student Records Maintained | 79 | 74% |
| Parental Involvement | 75 | 70% |
| College Application Assistance | 73 | 68% |
| Tracking High School Graduates | 72 | 67% |
| Tutoring | 71 | 66% |
| Contest/Science Fair | 64 | 60% |
| Test Preparation Activities | 63 | 59% |
| Teacher Training Workshops | 49 | 46% |

Total Programs: 107

## Additional Precollege Programs

The following precollege programs are actively providing services to minority students around the country. They have not been detailed in this book either because the services they offer are unique and cannot be presented within this format, or because complete information was not available at the time of this printing.

Career Awareness Program (CAP)
National Technical Association
1744 Payne Avenue
Cleveland, Ohio 44114

James Sawyer
216/433-4000

College Horizons
1414 40th Street
Sacramento, California 95819

Frances Tidey
916/739-0668

Comprehensive Activities to Upgrade Science Academics
Rio Piedras, PR 00928

Ronald Blackburn,
Executive Director
809/751-0178

INROADS
1221 Locust, Suite 410
St. Louis, Missouri 63103

Reginald D. Dixon,
President
314/214-7330

Junior Engineering Technical Society
JETS
Suite 405
1420 King Street
Alexandria, Virginia 22314-2715

Daniel W. Kuntz,
Executive Director
703/548-5387

Lubbock Alliance for Minorities in Engineering (LAME)
2010 Avenue R, Room 323
Lubbock, Texas 79411

Ernesto J. Gonzalez,
Executive Director
806/741-6337

Minority Program for Excellence in Science and Mathematics
Alton Senior High School
2200 College
Alton, Illinois 62002

Marie Shikadanz,
Director
618/474-2721

Northeastern University Progress in Minority Engineering Program
NUPRIME
Northeastern University
220 Snell Engineering Building
360 Huntington Avenue
Boston, Massachusetts 02115

David C. Blackman,
Director
617/437-5904

Regional Area Program for Minorities in Engineering
RAPME
Virginia State University
P.O. Box 64
Petersburg, Virginia 23803

Dr. Verna L. Holoman,
Director
804/520-6122/6111

Tacoma MESA
Pacific Lutheran University
University Center 102
Tacoma, Washington 98447

Carolyn Vaughn Young,
Director
206/535-7190

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PPG Industries Foundation
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Unisys
Unocal Foundation
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Amax Foundation, Inc.
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Analog Devices, Inc.
Armstrong World Industries, Inc. Charitable Foundation
Automatic Data Processing, Inc.
Batelle Memorial Institute
The Becton, Dickinson Foundation
Bell Communications Research
Betz Laboratories, Inc.
Black Collegian
The BOC Group, Inc.
The Bundy Foundation
Cameron Iron Works, Inc.
Career Communications Group
Carolina Power & Light Company
CBI Foundation
Centel Corporation
Central Soya Foundation
Champion International Foundation
$CH^2M$ HILL
Clark Equipment Company
The Clorox Company
Consumers Union
Cummins Engine Foundation
Data General
DSC Communications
ENSERCH Foundation
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Exxon Corporation
Federal Express Corporation
General Signal
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# APPENDIX H

# CASET FIELD-TESTED MODULE: SCIENCE IN THE FIELD

CASET FIELD-TESTED MODULE:
"Science in the Field"

A handbook for implementation of an intervention developed and tested for the U.S. Department of Defense through research conducted by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College, under Grant DAMD17-88-Z-8013 with support from the National Aeronautics and Space Administration under a Johnson Space Center Memorandum of Understanding.

The views, opinions, and/or findings contained in this handbook should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation; neither do they reflect those of the U.S. Department of Defense or the National Aeronautics and Space Administration.

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Reorder from: CASET, P.O. Box 580405, Houston, TX 77258-0405

About CASET and the CASET Consortium

The Center for the Advancement of Science, Engineering and Technology (CASET) of Huston-Tillotson College is a research-focused organization seeking to increase the participation of the underrepresented minorities (American Indians, Blacks, Hispanics, and women) in the science, engineering, and technology (SET) fields.

A research grant funded by the U. S. Department of Defense, with support from the National Aeronautics and Space Administration (NASA), enabled CASET to conduct original research through the twenty colleges and universities which constitute the CASET Consortium. These colleges and universities, scattered geographically throughout the United States, and reflecting a historical commitment to education for minorities and/or women, conducted original research during 1988, 1989, and 1990.

Each institution developed its own approach to increasing the "pool" of minorities and women in SET careers. Each conducted several interventions, generally one semester in length, with students; each collected demographic, opinion and performance data to measure the effects of those interventions. Data was collected by means of protocols developed by CASET, outcome measures developed by the institutions, and standard instruments such as transcripts and standardized test scores. All measures were taken on the intervention-group students, as well as on a control-group of students identified by each institution for comparison purposes.

Intervention mechanisms tested by individual institutions included study teams, tutoring, role modeling, group discussion, field trips, study skills training, working with parents and counselors, on-line instruction, multi-modality laboratory experience, career information workshops, and outdoor fieldwork. The institutions explored a number of different setting and scheduling formats; for example, some established Saturday Academies, some offered Summer residential programs, and others chose to incorporate their strategies into existing courses and semester schedules.

Student participants ranged from middle school to college, and were of various ability levels and backgrounds, depending on the goals and approach of each institution. The populations traditionally underrepresented in SET fields--American Indian, Black, Hispanic, and women students--were studied in these interventions, with the goal of developing interventions to increase their participation in SET fields.

After analyzing data from all institutions, CASET reported the study findings in three formats: a single-volume report on each intervention; a meta-analysis across all semesters and all institutions, and finally modules recommended by CASET for use and/or adaptation in other locales, based on tested interventions which achieved and replicated positive effects.

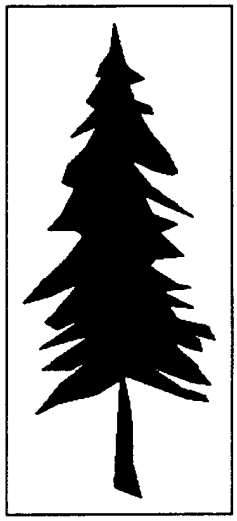
What is an intervention?

An intervention is an action designed to change the ideas or behavior of another person.

The CASET interventions are programs developed by CASET consortium members to enhance the opinions and/or the performance of students with respect to science, engineering and technology (SET) studies and careers.

What is "Science in the Field?"

"Science in the Field" is a CASET intervention which has been demonstrated to improve the opinions of participating students with respect to SET studies and careers. It is a one-week residential program of activities, mostly out-of-doors, allowing students to experience the world as a scientist does.



**********

Goal: To encourage underrepresented minorities and women to engage in scientific and technical study and careers

Objective: To improve student opinion about science as a career

Strategy: Experiential learning

Tactic: "Science in the Field"

**********

**About the CASET intervention at Western New Mexico University: "Science in the Field"**

The intervention described here was undertaken at Western New Mexico University (WNMU) under the direction of Dr. John Cunningham. During the two summers in which the project was implemented, 1989 and 1990, substantial positive effects on opinion were achieved, as measured by the CASET Opinion Protocol instrument which was given pre- and postintervention to intervention participants and control-group students.

Participants in the New Mexico study were high school students, primarily female and/or Hispanic. Participation was open to all students, not only the high-achievers. In the first year, eight students participated (thirteen were recruited, but five of these dropped out at the last minute.) In the second year, two separate one-week sessions were held: June 4-8 and June 11-15. Twenty-five participants were recruited for each; seventeen of the fifty dropped out before beginning, so that there were 16 participants the first week and 18 the second week (an additional student was recruited for the second week.).

The one-week intervention emphasized outdoor activity and experiential learning. A goal was to allow students to discover that scientists have fun doing science--that they get to explore and get dirty. Students stayed in a college dormitory--a first for most high school students--and spent a week doing active science: walking in deserts, climbing for geological study, fossil collecting, and picking out constellations in the sky with a star chart they had made. Recreational activities continued the active theme, and included swim parties and frisbee games.

Breakfasts and most dinners were served in the dormitory cafeteria, which also packed lunches for the students to take out on the field trips. Two dinners were cooked and served out-of-doors by the project staff: a barbecue the first night, and a fajita-and-bean outdoor supper the final afternoon. Transportation was via departmental van.

The project director for this intervention was a geologist and a male. The other two staff members accompanying the students for the intervention activities were Dr. Robert Miller, a male biologist, and Sandra Kruse, a female college student. These three accompanied the students on all activities; there were also two evening lectures by Dr. Kenneth Ladner, professor of chemistry.

Before the intervention began, a meeting was held for participants and their parents, giving them an opportunity to meet the staff and learn more about the week's activities. A hand-out was given participants, providing information about dates, times, exact places to report and to be picked up, and phone numbers of the staff, both at the university and at home.

Following is a copy of the hand-out given students at the meeting:

---

**WORKSHOP SCHEDULE AND NEEDS**

The workshop, "Natural New Mexico" will be offered in two sections:

June 4-8 and June 11-15

Participants should plan to meet at Eckles Hall dormitory at 10:00 a.m. on the appropriate Monday. The workshop will end at the dormitory at 7:00 p.m. Friday.

Below is a list of items that participants will need to bring with them:

Pillow (if desired), blanket or sleeping bag (the dorm provides sheets)

Any necessary medications

Toiletry items

Towel, wash cloth

"Camping style" clothing, rugged shoes (thongs won't cut it!)

Sweater and/or jacket

Bathing suit

Sunscreen or lotion

Hat

If any questions arise, contact:
John Cunningham, 538-xxxx (WNMU) or 538-xxxx (home)

Robert Miller, 538-xxxx (WNMU) or 538-xxxx (home)

---

Additional information on a hand-out might include what NOT to bring: Money, valuables, electronic equipment such as Walkman, cigarettes or any mind-altering substance or weapon. Any student bringing alcohol or any illegal drug or weapon will be sent home immediately. Also, include the name and telephone number of a contact person parents can call if they should need to reach their child in an emergency.

The intervention took place during a week in June. Students reported to the dormitory at 10:00 Monday morning, and were picked up at the dormitory between 6:00 and 6:45 p.m. the following Friday.

The schedule went like this:

| | | |
|---|---|---|
| Monday | 9:30 | Staff went to dormitory to meet students, due at 10:00. One staff member was in the dormitory parking lot; one in the appropriate dormitory wing, and one in the housing office. Assigned rooms and room-mates. |
| | 10:20 | (Staff and students) left dormitory, drove to Science building. |
| | 10:30 | Passed out and filled in registration forms, to register for one semester-hour college credit to be awarded for participation and writing a final essay. |
| | 11:00 | Lecture by geologist Cunningham: introduction; explanation of geology hand-outs on rocks and fossils; lecture on plate tectonics illustrated with transparencies. |
| | 11:30 | Lunch at University cafeteria. |
| | 1:00 | Discussion by geologist: geologic time, rock classification. |
| | 1:30 | Trip about one mile from campus to examine sedimentary rocks and fossils. |
| | 2:30 | Lecture by biologist on biomes, desert causes. |
| | 3:00 | Return to dormitory; free time to freshen up. |
| | 4:00 | Swim time at University pool. |
| | 5:00 | Change clothes time. |
| | 5:30 | Students transported to Forest Service picnic area (about 4 miles) for barbecue plus softball and frisbee. |
| | 7:00 | Return to dormitory. Dormitory Head Resident explains dormitory procedures and regulations. |
| | 7:30 | Return to rooms; free time; lights out. |

Tuesday 7:00 Breakfast at cafeteria, and pick up sack lunches.

8:30 Leave Science Building for Highway NM 15/35, through Gila National Forest, north of Silver City. Stops to examine igneous rocks, demonstrate tree classification key handout.

12:00 Lunch at Lake Roberts. Also discussion of lake history and problems (fish kill, silting).

12:30 Drive to ghost town of Georgetown.

1:48 Fossil collecting at Georgetown.

3:00 Return to Silver City.

3:45 Free time, cafeteria supper.

8:00 Astronomy lecturer Dr. Kenneth Ladner explains and supervises making of star chart.

9:00 Students use star chart to identify constellations.

9:45 Return to dormitory; lights out.

Wednesday

7:00 Breakfast at cafeteria; pick up sack lunches.

8:30 Leave Science Building for Glenwood (north on Highway 180). Stops at Gila River to discuss riparian environment, channelization, pollution, and proposed dam; and at Leopold Vista outlook to discuss volcanic caldera and associated mining district.

10:15 Tour of fish hatchery at Glenwood.

11:30 Lunch above fish hatchery; hike up picturesque canyon.

1:00 Return to Silver City, with stop at San Francisco Hot Springs (discussion of origin and life forms).

3:10 Free time and supper.

7:00 Swim party at university pool.

9:00 Return to dormitory; lights out.

Thursday

7:00 Breakfast at cafeteria; pick up sack lunches.

9:00 After passing out books (Mosaic of New Mexico, Scenery, Rocks, and History), travel to Redrock on

Gila River. Stop at Tyrone mine overlook to discuss workings of an open-pit copper mine.

11:00 Examine igneous rocks; lunch.

12:45 Fed, petted and photographed tame deer.

1:15 Drove around game refuge to see bighorn sheep.

2:30 Return to Silver City

3:45 Free time plus supper in cafeteria.

7:00 Chemistry and physics demonstrations (combination, static electricity, light behavior) by chemist Ladner.

9:00 Lights out.

Friday

7:00 Breakfast in cafeteria. Pick up sack lunch

9:00 Departure for Gila Cliff Dwellings (Originally a trip had been planned to a volcanic field, but extreme heat forced a change in plans.)

10:30 Tour Visitor's Center.

10:50 Examine cliff dwellings.

11:30 Lunch at picnic area.

12:30 Travel to City of Rocks

3:00 Students free to climb around and examine while staff prepares supper of fajitas and beans.

4:50 Eat, clean up area.

6:00 Return to dorm; parents meet and retrieve students.

Students were given the option of writing a paper at the end of the intervention in order to receive one hour of college credit. The first year, students did not take advantage of this; it may be that they did not understand the concept of "one hour" of credit, and thought that the effort represented more than "one hour." In the second year, however, 14 of the students submitted essays.

## "Science in the Field": Adapting the CASET Module for Specific Populations

A number of CASET interventions succeeded in improving students' performance in science and mathematics. Consistent improvements in opinion, however, proved more difficult to achieve.

Because of its proven success and replication of that success, this intervention developed at Western New Mexico University is the basis for the CASET intervention module "Science in the Field." This handbook provides the information needed to adapt the intervention for use in a variety of settings and with age groups younger and older than those students with whom it was developed.

> The intervention developed can be adapted for use with students in seventh grade through college. For pre-college students, it provides an introduction to college campus and faculty in addition to the science experiences.

**It is recommended that this project first be undertaken on a "pilot" basis with twelve students.**

After the first intervention, groups of 25 students can be handled comfortably. In their second year, WNMU scheduled two one-week interventions, one right after the other, for 25 students each time.

* * *

This handbook describes the staff time and other requirements needed to conduct the module, as well as specific instructions and suggestions to enable adaptation of the module for a variety of circumstances and student populations. This handbook is intended for use by

-- institutional decision-makers in determining whether the institution will undertake the **Science in the Field** CASET intervention

-- project directors conducting the **Science in the Field** CASET intervention

## Science in the Field

Requirements:

Project director: Responsible, personable, energetic scientist or science teacher; good rapport with younger students

Additional staff: **Two other science faculty members.** One might be a science teacher from the school system rather than your own institution. The project director and the other two faculty members, who will accompany the students on all activities, should represent both sexes.
**Contact person with school system.** Might be a teacher certification person from your institution.
Occasional: **Clerical staff person.**
During intervention, additional faculty for speakers or presentations.
A minimum of two additional staff (one male, one female) for **dormitory chaperons.**

Set-up staff time: **Project director:** One-eighth time beginning six months before intervention; increases to one-quarter time three months before intervention. Full-time during intervention.

**Teacher certification contact person**, or public school person: quarter time beginning three months before intervention

**Clerical staff:** One tenth time or less, beginning three months before intervention.

During activity: **Three full-time persons (at least two should be faculty members)** for one week, supplemented by **two additional speakers.** At least two **nighttime chaperons** (such as graduate students); the number depends on your dormitory arrangements.

Facilities: Vehicle(s) to transport participants and staff. Outdoor locations for geological, botanical, zoological, astronomical exploration.

Insurance coverage

Sleeping facilities: tents, cabins, or dormitories, with adequate chaperons

Food: Picnic boxes and dormitory food service for three meals/day. Nighttime snacks.

## Planning, Organizing and Implementing "Science in the Field"

START EARLY!

**PLANNING.....**

**Select** project director — Six months before intervention week

**Decide** dates, location, type of activities

**Recruit** faculty and staff — Three months before intervention week

**Set up** planning team

**ORGANIZING.....**

**Recruit** students

**Schedule** intervention activities

**Collect** supplies

**Confirm** arrangements: parents, speakers, transportation, food, housing — Two weeks before intervention week

**IMPLEMENTING....**

**Conducting the intervention** — Intervention week

---

For each of these steps, details and suggestions are provided in this handbook.

**Choosing your project director:**



Student participants will be exposed to science and scientists particularly through this person.

Everything about the project director, from personality to management skills, will color the experience of participants and of everyone involved.

Who will your project director be?

-- S/he will be resourceful, responsible, imaginative, with a genuine sense of the fun/play/thrill of "doing" science.

-- S/he will be a person you would trust out on the mountain with your son or daughter, from a safety standpoint and from every other standpoint.

-- S/he will be well organized. Details are important, in recruitment and planning as well as in implementation.

-- S/he will be an outdoorsman, and/or adventurous!

S/he will use good judgment in choosing the rest of the staff. Of course a balance of disciplines is ideal, but **the personality and character of the scientist is more important than which discipline s/he represents.**

Finally, the project director will be one who gets along with others. "Science in the Field" is a week's intensive contact between people of different ages, interests and personalities.

It falls on the project director to handle conflicts, make decisions, and ultimately to ensure that this intervention works.

**CHOOSING THE PROJECT DIRECTOR:**

**THE SINGLE MOST IMPORTANT DECISION OF THE PROJECT!**

STAGE I: DESIGNING THE INTERVENTION

**Stage 1 begins SIX MONTHS before the intervention!**

As you begin to think about the activities for your week of "Science in the Field," you will of course consider the areas of expertise of your project faculty and staff, and the **out-of-doors** areas near you. Consider these things:

Multi-sensory involvement: "Science in the Field" is a short, intense intervention. In school, students encounter the world of science mainly through words and pictures. In the field, however, science communicates with the students through all their senses. They will touch and breathe and even taste science.

See the familiar with new eyes: One way to let the intervention persist in the student's life is to change his/her understanding of surroundings. Are there colonies of living things all around of which s/he is unaware? In what environmental processes is your student participating, maybe unwittingly? What is his/her impact on the environment? Or let the students look up or down with new eyes: What is happening beneath the ground in your area? What is the story of the stars in view: Which are dying? Which may be new?

Keep moving: Young people spend their school days sitting still for long periods. Let your intervention be different: Show them there's more to science than sitting still. Let students climb, gather, reach, talk.

Learning need not be a silent process! There should be dialogue and sometimes laughter. The students need to be engaged in what they're doing--not silent spectators.

STAGE II: SETTING UP

Stage 2 begins
THREE MONTHS
before the
intervention!

The set-up phase will require the close cooperation of the project director and the public school contact person. During this phase, the "people" part of the intervention will be set up: faculty and participants. In addition, the actual activities of the intervention will be determined: obviously this task is dependent upon selecting the faculty.

The project director has four primary tasks for this period:

* Recruiting faculty and staff
* Setting up a planning team
* Scheduling of intervention activities
* Recruiting student participants

As you can see, this stage involves a great many people. The following activities will help you accomplish the tasks for this period. **IMPORTANT: ALL these activities should go on throughout this phase. DO NOT wait to finish one task before beginning the next. They should be simultaneously moving along: ESPECIALLY begin the task of student recruitment at least THREE MONTHS before the beginning of activities.** The first two activities should be done first; then begin all the others.

**1. Get the Pamphlet!**

The Project Director can find invaluable assistance in the CASET publication "Tips for Project Directors." That pamphlet, filled with tips and ideas gleaned from the experiences--positive and negative--of the CASET project directors, can be obtained by writing

CASET
P. O. Box 580405
Houston, TX 77258-0405

Also, of course, read all of this present handbook now!

**2. Contact the teacher certification division.**

If your institution has a teacher certification division, the project director is encouraged to contact that division and arrange to work closely with the division head or another senior staff member. The connections of that certification person with the personnel in the schools will be invaluable in several ways:

* Securing cooperation of the schools with the student recruitment effort

* Recommending faculty from the schools to participate in the project

* Providing knowledgeable audiences on whom to try out ideas: to ensure that students in the age group you have in mind will have the necessary background to understand the concepts

* Adding ideas about content, activities, and management of students, from their own experience

**3. Recruit faculty and staff**

> For the week in the field, plan to have <u>three staff persons there at all times</u>; one of these could be a college or graduate student. At night, you will need at least one staff member per dormitory area (that is, one for the boys' area and one for the girls' area), and one staff member per tent or cabin if you use tents or cabins any of the nights.

Unless you have an unusually dedicated teaching staff, the "night crew" staff will generally be different people from the daytime in-the-field team, although it might be nice for the teaching staff to spend at least one night "camping out" with the students.

Particularly if your students are below high-school age, you will find it extremely helpful to have other staff on hand, to help with the inevitable problems: a sick child, a discipline problem, late arrivals and early departures -- the unexpected events that are inevitable with a group of people, especially children. Graduate students or parents can be recruited for these helping roles.

> You will need drivers for transportation. **See your institution's insurance or legal department before contracting to transport students!**
>
> Very likely your state will require a chauffeur's license for transporting students.

Be sure your institution's legal department is aware of your plans.

You should know where you can take a student in case of a medical problem. Your active students may have allergies, develop fevers, get cuts, occasionally break bones. Don't be unprepared.

**4. Set up your planning team**

On your planning team, you need

* two educators with experience with your target age group
* two students of the target age group
* two parents of students of that age
* all your teaching faculty for the intervention

The team should begin meeting before student recruitment begins, with meetings scheduled every two weeks.

The team may subdivide for particular tasks, such as setting up a specific day's field trip; small subgroups will meet more often.

**5. Choose your dates:** Since you will be having most activities out of doors, choose your dates accordingly. Keep in mind wet seasons as well as temperature.

**7. Develop your schedule of activities.** Consider having a different focus each day. Some activity ideas:

* An archeological "dig"
* A geological "dig"
* Banding bats, birds, etc.
* Seining
* A nature trail
* An outdoor nighttime astronomy lecture/demonstration
* Tour different life zones: several days could be occupied here.

Depending on the geologic formations, life zones and aquatic environments in your area, fill the days with "in the field" work. Two points about this time:

1. Make plans in case of rain. Your outdoor activities do not have to be canceled in case of rain, unless the storm is electrical or otherwise dangerous. Still, anticipate the possibility of rain on any day, and decide ahead of time what you would do.

2. Avoid the field trips popular with your local schools, unless you can offer a new "twist" that makes them different. Your certification person and/or other school contacts can help you here. If your students have already toured the local science museum with the fourth grade and again with the Girl Scouts, you may not find another science museum tour to be a very exciting prospect for them.

Once you have the general plans developed and reviewed with your planning team, then get specific hour-to-hour plans. Consider where students will be, how they will get there, what they will eat and when, where they will sleep. Alternate quiet activities and vigorous ones.

Evenings must also be planned. Some suggestions:

* At least one evening, and possibly more, should be spent on astronomy exploration.

* One evening you might devote to telling students how to apply to colleges, and to your college in particular. Consider having a speaker from your admissions office.

* One evening of a "fun" activity, such as bowling or pizza or a movie, is a good idea.

* An evening activity related to the day's activities might involve making a collage of botanic specimens, or setting up an aquarium for specimens gathered in seining.

Meals will often not be in the cafeteria, since the students will be out-of-doors so much. Consider these:

* Your cafeteria may be able to provide box lunches to take into the field with you. Be sure you have an adequate cooler or ice-chest.

* Cook-outs on several evenings are well within the spirit of this intervention.

* Nighttime snacks would be appreciated by your hungry youngsters. Toast marshmallows!

When your plans are complete, make a good-copy chart, showing activities and meals for each day, as well as evening and sleeping plans.

**** Especially for your first time with this intervention there is no such thing as over-planning. If you have not planned sufficiently, you may find yourself surrounded by expectant-looking youngsters one afternoon, with no idea what to do with them. ****

**Sponge activities:** This is the term teachers use for activities to fill unexpected free time productively. It will happen: An activity you thought would fill the afternoon will be over at 2:30, and the students will be asking what they are to do now.

Anticipate this! Have some "spur-of-the-moment" activities already planned. Some ideas:

* Ask students to create a "rap" song to tell younger students about that day's activity in the field, or to teach a concept to the younger students. You could divide students into groups of four or five and let the groups compete. Group with the best rap song doesn't have to help with clean-up tonight.

* Ask them for ideas for next year's "Science in the Field" intervention. If they have none, ask them what they found most persuasive in this year's recruitment--what made them decide to sign up.

* Ask students to make and calibrate a sundial, using just a stick.

* Seat them in a circle with yourself and the other scientists present. You, and each of the other adults, tell how you decided to study science, and what you might do differently if you could.

Get other suggestions from your planning team--everyone on that team should have at least one "sponge" activity to suggest. Write them down! Bring the list in your pocket, at least the first time you undertake this project.

* * *

Plan to have something for students to take home with them. Two suggestions are the snapshot and tee shirt/sweatshirt. Your own activities may suggest an additional souvenir.

> A nice idea is to provide a tee shirt or sweatshirt for each participant, imprinted with the name of your institution or your program or "Science in the Field." You can have parents fill in shirt size on their application blank. Better to get the shirts too big than too small.

You want students to come away from the week with a good feeling. In any week some good and some bad experiences can be expected. Help your students remember the good.

So--those are some things NOT to do. Now, here are some positive suggestions:

First, before you begin, prepare a description of the schedule of activities and the personnel who will be with the group. A written description--with pictures if possible--can be a good recruiting tool, but be prepared to talk about what you have planned. The description should be an inviting one, and so should include these messages:

* **This will be fun.** (This particular message needs to come from peers of the students--see below--as well as from you.)

* **These are people you will like** -- the adults as well as the young persons. Dress casually, as you will for the intervention. Tell a little about the other faculty and planning team members--such as how many children they have, what experience they may have with young people, and/or other information that gives a positive "sense" of the person. Examples: "He grew up in a one-parent family." "Her parents immigrated to America." "She is the first person in her family to earn a college degree." "He grew up on a reservation." She was the youngest of six children."

* **People your own age** have helped plan this/ have done this last year.

Now, with these in hand and in mind, you are ready to begin your outreach to the community. Use all the opportunities you can.

* A picture in the paper, with accompanying story explaining the intervention, telling who is eligible and INCLUDING A PHONE NUMBER TO CALL, is a good beginning.

* Address school assemblies and science classes and science clubs.

* Speak to parents at PTA meetings and any other opportunity.

PLAN TO SPEND A LOT OF TIME ON YOUR RECRUITMENT EFFORT.

Some key steps to take during this important time:

1. DO <u>work with the teacher certification person</u> from your institution. S/he is known in the education community; besides providing introductions for you to key people, s/he can probably recommend people in the schools who are likely to be cooperative with your goals.

2. DO plan to <u>talk with a LOT of people</u>. ONE principal, counselor or teacher may set your materials on the desk and forget them. If you "put all your eggs in one basket," you may be in for a great disappointment.

3. DO bring with you some students when you visit the schools to address groups of students.

* If you have held your program before, these can be "alumni" who participated in previous years.

* If your program is new, let the two students from your planning team speak to the students you are recruiting, to tell them what is being planned for them.

4. DO make as much contact with parents as possible.

* Speak to PTA meetings

* Send mailings to students' homes (sending them through the mail is better than distributing them to students to carry home; students often forget the letters in their bookbags.)

* Some project directors have found it helpful to address church groups in the community.

5. DO plan to schedule meetings with parents well in advance of the beginning of your intervention. Parents want to see and hear you before they decide to turn their child over to you. They will have questions about what the child should bring and should wear.

* * * *

Give some thought to the **makeup of your student group.** It is not necessary that participants be top students, or even above average. However, because the group will spend a week in constant contact, personalities will be a consideration. This does not mean students need to have wonderful social skills or be "popular." It means if someone has a real adjustment problem--is disruptive, anti-social, a substance abuser or aggressive--that person should be screened out.

**The selection process should include an interview with the student, by you or someone whose judgment you respect. You should also speak with a teacher, counselor or principal who knows the student, before making your final selection.**

* * * *

## 6. Recruit student participants

BEGIN RECRUITMENT
EARLY! GIVE YOURSELF
AT LEAST THREE MONTHS.

Recruitment is probably the area in which CASET project directors discovered the most unhappy surprises. The sad facts, as reported by a number of project directors, are that the following happy thoughts ARE OFTEN MYTHS:

Myth #1: There are a sizeable number of enthusiastic students out there, who will "jump" at the chance to take part in my intervention.

**Reality: Students may be slow to show enthusiasm for programs suggested by adults, programs that threaten to be "good for them," and often programs about science at all.**

Myth #2: Students and their parents will welcome something to do with their time, especially in the summer.

**Reality: Students have a great many activities clamoring for their time, including jobs, child care for siblings or their own children, "hanging out," television, video games, sports, and sleeping. They may be loathe to give up any of these!**

Myth #3: I can count on school counselors, principals and teachers to encourage their students to enroll in my program.

**Reality: Of course, some will. A big surprise for CASET project directors, however, was the number of school personnel who did not "follow through" as the project director had anticipated and hoped. The reasons may reflect busy schedules or reluctance to endorse a new and unknown program--but whatever the reason, the clear message from the project directors' experience is:**

**DON'T DEPEND ON OTHERS TO DO YOUR RECRUITING**

and, similarly:

**DON'T COUNT ON ANY ONE SOURCE,
SUCH AS A SINGLE SCHOOL OR COUNSELOR**

to provide your participating students.

Consent forms/Medical forms: As students are recruited, you will need to get consent forms signed by their parents: permission to participate, release of liability, and permission to seek medical care if necessary. You will need to know whether the child has any allergies or chronic medical conditions, or special dietary requirements, or needs to take medication on a regular basis. You will need the physician's name and phone number, with permission to use a physician of your choice should circumstances make it necessary.

Send written confirmation/supply list to parents of each student who has been selected for your intervention.

* Welcome them

* Confirm when and where they will report, and when and where they will be picked up afterward

* Include your telephone number for them to call with any questions, as well as the number of the contact person families will call if they need to reach their student in an emergency during the intervention.

* Tell them what clothing and supplies to bring, and what NOT to bring, and what will happen if they bring what they are not supposed to bring.

Your list of clothing to bring will probably include at least two pair of walking shoes; three pair of jeans. Choose sweatshirts, light jackets, raincoats, tee shirts according to your seasons and climate. Advise students NOT to bring valuable belongings: jewelry, electronics, etc. Let them know the consequences if they bring any illegal substance or any weapon.

* * *

All the students who sign up will not participate. In general, you can figure that about one in four may not go: either they will get sick or some other circumstance will interfere. You will want to recruit a few more than you plan to work with, and most importantly you will want to CHECK BACK WITH THE PARENTS SEVERAL WEEKS BEFORE THE INTERVENTION BEGINS, TO SEE WHETHER THE STUDENT STILL PLANS TO ATTEND.

Even with this, some students you believed were surely recruited may not show up. This does not mean you did anything wrong; you have a lot of competition for students' time, and you won't always beat out that competition.

STAGE III: IMMEDIATE PREPARATION

IMMEDIATE PREPARATION
SHOULD BEGIN
TWO WEEKS BEFORE
INTERVENTION

There are a number of critical details to be checked in the final two weeks before your intervention. You may be able to delegate some of these to planning team members, but follow-up to be sure they are done, because they are essential!

1. Re-telephone parents of participating students, to confirm their participation, to remind them of when and where the students should report for the intervention, and to answer any questions they may have.

2. Confirm that you have all the necessary paperwork. Go over medical forms so you will know whether any student has an allergy, etc.

3. Re-check all transportation details: availability of vans and drivers, insurance coverage. Do not assume that a commitment made months ago or even weeks ago is still in place: CHECK!

4. Go over all meal and snack plans. Re-confirm with each person responsible for getting food: the cafeteria, anyone who is to pick up snacks at the grocery, any restaurant with which you may have made arrangements (such as for take-out fast-food.) Have you provided for drinks? coolers? ice? napkins? plates and silverware? trash bags for cleanup?

5. With the team or at least the faculty part of the team, go over the schedule for each day. It is not too late to make adjustments, and there probably will be some. Now that you have seen and talked with the students who will be going, is some of the material too easy? too hard? too boring? Have you scheduled too much for one day and not enough for another? Do you have quiet times and active times well mixed for variety? Are topics sequenced in a way that makes sense?

6. Check back with all speakers: PEOPLE DO FORGET, or some major life event may have pushed everything else out of the mind of someone you were counting on.

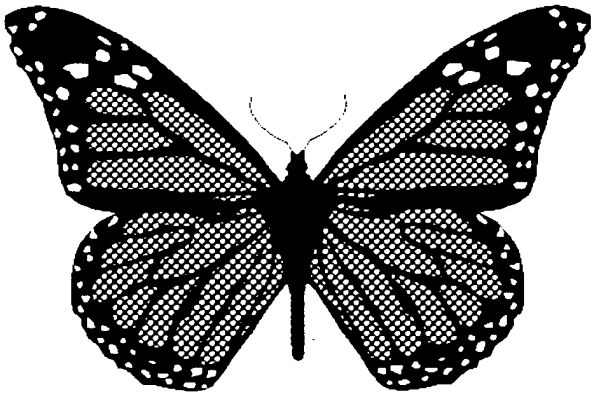
7. Get out your "sponge activity" list and your rainy day contingency plans. Are there any materials you need to have on hand?

8. If you can arrange to have a quick-developing camera on hand, it will be a real asset. Each participant can be given a snapshot of himself/herself participating in science-in-the-field, to take home as a souvenir. Additional snapshots of fun moments can be a real asset in next year's recruitment effort. Get film.

9. Re-check sleeping arrangements: dormitory reservations, chaperons, any supplies such as tents.

10. Have a first-aid kit with supplies appropriate for your part of the country and activities.

## STAGE IV: TIME TO GO!



After your hard work and thorough preparations, now it is time to enjoy the fruits of your labors. During the planning for this week, you thought carefully about content and teaching. Now that your week is underway, you will want to give attention to the quality of the experience. A good experience depends as much on feelings as on content.

> **Remember: The emotional "climate" will color your participants' experience as much as will anything you will say or do during this week.**

When you get together a group of personalities for prolonged contact, there are good and bad possibilities. Be aware of behavior, interaction, quality of experience. A smile, a gentle joke, can go a long way toward making unsure young people more comfortable.

Of course, problems may arise, and you will want to be prepared. Be aware of the possibility you may have to take more serious action. Be frank with yourself, and with your team before leaving, about the more difficult challenges that could face you. Decide what you would do about these possibilities before you go. Once the intervention is underway, be alert for possibilities such as:

* Interactions may become too intimate, or too hostile. People away from home, in an unfamiliar environment, sometimes feel that the rules and norms in the "real world" don't apply. Do not relax your vigilance; be prepared to intervene in highly-powered situations as necessary. Otherwise, the repercussions for your program and institutions could be severe.

* Of course you will have chosen chaperons in whom you have the utmost confidence. Be aware that you could have misjudged someone. Keep the group together; don't allow situations that could get out of hand.

* A student may bring liquor, cigarettes, or drugs, or a weapon. Here again, your selection process should minimize this possibility, but there is no way to eliminate it completely. Consequences must be immediate and severe: In the case of liquor or drugs, or a weapon, the offending student(s) must be sent home immediately. Make this clear in your first orientation meeting, and stick to it.

* A severe behavior problem could develop: a student with a "chip on his shoulder;" some outburst of unexpected and apparently inappropriate emotion. The **first** time such a thing happens, a quiet talk with the young person may take care of it. The **second** time, the talk will have to be serious: strong eye contact and the threat of being sent home may have the desired effect. If not, on the **third** offense you have little choice but to have the student picked up by the parents and taken home. Your primary responsibility is to the group; you cannot allow one student to ruin the experience for the others.

A few final thoughts:

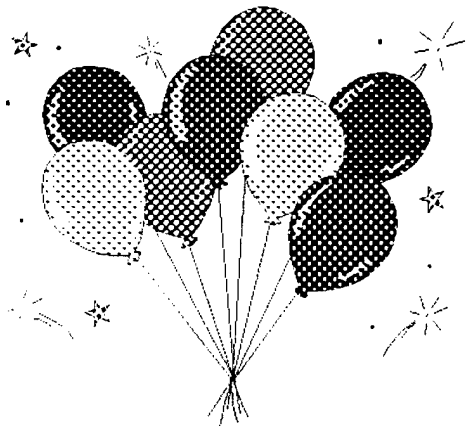
1. The students have taken the risk of signing up, and showing up. They are your allies: they want this to succeed as much as you do.

2. If students seem "not to be paying attention," don't yell at them. This is not school. WIN their attention: Call them all into a circle to pass around a specimen, or suggest a hike, or put them into groups for a task, or change the order of activities so something active is next.

3. Remember, the focus is not so much to teach content, as to show that science is neat and scientists are fun.

4. You must be a person of good will; otherwise you would not have undertaken this. The same can be said of the others who have come with you. Relax, and trust what you're doing. When this is over, you are likely to look back on it with real satisfaction.

5. Have a great time!



# APPENDIX I

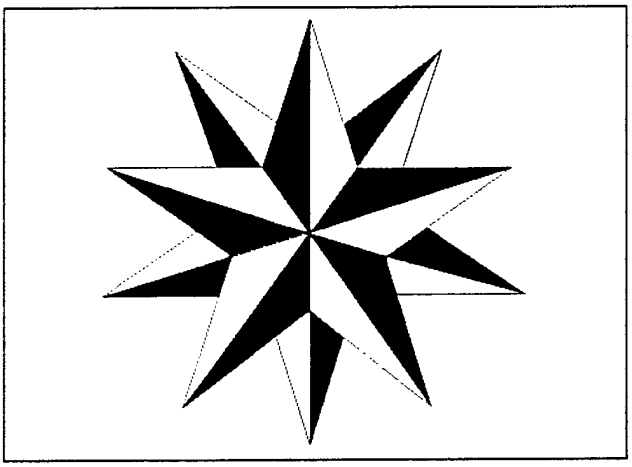
## CASET MODULE:

## TIPS FROM CASET, AN EXPERIENCE-BASED GUIDE TO CONDUCTING SUCCESSFUL INTERVENTIONS WITH STUDENTS

# TIPS FROM CASET

## for Project Directors

* * * *



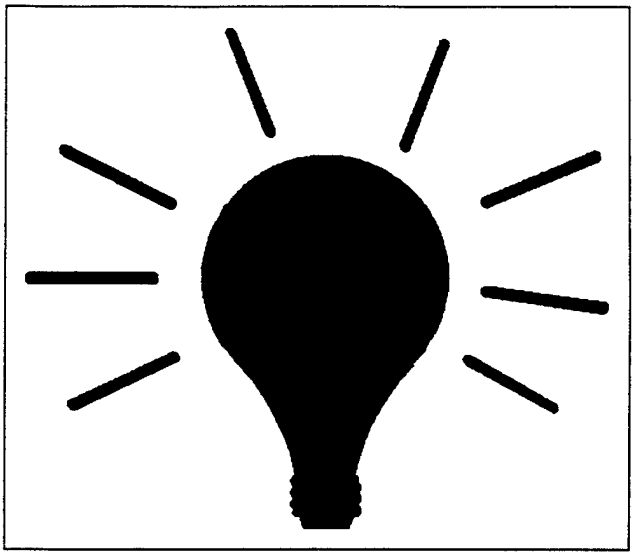
An Experienced-based Guide
to Conducting Successful Interventions
with Students

This booklet of ideas and suggestions grew from the hard-won experience of project directors conducting and testing interventions for CASET: the Center for the Advancement of Science, Engineering and Technology.

Interventions were conducted from coast to coast, in rural and urban areas, with female and minority students, ranging in age from fourth grade through college students. The interventions and research took place during 1988-1991.

Project directors were encouraged to report their successes and failures frankly, in order to maximize the learning to come from this wealth of experience.

We offer you here some very practical suggestions in response to commonly-encountered problems.



*NEW PROJECT DIRECTORS WANT TO KNOW.....*

*PROBLEM: In recruiting, I left brochures with school counselors, and put up posters. Hardly any students have called. What now?*

DON'T rely on just one or two sources for students. The brochures may never get past the counselor's or principal's desk. Get brochures out to teachers AND PARENTS. Use the school mailing list (best) or send brochures home with students (less reliable). Speak at the parent-teacher meeting, and have brochures with you. Consider approaching church groups and other community organizations.

During recruitment, consider publicizing in the local media. You probably have a good human-interest story to tell about the preparations for the program. Call your local newspaper; they will be glad to send out a photographer. Be sure the story includes

* a photo of students
* description of student eligibility requirements
* a phone number to call for information

Of course, you will have media coverage of your program while it is going on. That will help recruitment next year.

*PROBLEM: I'm just beginning to plan an intervention, and I'm concerned about the short attention spans of young children. I'm accustomed to working with college students, and even THEIR attention spans are short! How will I keep sixth graders paying attention?*

Students, especially young students, are most affected by things they DO, not lectures they simply hear. CASET project directors found that students responded enthusiastically to ACTION: On one field trip, youngsters got to sit in an F-18 and a P-3 aircraft. Students visited a theme park with instructors, studied the physics of a roller coaster, then rode it. One short but high-impact intervention included an astronomy lecture outside at night on a hill; on other days students were climbing, observing, and gathering in different ecological zones.

For those lectures you must have, keep them brief and impactful, with changes of activity frequently. FIFTEEN MINUTES IS LONG ENOUGH FOR YOUNG CHILDREN TO SIT AND LISTEN! After fifteen minutes, let them stand up: Call them into a circle (standing) to pass around a specimen to illustrate the lecture, or walk them outside "to see who remembers the five groups of vertebrates when we get back"--use your creativity. but LET THEM STAND UP AND MOVE!

*PROBLEM: When I addressed students in their classroom, they seemed reluctant and unsure. What can I say to assure them about this program?*

Let them see and hear people THEIR OWN AGE talking about the program. If you have held this program before, bring along some of your "graduates" (former participants) to address the students. If this is a new program, bring with you some peer tutors or other young people who will be involved--particularly those who have been involved in the planning and can tell the students what plans have been made for them.

If you have no young people involved either in the program or in the planning--WHY NOT? In that case, your best direction may be to recruit some class members from the group for whom you are planning the intervention, to help you plan.



*PROBLEM: I'm an astronomer, and a colleague from the physics department is going to help me with this program. What other staff do I need?*

On your planning team, you need

* two educators with experience with your target age group
* two students of the target age group
* two parents of students of that age
* all your teaching faculty for the intervention

For an intensive, outdoor, hands-on intervention, figure on one staff person for every five participants; some of these staff can be graduate students.

For classroom work, one staff member for every twelve students is a good ratio; a higher student/staff ratio can mean trouble, especially with younger students.

You will find it extremely helpful to have other staff on hand, to help with the inevitable problems: a sick child, a discipline problem, late arrivals and early departures -- the unexpected events that are inevitable with a group of people, especially children. Graduate students or parents can be recruited for these helping roles.

You may need drivers for transportation. See your institution's insurance or legal department before contracting to transport students!

You should know where you can take a child in case of a medical problem. Little ones develop fevers, get cuts, occasionally break bones. Don't be unprepared.

*PROBLEM: I am a University professor, with no real ties to the middle-school populations I will be recruiting. I don't know any middle-school teachers or administrators, and I'm not sure how to go about securing their cooperation with my program.*

Does your university have a teacher certification department? The head of that department is likely to have a number of connections in the educational community.

Involve the teacher certification person in your planning early; that person can probably advise and help you, not only with recruitment, but about designing your program to be effective with the age group you have in mind. For example s/he may be able to recommend practicing teachers to consult with you on subject-matter content -- or to serve as teachers in your project.

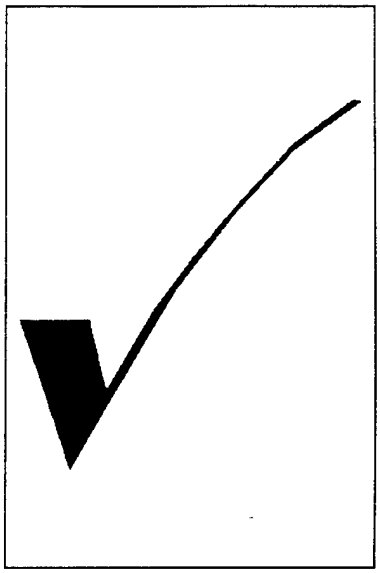
*PROBLEM: The discipline problems are running away with our program. It seems our faculty spends more time correcting than teaching. I know I need more staff, but there is no more money in the budget.*

Any time faculty does more correcting than teaching, it is likely that the tasks are not truly "grabbing" the students. We have seen severe discipline problems in these situations: Viewing a hard-to-see video on a poor-quality television; watching a science movie which continually referred to a lab manual which the students did not have; a less-than-dynamic teacher who seemed not to realize that his lecture was not understandable to fourth-graders. A visit to the classroom may enable you to diagnose the problem and make suggestions.

If indeed the problem is insufficient staff and you can't afford more, try these "free" sources of person-power:

1. Recruit parents. There is no better enhancement to your program's effectiveness than parental involvement. Parents can support your efforts during the program hours by being there; those same parents will reinforce your efforts at home, since they will understand your goals.

2. Students in your college's School of Education: Perhaps education students can get practicum credit for helping with your program. A number of education courses, particularly on the graduate level, may require students to spend a certain number of hours in a quasi-teaching capacity. Your teacher-certification liaison person can help here.



*PROBLEM: Is there a way to monitor the effectiveness of our program without a control group? I'd like to know whether we're really doing any good with all this effort.*

Your question gladdens our hearts! Far too often, programs are funded and run on the assumption that if they sound good and mean well, they MUST be good! But if all these programs are working, where are all the new young scientists that should be coming out of them?

Anyway, to your question: To determine the effectiveness of your own program, begin by defining your goals BEHAVIORALLY. Three steps here:

1. Determine what it is you hope to accomplish. Decide whether your intervention is primarily aimed at

* recruitment: getting more students to consider technical careers for themselves

* retention: lowering the loss of already-committed technical-major students, or

* performance by students: improving their skills in science or quantitative areas

2. Define short-term goals for your intervention. What do you want to accomplish right now? Examples:

If your primary goal is recruitment, your immediate goal is to increase awareness of the variety of careers available in quantitative areas. If your primary goal is retention, your immediate goal might be to increase the proportion of calculus students completing the course. A performance goal might mean an immediate goal of developing a particular level of competence in BASIC programming language.

Whatever your goal, make it specific and short-term.

3. State your goal in behavioral terms: That is, what will students have done, or be able to do, as a result of your intervention? Examples:

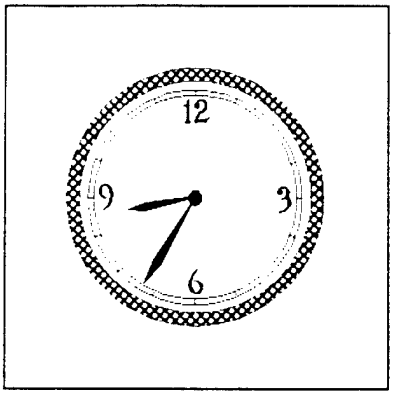
"Each student will be able to name ten different jobs in science fields." "Eighty percent of the calculus class will complete the course." "Each student will write a BASIC program to accomplish a particular task."

4. At the end of the program, test to see whether your objective has been met.

Ask students to show you the behavior you've predicted. Don't just assume that of course they can do it; don't just take the instructor's word that they've already written the program or whatever. You yourself listen to them name the jobs, or watch them write the programs.

Compile the results and look at them. How many succeeded? There will almost certainly be surprises: take a good look at them. Was your goal perhaps too ambitious, or not ambitious enough? Did students who attended or participated more do better? Did one group of students (older, younger, working with a different teacher) do better than another?

To round out what you know about the impact of your program, ask individual participants what they think of the program and the world of science. Finally, have a debriefing meeting with the staff to review the results, particularly any surprises.



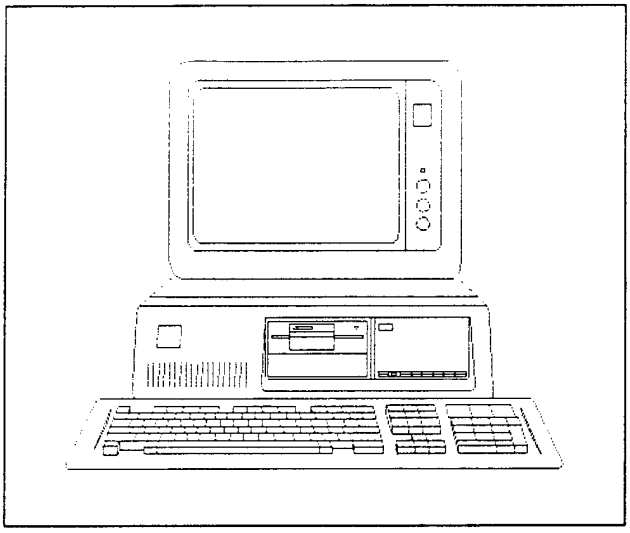

*PROBLEM: As our intervention progressed, attendance got lower and lower. I thought the instruction was good and understandable, and students didn't really have any complaints about it: they just always seemed to have something else to do.*

Pay attention to the bonding and social support network you build in your groups. These elements are part of what keep students coming back even in the face of schedule problems. You can't completely avoid schedule conflicts, but you can make sure your own program is one of the more attractive alternatives.

<u>Students helping each other</u> is one of the best builders of bonds in task groups. A student is less likely to miss a session if s/he feels that someone there is looking forward to seeing her/him, or depending on her/him for help.

Ideas for building a sense of "belonging:"

- Pairing students as "partners"
- Assigning big brother/big sister tutors
- Working in teams
- Having a name for your intervention, and using it often
- Using the pronouns "we" and "us" often!
- Reinforcing group achievement: "Look at what we've learned today!" "We have a really fine group. I'm proud of all of you."



*PROBLEM: The students are excited about our computer labs, but it seems we spend all our time trying to get the computers booted up and the programs loaded. In the meantime, students are shouting for help and the room is chaotic. HELP!*

There are two ways you can handle this problem, depending on the goals of your computer lab.

The simplest is to gain access to the computer room 30 minutes before your students are scheduled to arrive. Turn on the computers, load the program and otherwise prepare each workstation for use.

However, your goals may include teaching the students to boot up and load programs themselves. In this case, procure the services of assistants during at least the first few minutes, and preferably the whole lab time. The assistants can visit each workstation and help with problems--there will ALWAYS be questions, and someone whose screen does not match everyone else's screen.

Best prospects for these assistants?

PARENTS: They have a vested interest; they have clout with the students. Use them!

PEERS: Experienced students, perhaps a little older than those in your program. Your own children or those of faculty members may work cheaply.

VOLUNTEERS: Ask local companies to send volunteers, particularly those companies from which your institution purchases products, such as software or hardware.

*PROBLEM: I ran an intervention once before for high school students, and the transportation problems were overwhelming. Attendance was poor, and it seemed every day I heard stories of car break-downs and rides otherwise lost. I sure would like to avoid those headaches the next time.*

**Good for you for thinking ahead in such practical terms!**

**Unless you're equipped with some high-tech solutions involving televisions and computers, there are really only two ways to get together with young people who lack reliable transportation: You go to them, or you bring them to you.**

**Go to them: This was done by CASET project directors on both the high school and the middle school level. The project directors on these two projects arranged with the local schools attended by the students to use some of their own classrooms, and they conducted the intervention right there. Particularly for an after-school intervention, the school may be the location that will maximize participation for you.**

**On the other hand, your intervention may have equipment needs (such as a laboratory) that require students to come to your campus; or your intervention design may include the experience for the students of being on a college campus. In this case, consider providing bus or van service. You may find it easier to pick all the students up at their own school and drop them off there, even if yours is not an after-school intervention. Driving house-to-house may be complicated, and in at least one intervention, there was a problem with students' not notifying the project director of an impending absence, so that the bus made unnecessary stops.**

**In any case, be sure you are covered by the necessary insurance, particularly if you will be transporting students.**

*QUESTION: Which intervention activities did students like best?*

Program directors most often report three activities as having the highest impact: Field trips most of all, followed by tutoring and computer experience.

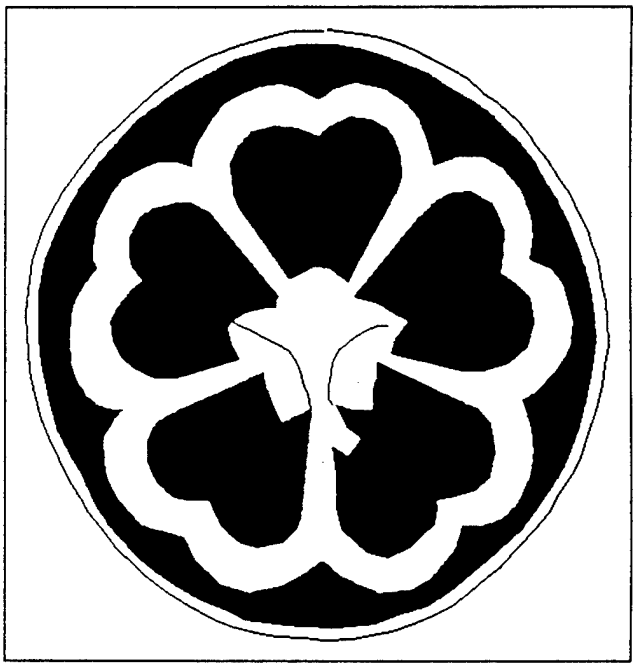
Program directors report field trips as the most popular part of their interventions. Besides being fun, they teach important lessons. They show the relevance of scientific information, but for many students they have particular impact: Some intervention participants are students who may never have traveled, stayed in a motel, or even eaten in a restaurant. For these students, the traveling involved in your field trips may open a new world of possibilities. The field trip experience can say "This is how you could live. People are living this way; scientists earn an income that makes this kind of life possible."

Tutoring: if your intervention takes place during the school year, some of your students may be having academic difficulties that may make their new aspirations seem unrealistic. Be aware that helping a student to "shine" right in his/her own classroom may be the most important thing you do: in addition, a good tutor will demonstrate good study skills so that the student learns how to learn.

The impact and importance of computer experience is mentioned over and over by our program directors. If hardware availability is a problem, consider a very small-scale computer experience. Two students at a time, with your teaching aide or graduate student, in a 30-minute or even 15-minute session, can learn and enjoy. How to schedule this? Consider your own situation: could two students at a time be released from a recreation period, rotated so everybody goes once a week? Is your transportation situation such that each student can have a designated day on which s/he arrives early or stays late for the computer time? Do you have a period scheduled for private study or tutoring, from which two students at a time could be taken for computer time?

Before your intervention begins, mentally "walk through" a day with your student. Consider the practical issues: bathrooming times and locations; food breaks: where will the food be and how will it get there? Be sure there are frequent changes of activity; your students go to school already, and more of the same sitting-and-listening mode will probably not be helpful or appreciated. Project directors and participants had positive things to say about almost every activity but rarely about a lecture.

Finally: Keep in touch with parents, especially during recruitment. This advice, like all the advice above, comes to you out of the hard-won experience of the CASET project directors. They join all of us at CASET, in wishing you and your students a successful and satisfying experience.



# APPENDIX J

# FUN D' MENTAL PHYSICS LABORATORY MANUAL

# Fun d' Mental Physics

## Laboratory Manual

*Rev. 2.2*

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# Preface

This laboratory manual is based upon the premise that every aspect of the scientific method of investigation should be introduced and practiced in the science laboratory from the very beginning.

Therefore, instead of including a large number of carefully planned and structured "cookbook" experiments to illustrate the variety of topics associated with each phenomenon, this manual includes only a minimum number of "open-ended" experiments which emphasize only the most fundamental principles associated with each phenomenon. It is the students' responsibility to use the scientific method of investigation to further explore the multiple ramifications associated with each fundamental phenomenon by designing and performing their own experiments.

In order to insure that every aspect of the scientific method is covered in every experiment, the manual follows a consistent and systematic approach which echoes the scientific method itself. Every experiment begins with an experience which introduces a physical phenomenon and ends with the student's report of an experiment which intestigates that phenomenon. More specifically, every experiment contains the following eight elements: (1) Observation, (2) Analysis, (3) Theory, (4) Concepts, (5) Practice, (6) Design, (7) Set-Up, and (8) Performance.

We call this structured approach to scientific investigation of fundamental principles the Fun d' Mental laboratory approach. It is very similar to the 4MAT® system developed by Dr. Bernice McCarthy which teaches according to the way people naturally learn and think.

The only significant difference between the Fun d' Mental approach and the 4MAT® system is that the Fun d' Mental approach is designed specifically for a laboratory course accompanied by a lecture while the 4MAT® system is designed for a fully integrated learning environment. In other words, the 4MAT® system emphasizes all learning styles and brain modes while the Fun d' Mental approach emphasizes those learning styles and modes not included in the regular lecture portion of the course.

This means that the Theory, Concepts, and Practice portion of the Fun d' Mental experiment are usually de-emphasized. Only when new material is being covered are these parts of the experiment very extensive. In most cases, these parts consist only of brief summaries of principles, reviews of concepts, and practice with problems suitable for experimental verification.

The Fun d' Mental approach to science laboratories is still in the experimental stage of development so that this manual is expected to undergo several revisions before being ready for general distribution. It is currently being written as part of a research project funded through the Center for the Advancement of Science, Engineering and Technology (CASET) in an attempt to improve the retention and performance of women and minority students in the introductory technical physics laboratory courses at Texas A&I University.

We wish to express our appreciation to CASET for this support and hope that this manual proves beneficial toward this end.

L. D. H.
D. L. S.

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Experiment 1.

# Science and Learning

The scientific method of investigation has been utilized for centuries to help human beings learn more about the secrets of nature. Only recently has its correlation to the way people naturally learn and think been fully appreciated. This experiment is intended to introduce and explore the relationship between learning theories, methods of teaching, and the scientific cycle of investigation.

## 1. LEARNING STYLES

OBSERVATION: The ability to learn new information and skills is the key to success in our ever changing world, so if you learn nothing else from college but how you learn, then you have accomplished a great deal. Since different people learn different ways, please take out a sheet of paper and briefly describe how you learn.

ANALYSIS: Combine your result with that from the rest of the class and arrange the data into groups according to learning styles. List the general characteristics of each group. How many distinct learning styles can you identify? Which style is most common for the class? Which is least common? Is this result surprising or is this what you would expect from a class like yours?

THEORY: According to modern learning theory there are four styles of learning. Everyone learns to some extent in every style, but most people prefer one style or the other. To identify which style you prefer, take the following two tests. The first test determines how you process information and the second how you perceive information.

### Test 1. Information Processing.

Please circle the characteristic (A) or (B) in each of the following lines that best describes how you process information in a learning environment.

I LEARN BEST WHEN I

| | | |
|---|---|---|
| 1. | (A) watch carefully | (B) participate in activities |
| 2. | (A) reflect upon an experience | (B) repeat an experience |
| 3. | (A) take my time | (B) get immediate results |
| 4. | (A) observe things | (B) experience things |
| 5. | (A) analyzing results | (B) use trial and error |
| 6. | (A) am observant | (B) am active |
| 7. | (A) reflect upon what happens | (B) try things to see what happens |
| 8. | (A) listen and watch carefully | (B) work hard to get things done |
| 9. | (A) consider all sides of an issue | (B) experiment with different things |
| 10. | (A) am quiet and reserved | (B) am active and outgoing |
| 11. | (A) am watching things | (B) am doing things |
| 12. | (A) ponder the situation | (B) manipulate the situation |
| 13. | (A) look over things carefully | (B) pick up and play with things |
| 14. | (A) am deliberate | (B) am spontaneous |
| 15. | (A) watch and listen | (B) do things |
| 16. | (A) examine things | (B) explore things |
| 17. | (A) am curious about things | (B) am responsible about things |
| 18. | (A) observe from the sidelines | (B) try things out for myself |
| 19. | (A) am careful | (B) am practical |
| 20. | (A) watch things happen | (B) make things happen |

Totals: #A's = _____ #B's = _____

Difference: #A's - #B's = _____

**Test 2. Information Perception.**

Please circle the characteristic (C) or (D) in each of the following lines that best describes how you perceive information in a learning environment.

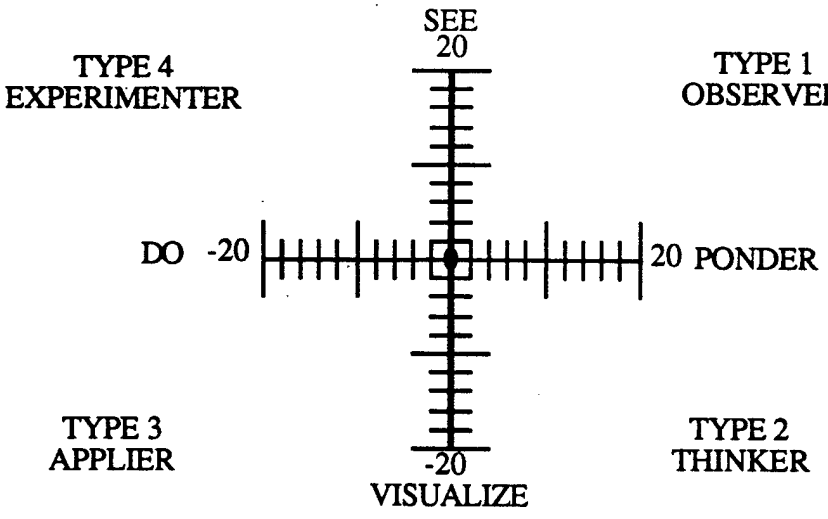
| | WHEN LEARNING, I TEND TO | |
|---|---|---|
| 1. | (C) use intuition | (D) use logic |
| 2. | (C) get involved | (D) think things out |
| 3. | (C) discuss people and experiences, | (D) discuss ideas and theories. |
| 4. | (C) use hunches | (D) use reasoning |
| 5. | (C) be creative | (D) be systematic |
| 6. | (C) become personally involved | (D) consider ideas and theories |
| 7. | (C) experience things | (D) think about things |
| 8. | (C) consider personal impressions | (D) consider rational theories |
| 9. | (C) use my feelings | (D) use my thinking |
| 10. | (C) make quick decisions | (D) evaluate things carefully |
| 11. | (C) be receptive | (D) be reserved |
| 12. | (C) use personal experience | (D) use analytical thinking |
| 13. | (C) react quickly | (D) ponder the alternatives |
| 14. | (C) accept things as they are | (D) analyze everything |
| 15. | (C) be spontaneous | (D) be deliberate |
| 16. | (C) have strong feelings and reactions | (D) reason things out |
| 17. | (C) enjoy new experiences | (D) enjoy new ideas |
| 18. | (C) need concrete examples | (D) visualize abstract concepts |
| 19. | (C) be emotional | (D) be rational |
| 20. | (C) trust my intuition and feelings | (D) rely on my logic and thinking |

Totals: #C's = _____ #D's = _____

Difference: #C's - #D's = _____

**Your Learning Style**

Plot the result of these two tests on the graph below to determine your learning style. The difference #A's-#B's for the first test should be plotted horizontally on the DO-PONDER axis, and the difference #C's-#D's for the second test should be plotted vertically on the SEE-VISUALIZE axis. Your result should be a single point located in one of the four quadrants. This quadrant determines which type learner you are.



CONCEPTS:

1. When it comes to information processing: (a) What is the difference between "active experimentation" and "reflective observation"? (b) Which of these corresponds to Test 1, column A? Column B? (c) Which type person ponders things in his/her mind? Which needs to physically manipulate things with his/her hands? (d) Why is the horizontal axis labeled "DO-PONDER"?
2. When it comes to information perception: (a) What is the difference between "concrete experience" and "abstract conceptualization"? (b) Which of these corresponds to Test 2, column C? Column D? (c) Which type person needs to see, feel, hear, smell, and/or taste something to really understand it? Which is able to visualize things clearly in the mind? (d) Why is the vertical axis labeled "SEE-VISUALIZE"?
3. Describe the characteristics of each type of learner. What other set of names might be just as descriptive as Observer, Thinker, Applier, and Experimenter?
4. Explain why everyone learns to some extent in every style.
5. Explain why Type 2 Learners generally do better in school than the others. Which type generally has the most difficulty in school? Why?

PRACTICE:

1. Is this theory of learning consistent with how you learn? Explain the differences between the theoretical description of your learning style and your original description of how you learn.
2. Apply the above theory to the class. (a) Reanalyze the classroom data by placing each student in the appropriate learning style group. (b) Look at the descriptions in each group and identify additional characteristics of each learning style (besides how people perceive and process information).

## 2. BRAIN LATERALIZATION

THEORY: Modern research has shown that the human brain employes two distinct modes of thinking. These thought processes, which seem to take place in the two different hemispheres of the brain, are called LEFT MODE and the RIGHT MODE. To some extent every individual utilizes both modes of thinking, but for most people one mode or the other dominates. To determine your dominant mode, complete the following test:

1. I base my decisions on (A) facts, (B) feelings.
2. I recognize (A) cause and effect, (B) patterns and trends.
3. I like to communicate through (A) words, (B) pictures.
4. I prefer (A) controlled, systematic experiments, (B) open-ended, creative experiments.
5. I solve problems through (A) deductive reasoning, logic, (B) inductive reasoning, hunches.
6. I make (A) objective evaluations, (B) subjective evaluations.
7. I prefer (A) written instructions, (B) oral demonstrations.
8. I am (A) rational, (B) intuitive
9. I tend to notice (A) distinctions between things, (B) similarities between things.
10. I prefer (A) a clear chain of command, (B) a loose chain of command.
11. My life is (A) planned and structured, (B) fluid and spontaneous.
12. I like to (A) analyze things by breaking them down into constituent parts, (B) synthesize things by putting them together to make a whole.
13. I primarily rely on (A) words for thinking and remembering, (B) images for thinking and remembering.
14. I express myself by (A) talking and writing, (B) drawing and arranging things.
15. I prefer to consider things (A) sequentially, (B) simultaneously.
16. I tend to be (A) specific, (B) general.
17. I analyze problems by (A) looking at the parts of things, (B) looking for patterns and configurations.

18. I am (A) careful and deliberate, (B) carefree and spontaneous.
19. I prefer (A) multiple choice tests, (B) open-ended questions.
20. I like (A) logical thinking, (B) analogical thinking.
21. I tend to (A) control my feelings, (B) allow my feelings to flow.
22. I respond best to (A) a structured environment, (B) an unstructured environment.
23. I concentrate on (A) the critical parts, (B) the whole picture.
24. I prefer (A) established, certain information, (B) new, tentative information.

Totals: #B's = _____

#A's = _____

Difference: #B's - #A's = _____

After finishing the above test, count the number of times you answered A and B. Subtract the number of A's from the number of B's and plot the results on the following scale to determine your brain orientation:




CONCEPTS: Construct a table listing the general characteristics of Left Brain, Right Brain, and Whole Brain thinking. **Hint:** Look at the respective answers to the questions on the preceding test to determine the characteristics of (A) Right Brain and (B) Left Brain thinking. Summarize the major characteristics of each mode in an appropriate table. Then add a brief description of Whole Brain thinking to the table.

PRACTICE:
1. Does the above description of your brain lateralization properly describe the way you think?
2. Use the classroom data to determine how many students in your class are left, right, and whole brain oriented. Is this what you would expect?

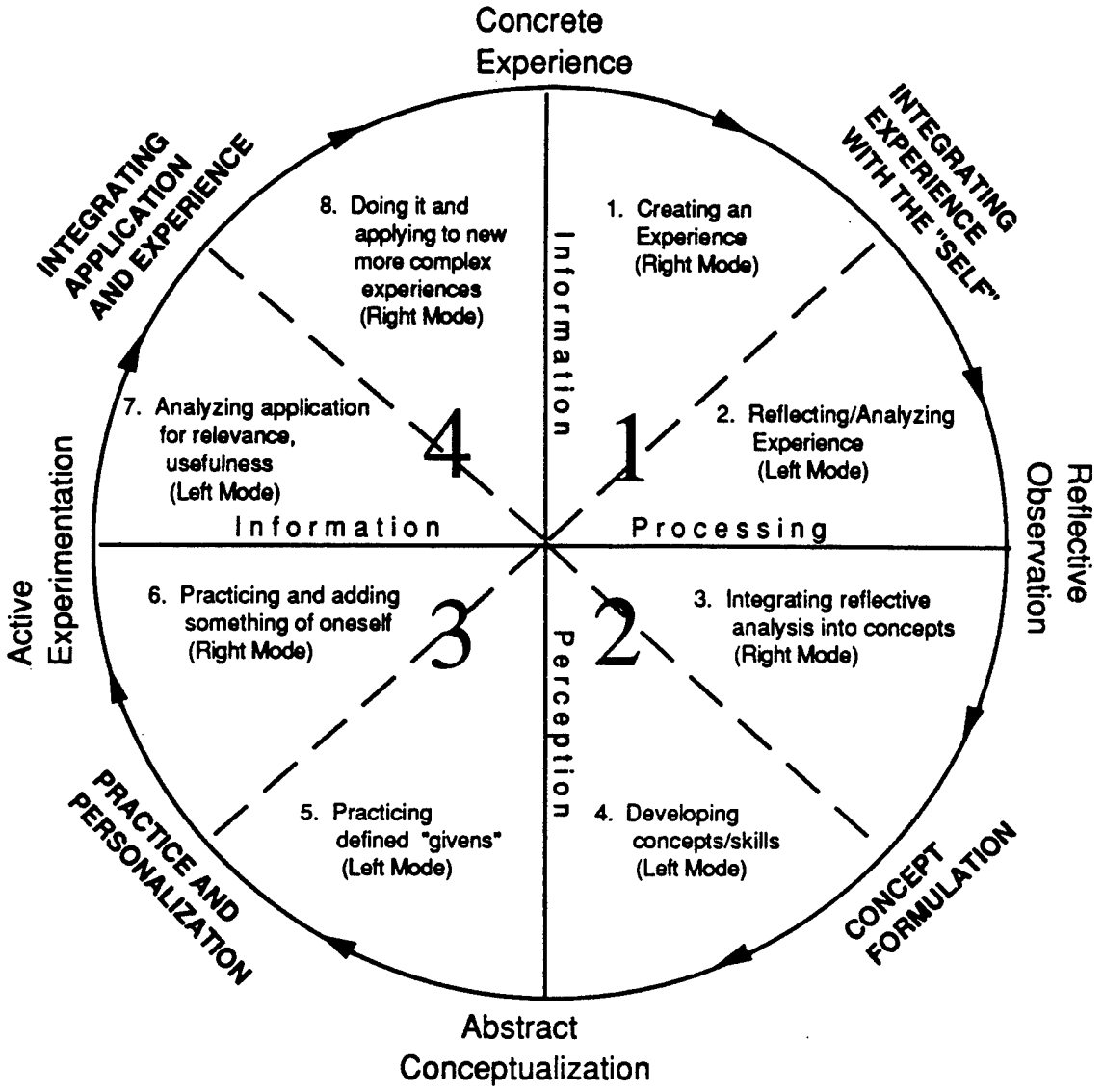
## 3. 4MAT TEACHING

THEORY: Dr. Bernice McCarthy developed a system of teaching which incorporates all four style of learning and both modes of thinking. This system is illustrated in the diagram on the following page.

Please look it over before continuing below.

CONCEPTS:
1. List the eight steps used in the 4MAT method of teaching and explain how each step emphasizes one specific learning style and one specific brain mode.
2. Which of these steps are emphasized in traditional classroom environments?
3. Why is the 4MAT system expected to be more successful than traditional teaching methods?
4. Why does it begin with Step 1 instead of some other step? Is learning complete with Step 8?

PRACTICE: Briefly describe how the 4MAT method could be used to teach swimming. Specifically, what are the eight steps that could be used? How does this differ from a typical swimming class.



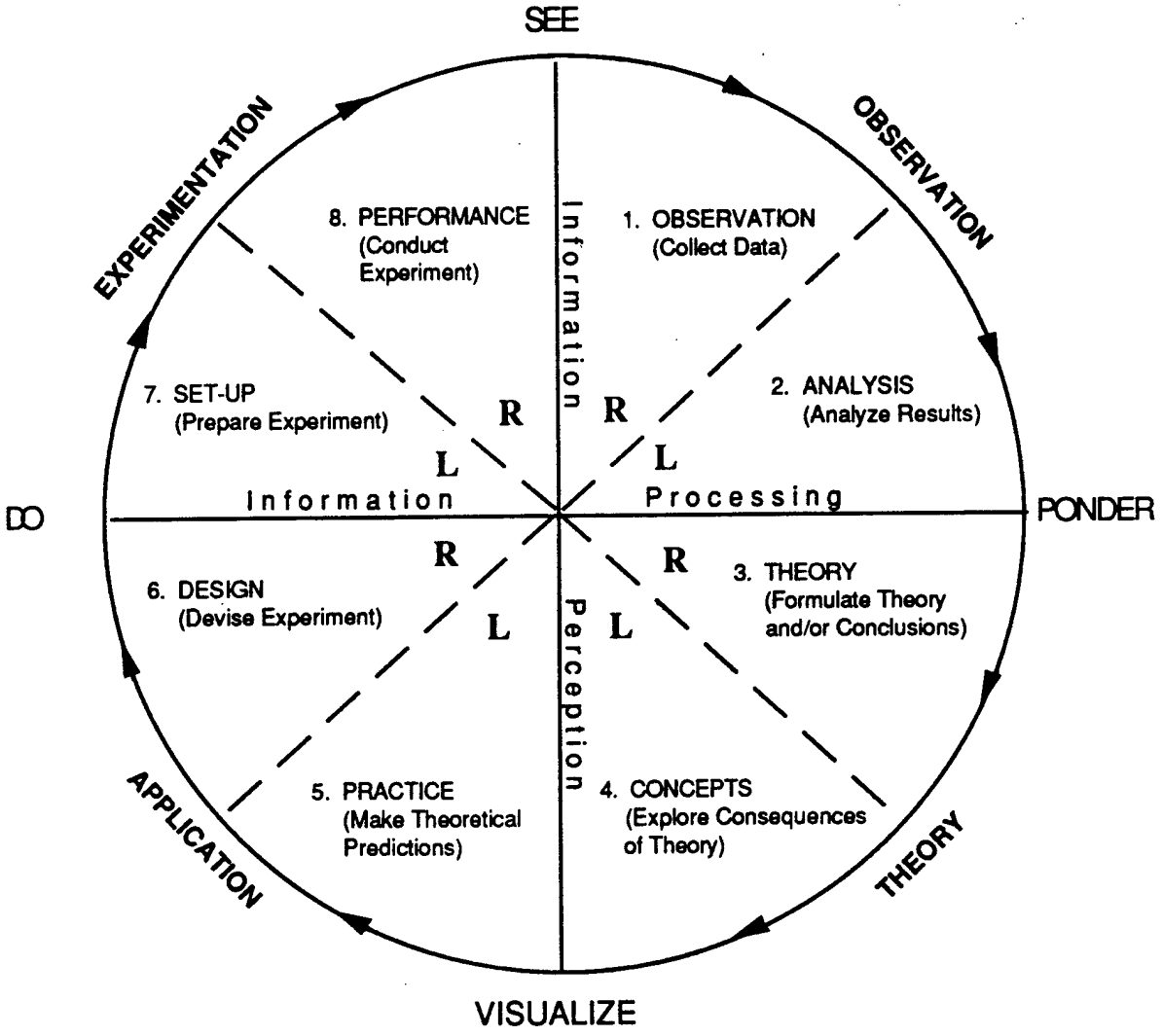

DESIGN: Design a 4MAT module for teaching any topic of your choice. Start with an idea and discuss it with your instructor. Then write a brief outline of the eight steps that should be followed. Finally, obtain approval of your instructor before proceeding further.

SET-UP: Discuss your outline with others who are acquainted with the subject to see if it is both consistent with the 4MAT system and practical as a method of teaching the material.

PERFORMANCE: Complete your 4MAT module by filling in the details a **teacher** would need to know in order to teach the subject properly. Remember, this is an eight-step teacher's guide (not a student manual). Assume the teacher knows the subject matter but does not know how you want it presented. In other words, any knowledgeable teacher should be able to take your module and teach the subject according to the 4MAT method.

## 4. SCIENTIFIC CYCLE OF INVESTIGATION

THEORY: The scientific method of investigation is a never-ending cycle for learning about natural phenomena. The following figure illustrates this cycle:




CONCEPTS:

1. Although ideally the scientific cycle is a never ending learning process, for practical reasons it often is broken up into segments that have a beginning and ending. (a) Where does the scientific cycle usually begin? Where does it usually end? (b) Where does a scientific experiment usually begin? End? (c) Where does a scientific report usually begin? End?
2. Can the scientific method be used to study every subject? Even in everyday life? Why don't you use it more often?
3. Compare the scientific cycle with the 4MAT system. How are they similar? How are they different? Could the scientific cycle itself be used as a teaching model?

PRACTICE: It has often been said that hot water will freeze faster than cold water. Describe how this phenomena could be studied scientifically? At what point on the scientific cycle should you begin your investigation? Specifically what eight steps should be followed?

DESIGN: Design a scientific experiment to test some theory or questionable folklore you have heard. Briefly describe the purpose and procedure of your experiment. Obtain the approval of your lab instructor before continuing.

SET-UP: Obtain the equipment needed to perform your experiment, familiarize yourself with its operation, and set it up as designed. Be sure to consult your instructor for guidance, assistance, and approval before going too far. (Otherwise, you may waste significant time, have to repeat considerable work, damage expensive equipment, and/or injure your own body.)

PERFORMANCE: Once everything is set up properly and approved by your instructor, then begin taking data. Analyze your results as you go (so you can modify the experiment if it is not working as intended). Once your data is complete and your analysis finished, you should formulate your conclusions and write a report of your findings.

## 5. FUN D' MENTAL EXPERIMENTS

THEORY: The teaching method used in this manual is called the Fun d' Mental approach. It is based upon the scientific cycle of investigation but assumes that a significant part of the material is being taught in a lecture course accompanying the laboratory. Therefore only the most fundamental concepts are covered in the manual and students are expected to use their mental facilities to extend these concepts through scientific investigation. Hopefully, the students will have fun doing so.

CONCEPTS:

1. Look at the various experiments contained in this lab manual. (a) Name the steps used in the Fun d' Mental teaching approach. (b) What is the normal sequence of these steps? Which step is normally first? Last? (c) Why is this sequence often broken? Does this violate the principle of the scientific cycle? Explain.
2. How is the Fun d' Mental approach similar to the 4MAT system? How does it differ?
3. How is the Fun d' Mental approach similar to the scientific cycle? How does it differ?

PRACTICE: Briefly describe how the Fun d' Mental approach could be used to teach swimming. Specifically, what are the eight steps that could be used? How does this differ from a typical swimming class.

DESIGN: Design a Fun d' Mental experiment to teach any scientific topic of your choice. Begin by selecting a topic. Then briefly outline the experiment. Consult your laboratory instructor before proceeding too far.

SET-UP: Obtain the equipment needed to perform your experiment, familiarize yourself with its proper operation, and take sufficient data to demonstrate that everything works according to your design and that valid conclusions can be drawn.

PERFORMANCE: Finish writing your Fun d' Mental experiment by filling in your outline with the information the **student** would need to perform the experiment. (Remember, this is a student's guide not a teacher's module). Assume you are writing to a student who has a textbook covering the topic and a student lab instructor who has taken the course before. Also assume that the student is attending an accompanying lecture section which covers the theory and problems in detail. Your job (should you decide to accept this assignment) is to write an experiment to supplement the lecture by emphasizing the learning styles and brain modes which are not adequately implemented in the lecture environment. (As usual these authors will disavow any knowledge of your actions, should you fail in your attempt.)

Experiment 2

# Linear Kinematics

Linear kinematics is the study of the motion along a straight line and involves such concepts as position, velocity, and acceleration.

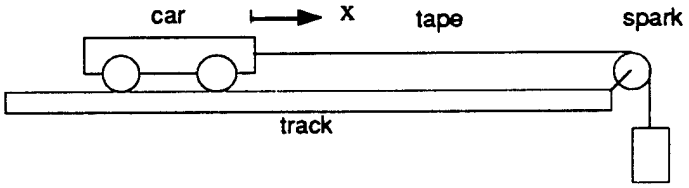
It is a useful tool in and of itself, allowing us to describe quantitatively any type of motion along a straight line (whether it be an automobile speeding down the highway or a balloon rising gently into the sky). But more importantly, the concepts derived in linear kinematics are foundational to the study of all types of motion. By generalizing these concepts to include two- and three-dimensions and then applying them to extended bodies and distributed masses, we are able in principle to describe quantitatively any type of motion we might choose (from the violent turbulence of a thunder storm to the plasid setting of the sun).

The **purpose** of this experiment is to explore the various aspects of linear kinematics and to introduce the concepts and techniques needed to take simple measurements, analyze data, and formulate experimentally valid conclusions.

The **equipment** needed for this experiment includes: spark tape, car and track apparatus, meter stick, sonar motion detector, ring stand with weight suspended by a spring, stop watch, linear air track, riser blocks, smart pulley, stop gates, and simple pendulum.

## OBSERVATION

1. Watch carefully as your lab instructor sets up the spark tape, car and track apparatus as illustrated below and records the motion of the system:




2. Inspect the tape and observe how the spacing between holes increases uniformly as one moves down the tape. As your instructor measures the position of each point, record the data ($\Delta t$, n, t, and x) in your own personal Lab Data Book.
3. Finish constructing the data table for this experiment by calculating $\Delta x$, v, $\Delta v$, and a.

## ANALYSIS

1. Plot a graph of x versus t and interpret the results.
2. Plot a graph of v versus t and interpret the results.
3. Plot a graph of a versus t and interpret the results.
4. Inspect your graphs and data. (a) Are any of the quantities x, v, and/or a constant during a portion of the motion? (b) Use only the data during which these are constant and apply statistical analysis to determine the experimental values of these constants. (See Appendix 1 for an example of applying statistical analysis.)
5. Read the values of these constants directly from the above graphs and compare the results with those calculated statistically.
6. Formulate conclusions.

## THEORY

1. **General definitions:**
   (a) The position of a moving particle may be expressed as a function of time:

$$x = x(t) .$$

(b) Velocity is the time rate of change of position:

$$v = \frac{dx}{dt} .$$

(c) Acceleration is the time rate of change of velocity:

$$a = \frac{dv}{dt} .$$

2. **Constant velocity:**

$$x = v\,t$$

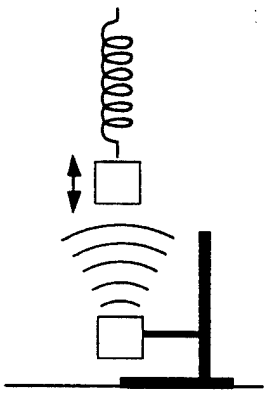
3. **Constant acceleration:**

$$x = v_o\,t + \tfrac{1}{2}\,a\,t^2$$

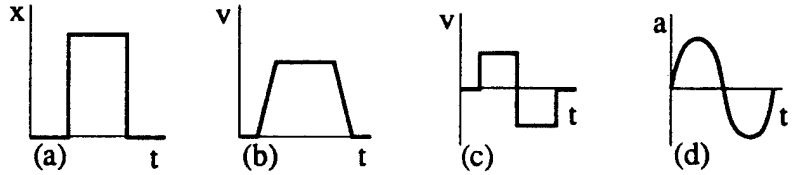
$$v = v_o + a\,t$$

$$v^2 = v_o^2 + 2\,a\,x$$

## CONCEPTS



1. Watch your lab instructor set up the sonar motion detector and demonstrate the following types of motion. (a) Constant velocity. (b) Constant acceleration. (c) The simple harmonic motion of an oscillating spring mounted weight. In each case notice the relationship between position, velocity, and acceleration as they vary with time.
2. Use the sonar motion detector yourself to verify that you can move your hand so as to produce the following types of motion. (a) Constant position. Velocity. Acceleration. (b) Linearly increasing position. Velocity. Acceleration. (c) Simple harmonic motion.
3. Use the sonar motion detector to demonstrate that you can move your hand to produce motion resulting in the following graphs:




## PRACTICE

1. **Calibration:** Calibrate the sonar motion detector. Either adjust its software to read the correct values of position, velocity, and acceleration or else determine the constants and calculations required to convert its readings to the correct values.

2. **Slopes:** Refer back to your x versus t curve constructed in Analysis 1 of this experiment. Make sure you have drawn a smooth curve through the data points. (a) Determine the slope of this smooth curve at several points and draw a new curve of v versus t. Compare this new curve with the old one (constructed in Analysis 2) and formulate conclusions. (b) Determine the slope of the new smooth curve of v versus t at several points and draw a new curve of a versus t. Compare this new curve with the old one (constructed in Analysis 3) and formulate conclusions.

3. **Graphical Analysis:**
   (a) Theoretically the motion of the car observed in Observation 1 of this experiment should be constant acceleration until the falling weight stops and constant velocity thereafter. Why?

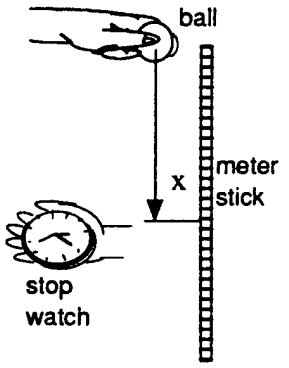
(b) If the system starts from rest, then the first part of the motion should be described by $x = \frac{1}{2} a t^2$. Why? Plot a graph of x versus $t^2$ to see if this is true. If so, use graphical analysis to determine the experimental value of a. (See Appendix 2 for an example of using graphical analysis.) Formulate conclusions.

(c) If the system was initially in motion, the first part of its subsequent motion should be described by $\frac{x}{t} = v_o + \frac{1}{2} a t$. Why? Plot a graph of x/t versus t to see if this is true. If so, use graphical analysis to determine the experimental value of $v_o$ and a. Formulate conclusions.

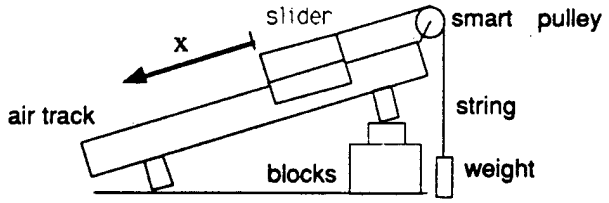
(d) If the system moved at constant velocity after the weight stopped, the last part of its motion should be described by $x = v_f t$. Why? Use graphical analysis on the last part of your original x versus t curve (Analysis 2) to determine the experimental value of this final velocity $v_f$.

(e) From your data determine the position of the car and the time when it stopped accelerating. Then write its complete equation of motion while data was being recorded.

4. **Stop watch and free fall:**
   (a) Set up the free fall apparatus as shown at right:
   (b) Practice using the system until you are familiar with its operation and limitations?
   (c) Calibrate your stop watch and meter stick against appropriate standards.
   (d) Analyze the motion of the system.

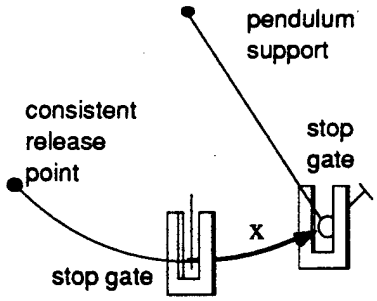



5. **Air track and smart pulley:**
   (a) Set up the linear air track and smart pulley as shown below:




   (b) Practice using the system until you are familiar with its operation and limitations?
   (c) Use a stop watch to calibrate the smart pulley timing circuitry.
   (d) Analyze the motion of the system.

6. **Stop gates and pendulum:**
   (a) Set up the electronic stop gates as illustrated at right:
   (b) Practice using the system until you are familiar with its operation and limitations?
   (c) Use a stop watch to calibrate the stop gate timing circuitry.
   (d) Analyze the motion of the system.



## DESIGN

Design an experiment to quantitatively explore or test some aspect of linear kinematics.

1. **Purpose:** First decide what type of motion you wish to investigate and what property of that motion you want to study. For example: (a) To study the motion of a ball rolling on an inclined plain and measure its acceleration as a function of tilt angle. (b) To study the motion of a block sliding to rest and measure its deceleration. (c) To study the vertical motion of a spring mounted weight and measure its acceleration as a function of displacement.
2. **Method:** Then decide what apparatus you are going to use, how you are going to set it up, and what measurements you will take. Generally you should draw a diagram of the experimental set-up you plan to use and identify the physical quantities you plan to measure. Be sure you understand how to measure the quantities with sufficient accuracy to formulate valid experimental conclusions.
3. **Proposal:** You may want to consult your lab instructor for suggestions and/or constructive criticism before finalizing your proposal while you are still in your initial design stage. Conversely, you may simply seek approval of a design you have already formulated during the previous week while preparing for this particular laboratory experiment. In either case, once your proposal is complete, you will need to have it approved by your lab instructor before proceeding with your experimentation.

## SET-UP

1. **Assembly:** Once you have had your design approved, you should obtain the necessary equipment and set up your apparatus.
2. **Calibration:** Calibrate your measuring instruments to make sure they are functioning properly.
3. **Preliminary Data:** Make a *dry run* of the experiment to be sure everything is working properly.
4. **Preliminary Analysis:** Make a quick analysis of your preliminary data to be sure it is meaningful.
5. **Preliminary Conclusions:** Determine whether or not there are any surprises in the results of your dry run and modify your design as necessary to fulfill the purpose of the experiment.

## PERFORMANCE

1. **Performance:** Conduct the experiment as designed, modify it if necessary to obtain meaningful results, and try to improve your experimental techniques and accuracy as you gain experience with the equipment and phenomena.
2. **Observation:** Record your data as accurately as possible repeating the experiment as often as necessary to explore the phenomenon and reduce experimental errors.
3. **Analysis:** Perform the appropriate analysis for the data and phenomenon under investigation. If unexpected results are obtained, additional analysis should be performed until a clear picture and understanding of the phenomenon is obtained.
4. **Conclusions:** Formulate valid conclusions based upon the analysis of the experimental result.
5. **Report:** Prepare a final report of the experiment. Check with your lab instructor to find out whether this should be (a) an oral report, (b) an informal report, or (c) a formal report.

Experiment 3

# Vector Kinematics

Vector kinematics is the study of motion in two- or three-dimensional space. It involves such concepts as vector position, velocity, and acceleration and how they change with time and allows us to describe quantitatively any type of motion in space (from the smallest insect crawling on the ground to the largest galaxy flying through the cosmos).

The **purpose** of this experiment is to explore the various aspects of vector kinematics including parabolic and circular motion.

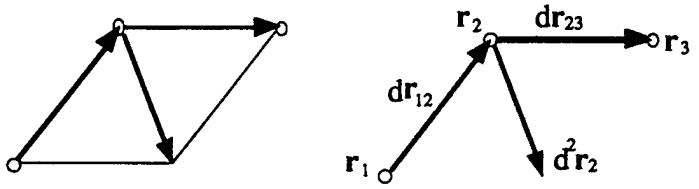
The **equipment** needed for this experiment include: strobe light, air table, Polaroid camera, opaque projector, tuning fork, camcorder, stop action VCR, wall grid, and a computer with a spread sheet program.

## OBSERVATION

1. Watch carefully as your lab instructor sets up the air table, strobe light, and Polaroid camera to study parabolic motion. Assist him/her as necessary to photograph the motion.
2. Project the photograph life size. (Why?) Trace the important features of the projected motion on a large piece of paper. Use this paper as your original graphical data.

## ANALYSIS

1. Graphically determine the acceleration at every point and the velocity between points.
   (a) For each three consecutive points draw lines as illustrated on the left below.




These lines are parallel to and have lengths equal to the corresponding vectors shown on the right. The points $\mathbf{r}_1$, $\mathbf{r}_2$, $\mathbf{r}_3$ are any three consecutive positions of the puck; the vector $d\mathbf{r}_{12}$ and $d\mathbf{r}_{23}$ are the corresponding displacement vectors (changes in vector positions); and the vector $d^2\mathbf{r}_2$ is the change in the displacement vectors (change in change in vector position).

Since $\mathbf{v} = d\mathbf{r}/dt$ and $\mathbf{a} = d\mathbf{v}/dt = d^2\mathbf{r}/dt^2$ (See Theory 2(a).), it follows that **v** is proportional to **dr** with a constant of proportionality equal to 1/dt and **a** is proportional to $d^2\mathbf{r}$ with a constant of proportionality equal to $1/dt^2$.

   (b) Record the time interval dt between strobe flashes and construct a table listing the following quantities:
   - n - number of each point
   - t - the time of each flash
   - dr - magnitude of displacement **dr** between successive points
   - v - magnitude of velocity **v** between successive points
   - $d^2r$ - magnitude of change in displacement $d^2\mathbf{r}$ in neighborhood of each point
   - a - magnitude of acceleration **a** in neighborhood of each point

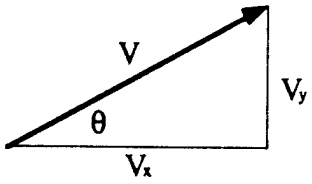
2. Analyze the velocity.
   (a) Plot a graph of v versus t and analyze the result. Is the magnitude of velocity constant?
   (b) Look at your original graphical data. Is the direction of the velocity constant?
   (c) Is the vector velocity constant?

3. Analyze the acceleration.
   (a) Plot a graph of a versus t and analyze the result. Is the magnitude of the acceleration constant? Use numerical analysis to calculate its value. (See Appendix 1.)
   (b) Use graphical methods to determine the magnitude of the acceleration vector. Is it constant? What is its value? How does this compare with the numerical value calculated above?

   *Hint:* The graphical method uses marks on the edge of a piece of paper to compare the magnitudes of vectors. Begin each vector at the same point on the edge of the paper and put a dot where each vector ends. The distribution of dots can be used to determine the average length of the vectors and the uncertainty of the measurement.
   (c) Is the direction of the acceleration constant?
   (d) Is the vector acceleration constant?

## THEORY

1. **Vectors:**
   (a) Components:



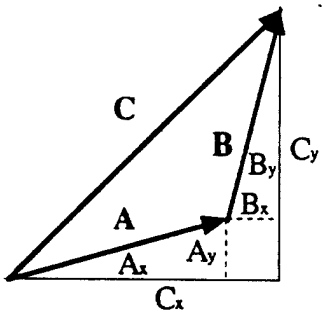

$$V_x = V \cos\theta$$

$$V_y = V \sin\theta$$

$$V = \sqrt{V_x^2 + V_y^2}$$

$$\tan\theta = \frac{V_y}{V_x}$$

   (b) Addition:




$$C_x = A_x + B_x$$

$$C_y = A_y + B_y$$

2. **Vector Kinematic:**
   (a) Definitions:

$$\mathbf{r} = \mathbf{r}(t)$$

$$\mathbf{v} = \frac{d\mathbf{r}}{dt}$$

$$\mathbf{a} = \frac{d\mathbf{v}}{dt}$$

   (b) Parabolic Motion:

$$v_{ox} = v_o \cos\theta_o$$

$$v_{oy} = v_o \sin\theta_o$$

$$x = v_{ox}\, t$$

$$y = v_{oy}\, t - \tfrac{1}{2} g\, t^2$$

$$v_x = v_{ox}$$

$$v_y = v_{oy} - g\, t$$

$$v = \sqrt{v_x^2 + v_y^2}$$

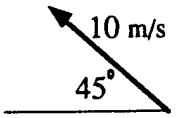
$$\tan\theta = \frac{v_y}{v_x}$$

(c) Circular Motion:

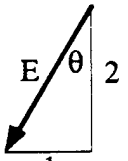
$$a_r = \frac{v^2}{r}$$
$$a_t = \frac{dv}{dt}$$
$$v = 2\pi r f$$
$$f = \frac{1}{\tau}$$

## CONCEPTS

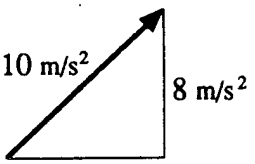
1. (a) What is a unit vector? (b) What are the vectors **i**, **j**, **k**? (c) How can they be used to represent other vectors?
2. Find the magnitude, direction, x-component, and y-component of each of the following vectors: (a) $\mathbf{A} = 3\mathbf{i} - 4\mathbf{j}$, (b) $\mathbf{B} = (-5, 12)$, (c) C = 10 ft at 30° below negative x-axis.



(d)



(e)



(f)

3. A particle moves according to the equation $\mathbf{r} = 10\ \text{m/s}\ t\,\mathbf{i} + 2\ \text{m/s}^2\ t^2\,\mathbf{j}$. (a) What is its position after 2 seconds. (b) What is its speed after 2 seconds? (c) What is its acceleration after 2 seconds? (d) Describe the motion of the particle?
4. A particle moves according to the equation $\mathbf{r} = A\cos\omega t\,\mathbf{i} + A\sin\omega t\,\mathbf{j}$, where A and ω are constants. (a) Is the magnitude of the position vector a constant? (b) The velocity vector? (c) The acceleration vector? (d) Prove that the direction of the acceleration is always opposite the position vector. (d) Describe the motion of the particle.

## PRACTICE

1. **Calibration:**
   (a) Calibrate the strobe light against (1) line frequency and (2) a vibrating tuning fork.
   (b) Determine how many frames per second are shot by the camcorder by taping (1) a vibrating tuning fork, (2) digital clock reading seconds, and (3) a revolving second hand on a clock. Play the recordings back one frame at a time and count the number of frames shot per second.
   (c) Measure the size of the grid divisions on the wall grid.

2. **Parabolic motion:** Show that the motion of the puck on a tilted air table is parabolic and obeys the equations of Theory 2(b).
   (a) Draw a horizontal and vertical axis where the motion begins and construct a table listing n, t, x, and y for each point.
   (b) Plot a curve of x versus t and use graphical analysis to find $v_{ox}$.
   (c) Plot a curve of y/t versus t (Why?) to find $v_{oy}$ and g. (Note that $g \neq 9.8\ \text{m/s}^2$. Why?) Compare this value of g with the values of a calculated in Analysis 3.
   (d) Measure $v_o$ and $\theta_o$ directly from the projected motion and calculate $v_{ox}$ and $v_{oy}$. Compare the result with that obtained from the above curves.
   (e) Devise a method for verifying the equations for $v_y$, v, and tan θ.
   (f) Formulate conclusions.

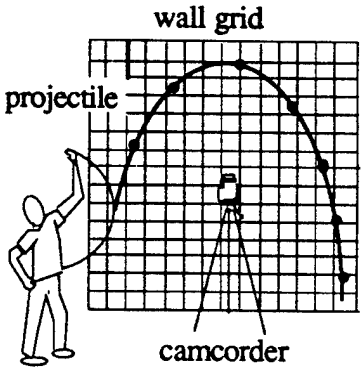
3. **Vertical Circle and Camcorder:** Video record the motion of a particle moving in a vertical circle and show that the equations in Theory 2(c) characterize its motion.
   (a) Sling a mass in a vertical circle silhouetted against a wall grid and record the motion with a video camera.
   (b) Select a meaningful segment of the recording and play it back one frame at a time. For each frame read the x- and y-position of the mass.
   (c) Construct a computer spread sheet containing columns n, t, x, y, $x_c$, $y_c$ and enter the data for the motion.
   (d) Add additional columns to the spread sheet for the variables r, $v_x$, $v_y$, v, $a_x$, $a_y$, a, $a_R$, $a_T$, $v^2/r$, dv/dt and program the spread sheet to calculate these values.
   (e) Plot $a_R$ versus $v^2/r$, plot $a_T$ versus dv/dt, and formulate conclusions.
   (f) Measure the period of one cycle $\tau$, calculate the frequency $f$, compare with v, and formulate conclusions.

## DESIGN

Design an experiment to quantitatively explore or verify some aspect of vector kinematics. Obtain guidance and approval from your lab instructor before actually setting up your experiment.

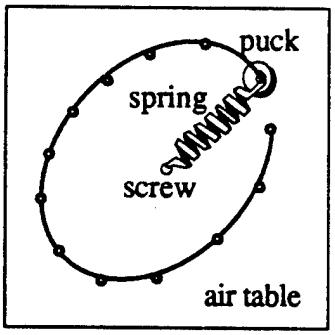
The following examples are given to illustrate what is expected and to help stimulate your own creativity:

1. **Projectile Motion** by First X. Ample
   Purpose: To study the motion of a free projectile and verify the equations that theoretically describe it.
   Method: Video camera and graphical analysis of vector motion.
   Equipment: Camcorder, wall grid, stop action VCR, graph paper.
   Set-up:




   Procedure:
   1. Toss the ball and video tape its motion silhouetted against the wall grid.
   2. Play back motion one frame at a time, reading coordinates of ball.
   3. Plot coordinates on graph paper.
   4. Analyze motion graphically to show horizontal velocity is constant.
   5. Measure acceleration vector and show it is a constant pointing straight downward and equal to the acceleration of gravity 9.8 $m/s^2$.
   6. Formulate conclusions.

2. **Horizontal Motion of Mass on a Spring** by Zample Twain
   Purpose: To study the horizontal motion of a particle attached to horizontal spring.
   Method: Air table, strobe flash, and graphical analysis of motion.
   Equipment: Air table, puck, spring, strobe flash, Polaroid camera, film, projector, large sheet of paper.
   Set-up:

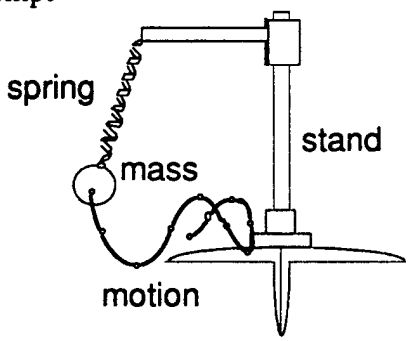



   Procedure:
   1. Photograph motion, project life size on large sheet of paper, trace, and analyze motion graphically.

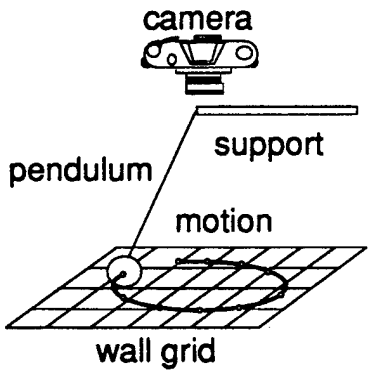
2. Analyze velocity: Is the magnitude of velocity a constant? Is its direction always perpendicular to radius vector? If not constant, where is the velocity a maximum? A minimum? Is it perpendicular to radius vector at these times?
3. Analyze acceleration: Is the magnitude of the acceleration a constant? Is it always directed along the radius vector? If not constant, where is the acceleration a maximum? A minimum? Are these the same points as for velocity?
4. Formulate conclusions.

3. **Bouncing Motion of Mass on a Spring** by Third A. Tempt
Purpose: ...
Method: ...
Equipment: ...
Set-up:

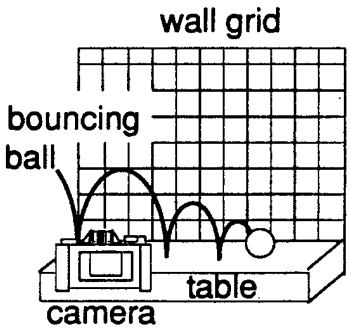
Procedure: ...




4. **Orbital Motion of a Pendulum** by Fourth Try
Set-up:




5. **Bouncing Ball** by Last O. These
Set-up:




**SET-UP**

After obtaining the approval of your laboratory instructor, utilize the equipment available in the laboratory to **assemble** your apparatus.

In the process of setting up the experiment you will need to **calibrate** your measuring instruments, take some **preliminary data**, and do some **preliminary analysis** to make certain that everything is functioning as intended. Failure to do this may result in your having to repeat the whole experiment because of worthless data.

As you are checking out the set-up, you should also formulate some **preliminary conclusions**. You may find it necessary to make adjustments which you did not originally anticipate or even to go back and redesign certain aspects of your original experiment.

Experience such as this is the only way to improve your experimental technique and to gain a feel for what actually happens in the real world. It is all part of the scientific method of investigation.

## PERFORMANCE

Once you have finished setting up your equipment and verified that everything is functioning as intended, proceed with the actual **performance** of your experiment .

Remember to keep an open mind as the experiment progresses to see for yourself how the theory does or does not correlate with the real world. Again, according to the circumstances, you should adjust and/or modify your experiment as necessary to obtain meaningful results. If something totally unexpected occurs, you may even have to decide whether to continue on your original course of action or to pursue a new course in the direction indicated by your new experience.

As you accumulate more **data**, continue your **analysis**, and formulate your **conclusions** you are actually continuing around the scientific cycle of investigation. How far you continue depends upon your interests, your time and your lab instructor. Eventually, of course, as you begin to master the material, you will have to break the cycle and finalize the result. This is accomplished by assimilating all that you have learned about the phenomenon and arranging it into an informative **report**. Check with your lab instructor to find out which type of report you should complete for this experiment.

Experiment 4

# Equilibrium

Conceptually force may be defined as a push or pull - an attempt to make something move. If the object does not move, additional forces must be present to render a resultant equal to zero. This is called translational equilibrium.

Torque is the rotational equivalent of force - a twisting attempt to make something rotate. If there is no rotation, other torques must be present to render a net moment of force equal to zero. This is called rotational equilibrium.

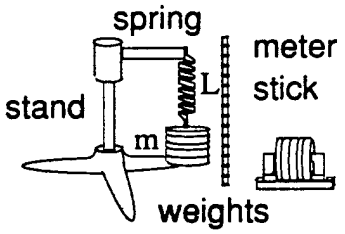
An object in both translational and rotational equilibrium is said to be in static equilibrium. It is either completely at rest or else moving at constant speed in a straight line.

The principles of static equilibrium allow us to describe quantitatively the relationship between various types of forces and to design structures that will withstand these forces (whether they be massive buildings reaching toward the sky or small sailboats driven by the wind).

The **purpose** of this experiment is to study the phenomenon of equilibrium and to explore the relationship between the forces and the torques producing equilibrium.

The **equipment** needed for this experiment includes: stand, spring, weights, meter stick, computer spreadsheet program, spring balance, plumb bob, sheet of cardboard, strings, support, force table apparatus.

## OBSERVATION




1. Watch your lab instructor (a) set up the apparatus shown at right, (b) stretch the spring by adding weights, and (c) enter the following data into a computer spreadsheet program: n (data point number), m (suspended mass), L (stretched length of spring).
2. What is the original, unstretched length of the spring $L_0$? Was it the same before and after stretching or did some permanent stretching occur (hysteresis)? Was the elastic limit of the spring exceeded?
3. What is the original, unstretched length of the spring when measured horizontally? How does this compare with the vertical unstretched length? Why? How could you measure the horizontal stretch of a spring when weights are added?

## ANALYSIS

1. The **weight** w of a mass m is given by the equation $w = m g$, where $g = 9.8$ N/kg (a constant numerically equal to the acceleration due to gravity). Since this weight is the force stretching the spring, enter this equation into the spreadsheet to calculate F listed in another column of the spreadsheet.
2. **Hook's Law** states that the force F stretching a spring by an amount $x = L - L_0$ beyond its original length is given by $F = k x$, where k is a constant. Have the spreadsheet plot a curve of F versus L and conclude whether or not Hook's Law is valid experimentally. From the graph determine the values of k and $L_0$.
3. How does this value of $L_0$ compare with that measured directly in Observation 2? Which is more accurate? Why?
4. Have the spreadsheet plot a curve of L versus m. (a) Discuss the difference between the two curves. Would the second graph have validated Hook's Law just as well as the first? Why? (b) Determine the values of k and $L_0$ from this graph? Are they the same as determined from the first graph? Why or why not? (c) If you were plotting the curves by hand, which of the two plots would be easier? Why?

5. Look at a **spring balance** (or **force gauge**) and describe how it works. (a) How could it be used to measure forces? (b) Does it matter whether or not it is oriented horizontally or vertically? (c) How could the above experiment be used to calibrate a spring balance? (d) How can a raw spring itself be used as a force gauge?

## THEORY

1. **Newton's Third Law:**

Technically, force is the physical phenomenon that describes the interaction between two particles. Since there are always two particles involved, there are always two forces. Each force acts **on** one of the particles (the one whose motion is being considered) and is said to be caused **by** the other particle (the one which is being ignored). Newton's Third Law is a statement of the fact that these two forces (called an action/reaction pair) are always equal in magnitude and opposite in direction to one another. Consequently the same symbol is often used to represent both forces as illustrated below:




Gravitational forces (action and reaction) between two unequal masses.

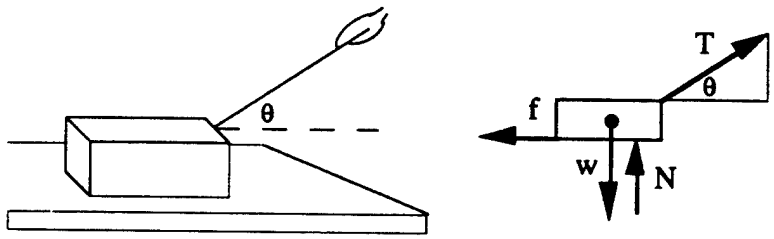
2. **Identifying forces:**

There are four types of forces known to occur in nature: gravitational, electromagnetic, weak nuclear, and strong nuclear. Gravitation is the long range force responsible for weight, electromagnetism is the force between charged particles, the weak nuclear force makes free neutrons decay into protons and electrons, and the strong nuclear force holds the nucleus of atoms together. Since the two nuclear forces are too short ranged to affect macroscopic motion and the electromagnetic force acts at a distance only between charged bodies, the only forces acting on uncharged bodies of reasonable size are those due to gravitation and those due to actual physical contact. The following chart summarizes the characteristics of some of these forces:

| Symbol | Name | Type | Direction |
|---|---|---|---|
| w | weight | gravitation | straight down |
| T | tension | string | pulling along string |
| N | normal | surface | pushing perpendicular to surface |
| $f$ | friction | | opposing the motion, parallel to surface |
| $F_x$ | arbitrary force | other contact | component of force in x-direction |
| $F_y$ | | | component of force in y-direction |

3. **Friction:** The friction force f is related to the corresponding normal force N according to the equation $f = \mu N$, as long as (a) the contact surfaces are *on the verge of sliding* or (b) the surfaces actually are *sliding*. Otherwise $f \leq \mu N$ (i.e. when the surfaces are not even close to sliding).

4. **Force Diagram:** The illustration at right shows a physical situation and its accompanying force diagram. The force diagram is constructed by isolating the body, identifying the forces



trying to move it, and drawing each force at the appropriate location and in the correct direction. (If the problem is to be solved graphically, each force must also be drawn with the correct magnitude.)

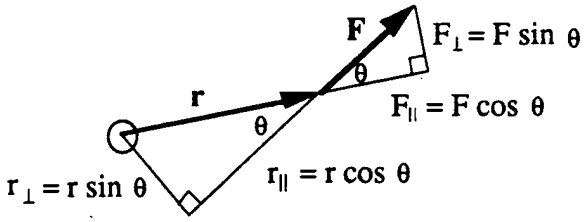
5. **Translational Equilibrium:**

$$\Sigma F_x = 0$$
$$\Sigma F_y = 0$$

6. **Torque:**

The torque $\Gamma$ due to a force **F** acting at a displacement **r** from an axis of rotation O is defined through any one of the following equivalent equations:

$$\Gamma = \mathbf{r} \times \mathbf{F}$$
$$\Gamma = r F \sin\theta$$
$$\Gamma = r F_\perp$$
$$\Gamma = r_\perp F$$




7. **Rotational Equilibrium:**

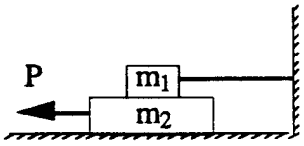
$$\Sigma \Gamma = 0$$

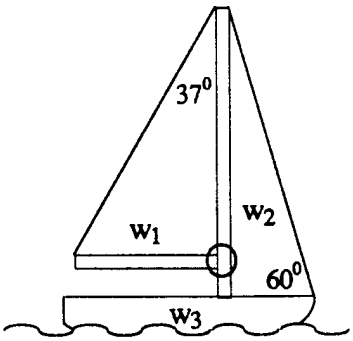
8. **Center of Mass:**

$$\bar{x} = \frac{\Sigma m x}{\Sigma m} \qquad \bar{y} = \frac{\Sigma m y}{\Sigma m}$$

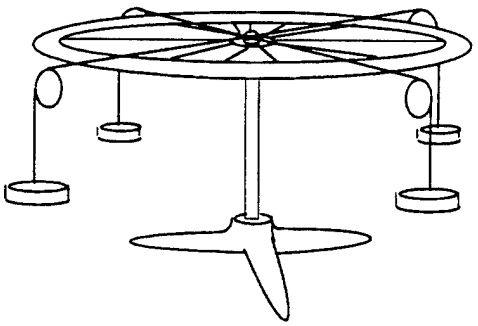
**CONCEPTS**

1. Explain how to demonstrate experimentally that force is a vector. (a) How could you show that a force resolves into the proper components regardless of its magnitude or direction? (b) How could you show that two forces add like vectors regardless of their magnitudes or directions?
2. (a) Identify the forces acting on each of the bodies shown in the illustration at upper right. (b) What is the reaction force corresponding to each of these forces?
3. Set a block on an inclined plane and adjust the angle of tilt until the friction equation (Theory 3.) is valid. Also demonstrate the situation where the inequality is valid?
4. (a) Identify the forces acting on each of the bodies shown in the illustration at lower right. (b) What is the reaction force corresponding to each of these forces? (c) Which of these forces produces a torque about the axis indicated by O? (d) What is the direction of each of these torques?
5. Explain how the center of mass of a sheet of material can be found by using a plumb bob and suspending the sheet successively from several points.
6. How is center of mass related to torque? What is the difference between center of mass and center of gravity?

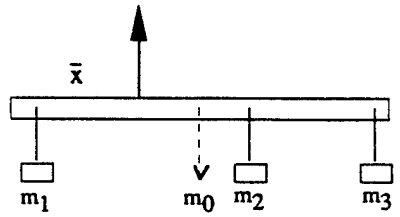


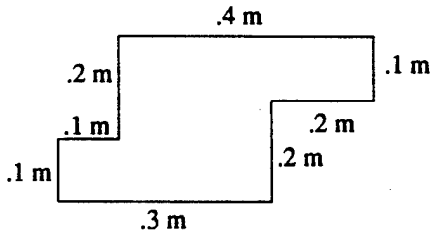
## PRACTICE



1. Set up the force table as illustrated at right and adjust the four hanging weights and the angles until equilibrium is established. (a) Measure the angles and weights. (b) Use a ruler and protractor to draw a force diagram to scale on a sheet of paper. (c) Add the force vectors graphically. (d) Explain why they do not add to zero. (e) Formulate conclusions.
2. (a) Draw a force diagram for each of the bodies illustrated in Concepts 2. (b) Resolve each vector force into its components. (c) Write the equations that pertain to these forces.
3. (a) Draw a force diagram for the bodies illustrated in Concepts 4. (b) Resolve each vector force into its components. (c) Write the equations that pertain to these forces.
4. Set up the system illustrated at right. (a) Measure each mass and its location. ($m_0$ is the mass of the rod system and $m_i$ are the hanging masses.) (b) Calculate the horizontal position $\bar{x}$ of the center of mass of the system. (c) Measure this value experimentally. (d) Compare your two answers and formulate conclusions.




5. (a) Calculate the x- and y-coordinates of the center of mass of the thin sheet of material shown at right. Does your answer depend upon the density or the weight of the material? (b) Construct such an object and measure the position of its center of mass experimentally. (c) Compare your two answers and formulate conclusions.




## DESIGN

Design an experiment to quantitatively explore or verify some aspect of equilibrium. Obtain guidance and approval from your lab instructor before setting up your experiment.

The following examples are given to help stimulate your own creativity:

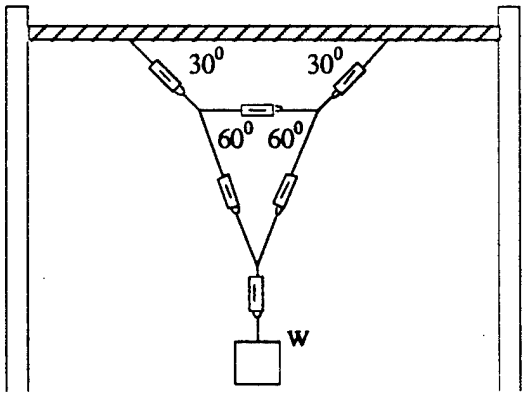
1. **Suspension** by Spider Web

   Purpose: To show that the tension in the strings suspending a mass are correctly predicted by Newton's Second Law.

   Method: Spring balances placed in suspension lines.

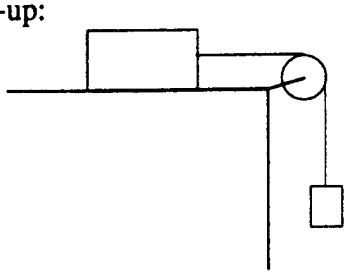
   Equipment: Spring balances, mass, strings, support frame.

   Set-up:

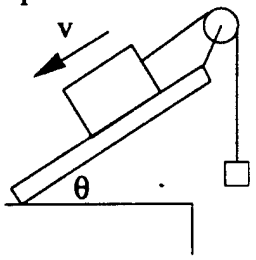



   Procedure:
   1. Construct the apparatus shown at right.
   2. Read the tension in each string and measure the mass suspended.
   3. Calculate the tensions according to theory.
   4. Compare the theory with the result.
   5. Formulate conclusions.

2. **Friction** by Vary S. Methods
Set-up:



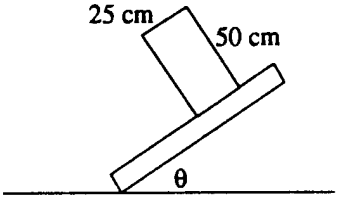
3. **Constant Velocity** by A. Justin Angle
Set-up:



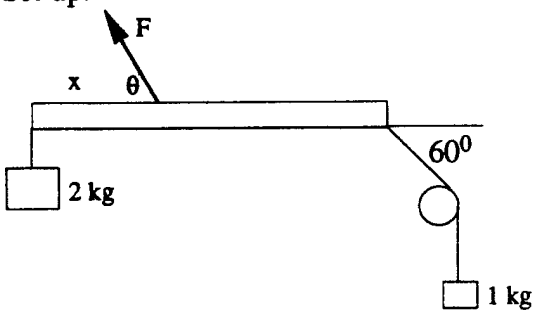

4. **Walk the Plank** by X. Versus Torque
Set-up:



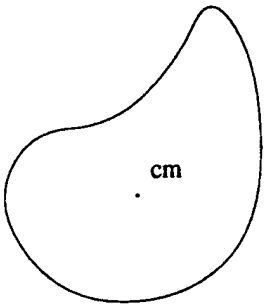

5. **Tilt or Slide** by Increase N. Slope
Set-up:




6. **Single Equilibriant (F, θ, x)** by Theery Anne Trials
Set-up:




7. **Center of Mass** by Odd Shape
Set-up:




**SET-UP**

After obtaining the approval of your laboratory instructor, **assemble** your apparatus, **calibrate** your instruments, take some **preliminary data**, make some **preliminary analysis**, and form some **preliminary conclusions**. If necessary, modify or redesign your experiment before continuing.

**PERFORMANCE**

Once you have verified that everything is functioning as intended, proceed with the actual **performance** of your experiment. Then finalize your **data, analysis, conclusions**, and **report**.

Experiment 5

# Dynamics and Gravitation

Dynamics is the study of how forces affect the motion of material bodies. It allows us to determine how and why objects move the way they do and to design systems that will move the way we want (whether these systems are arrows shot from a bow or children swinging in the park).

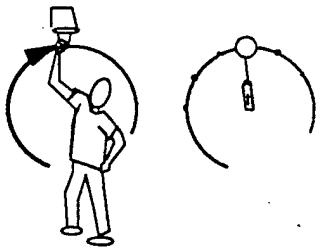
Gravitation describes how massive bodies are attracted to one another over finite distances. It explains why everything has weight and how the moon causes the tides.

The **purpose** of this experiment is to study the phenomena of dynamics and gravitation and to explore the relationship between them.

The **equipment** needed for this experiment includes: Bucket of water, simple pendulum, force gauges, wall grid system, computer spreadsheet, air table system, smart pulley system, and Cavendish apparatus.

## OBSERVATION

1. Watch your lab instructor sling a bucket of water over head. (a) Why does the water not fall out? (b) How does one start and stop the bucket without getting wet?
2. To quantify the above phenomenon, replace the water bucket with a pendulum bob moving in a vertical circle on the end of a string attached to a spring gauge. (a) Video tape the motion silhouetted against a wall grid and play the tape back one frame at a time. (b) Record the position of the mass and the tension in the string at each data point.
3. Calibrate your camcorder's shutter speed.



## ANALYSIS

1. **Acceleration:** (a) Either use graphical techniques or a computer spreadsheet to calculate the acceleration at every point along the path. (b) Where is the acceleration greatest? Least? (c) Is it always radial or is there a tangential component?
2. **Tension:** (a) From Observation 2(b) determine where the tension is greatest. Least. (b) Is the tension always radial or is there a tangential component? (c) Is the vector tension force always proportional to the vector acceleration? (In other words, are the two vectors proportional in magnitude and parallel in direction?) Why?
3. **Net Force:** (a) Measure the mass of the bob and calculate its weight. (b) At every point add the weight of the object vectorially to the tension and determine the resultant force. (c) Is this vector force always proportional to the vector acceleration?
4. **Mass:** (a) Plot a curve of the magnitude of the resultant force versus the magnitude of the acceleration. (b) What is the slope of this curve? How does it compare with the mass of the bob?
5. **Conclusions:** What conclusions can you draw from all of this?

## THEORY

1. **Newton's Second Law:**

$$\mathbf{F} = m\,\mathbf{a}$$

or

$$\Sigma F_x = m\,a_x$$

$$\Sigma F_y = m\,a_y$$

2. **Newton's Law of Gravitation:**

$$F = G\frac{m_1 m_2}{r^2}$$

$$G = 6.67 \times 10^{-11}\ N\ m^2\ kg^{-2}$$

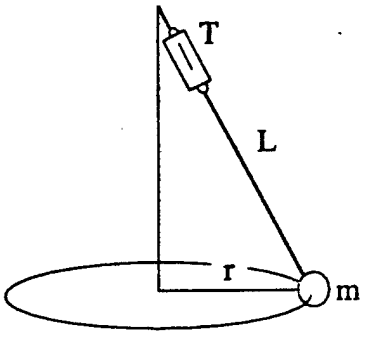
## CONCEPTS

1. (a) What does the symbol **F** represent in Newton's Second Law? (b) What does the symbol F represent in Newton's Law of Gravitation?
2. Explain why a free projectile moves in a parabolic path near the surface of the earth.
3. Explain the concepts of (a) centrifugal force, (b) centripetal force, and (c) the equation $\Sigma F_r = m a_r$, where $a_r = v^2/r$.
4. Explain why a person weighs less (a) on the top of a mountain, (b) on the equator, (c) on the moon than at sea level on the surface of the earth.

## PRACTICE

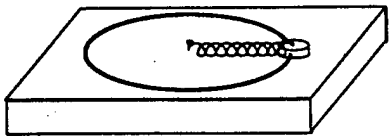
1. Use the data collected in this experiment to verify the equations $F_r = m v^2/r$ and $F_t = m\ dv/dt$ for circular motion. (a) Resolve the net force (determined in Analysis 3) into its radial component $F_r$ and tangential component $F_t$. (b) Determine the speed of the particle at each data point by averaging its speed before and after that point. (c) Determine the change in speed dv/dt at each data point by taking the difference between the speeds before and after that point. (d) Plot curves of $F_r$ versus $v^2/r$ and $F_t$ versus dv/dt, determine their slopes, and compare with the mass m. (e) Formulate conclusions.

2. Set a pendulum in horizontal circular motion as shown at right. (a) Measure its length L, mass m, radius of orbit r, period $\tau$, and tension T. (b) Use L, m, r, and g to calculate theoretically the values of $\tau$ and T. (c) Compare the calculated values with the experimental values and formulate conclusions.

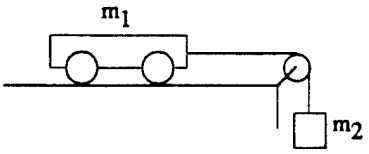



3. Set up the air table system as shown below and practice releasing the puck into circular motion. (a) Explain how this system could be used to verify Newton's Second Law. (b) What quantities would you need to measure experimentally? (c) Explain how each of these quantities could be measured.

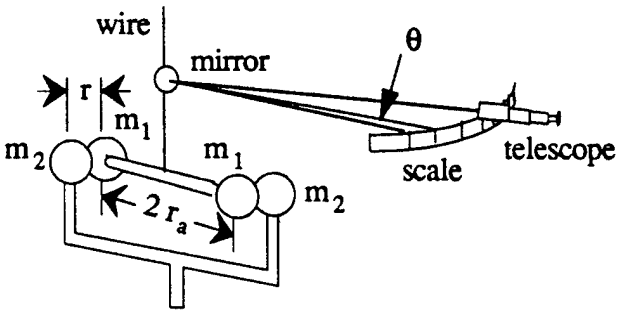




4. Set up the smart pulley system as shown below and practice taking data. (a) Explain how this system could be used to verify Newton's Second Law. (b) What quantities would you need to measure experimentally? (c) Explain how each of these quantities could be measured.




5. Set up the Cavendish balance experiment as shown at right. (a) Explain how this system could be used to determine the universal gravitational constant. (b) What quantities would you need to measure experimentally? (c) Explain how each of these quantities could be measured. (d) Explain how a laser could be used instead of the telescope.




## DESIGN

Design an experiment to quantitatively explore or verify some aspect of dynamics and/or gravitation. Obtain guidance and approval from your lab instructor before setting up your experiment.

1. **Purpose:** Decide what type of motion you want to analyze and what you hope to accomplish by the experiment. Ideas can be obtained from Experiments 2 and 3 in this lab manual, from the problems you have worked from the text book, and and from real life experiences you have encountered in the past. Select something that is interesting but practical. (Studying the dynamics of a golf ball hit from a tee at the country club could require more time and effort than you can afford for this experiment.)
2. **Method:** Make sure you understand what quantities you will need to measure and how you plan to record and analyze the data. Again look over the previous experiments for ideas as to how to take, record, and analyze data pertaining to force and motion.
3. **Equipment:** Make sure you have the equipment you need and know how to use it.
4. **Set-up:** Draw a diagram illustrating how you plan to set up the experiment.
5. **Procedure:** List the steps you plan to follow to accomplish your experimental goal.

## SET-UP

After your design has been approved, set up your experiment and practice using the equipment to verify that everything is operating as intended.

## PERFORMANCE

Once you have verified that everything is functioning properly, perform your experiment, collect the data, do your analysis, formulate your conclusions, and prepare your report.

Experiment 6

# Work, Energy, and Power

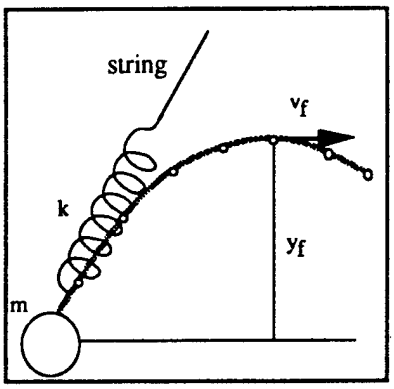
Work is force acting through a distance - a measure of the success of a force trying to move an object in a certain direction. Energy is a measure of how much work can be done. The Law of Conservation of Energy states that energy is neither created nor destroyed but simply changed from one form to another. Power is the rate of doing work (or expending energy).

These concepts are important because they place limits upon what is and what is not physically possible. (For example, it is impossible to build a perpetual motion machine of any kind.) They allow us to express quantitatively how much can be accomplished under a given set of circumstances (whether it be how much weight you can lose by jogging a mile or how many horses it takes to replace a gasoline engine).

The **purpose** of this experiment is to study work, energy, and power and to explore their relationship with one another.

The **equipment** needed for this experiment includes: Air table apparatus, tether ball, mass, spring, string, camcorder system, stop gate system, stop watch, bathroom scales, tape measurer, air track system, smart pulley system.

## OBSERVATION




1. Watch your lab instructor set up a tilted air table and photograph the motion of a spring launched projectile illuminated by a strobe light. Project the photograph life size and measure the following quantities: (a) the original length $L_0$ of the spring, (b) the original stretch in the spring $x_0$, (c) the speed $v_f$ of the mass at the top of its arc, (d) the maximum height $y_f$ of the mass above its starting point, (e) the mass m of the puck.
2. Calibrate the spring and determine its spring constant k.
3. Determine the effective acceleration of gravity g' on the tilted air table. (a) Measure the mass m' which when hung over a pulley will suspend the mass m on the tilted air table. Calculate g' through the equation $m\,g' = m'\,g$. Why is this equation valid? (b) Measure the tilt angle $\theta$ and calculate g' from the equation $g' = g \sin\theta$. Why is this equation valid? (c) Compare these values for g' and decide which is the more reliable.

## ANALYSIS

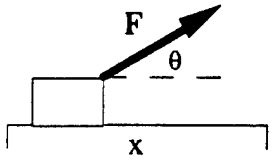
1. **Initial Energy:** (a) Show that the work required to stretch the spring is $\frac{1}{2} k x_0^2$. (b) Explain why this is also equal to the total energy of the system $E_0$ before it was released. (c) Calculate the value of $E_0$ for this system.
2. **Final Energy:** (a) Show that the work required to lift the mass m up the incline a distance $y_f$ above its original position is $m g' y_f$. (b) Show that the kinetic energy of a mass m moving with speed $v_f$ is $\frac{1}{2} m.v_f^2$. (c) Show that the total energy $E_f$ of the system at the top of its arc is the sum of these two values. (d) Calculate the value of $E_f$ for this system.
3. **Conservation of Energy:** Compare the values of $E_0$ and $E_f$ for this system and formulate a conclusion about whether or not energy is conserved in this situation.

## THEORY

1. **Work:**

$$W = \int \mathbf{F} \cdot d\mathbf{r}$$

$$W = F \times \cos\theta$$




2. **Energy:**

$$E_k = \tfrac{1}{2} m v^2$$

$$E_g = m g y$$

$$E_s = \tfrac{1}{2} k x^2$$

$$E_G = -G \frac{m_1 m_2}{r^2}$$

3. **Law of Conservation of Energy:**

$$E_o = E_f$$

4. **Power:**

$$P = \frac{dW}{dt}$$

$$P = \mathbf{F} \cdot \mathbf{v}$$

4. **Efficiency and Simple Machines:**

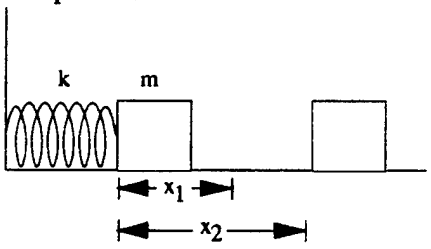
$$AMA = \frac{F_{out}}{F_{in}}$$

$$IMA = \frac{x_{in}}{x_{out}}$$

$$Eff = \frac{W_{out}}{W_{in}} = \frac{P_{out}}{P_{in}} = \frac{AMA}{IMA}$$

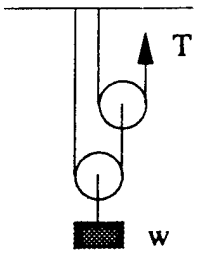
## CONCEPTS

1. (a) Under what conditions is $W = F x$ ? (b) $W = \int F\,dx$ ? (c) $W = F x \cos\theta$ ?
2. (a) Is energy a vector or a scalar? (b) Can energy be negative? Explain. (c) Under what conditions does $E_G$ reduce to $E_g$? (d) What is the equation for the total energy of a mass suspended by a spring and oscillating vertically?
3. (a) What is the original energy of a rock of mass m dropped from a height y onto a surface? (b) What is its energy just before it hits the surface with velocity v? (c) What is its energy after coming to rest? (d) How do these answers relate to the Law of Conservation of Energy?
4. (a) Under what conditions is $P = \mathbf{F} \cdot \mathbf{v}$ ? (b) $P = m\,\mathbf{v} \cdot \mathbf{a}$ ? (c) $P = k\,\mathbf{x} \cdot \mathbf{v}$ ? (d) Can a mass accelerate without expending power? Explain.
5. Use a tether ball as a pendulum. Begin by holding it to your face and releasing it without moving. (a) Can you resist flinching when it comes back? (b) Why does it come back? (c) How does it know how fast to go at the bottom? How does it know where to stop? (d) What happens to its amplitude after a while? Why? Will it ever reach equilibrium? Will it ever stop? (e) When put into circular motion, why doesn't it speed up or slow down?
6. A mass m is pressed against a horizontal spring of constant k compressing it an amount $x_1$ as shown at right. It is released from rest and slides a total distance $x_2$ before coming to rest again. (a) Where would the mass attain its maximum speed? (b) How could this system be used to study conservation of energy? (c) What quantities would you need to measure experimentally? (d) How



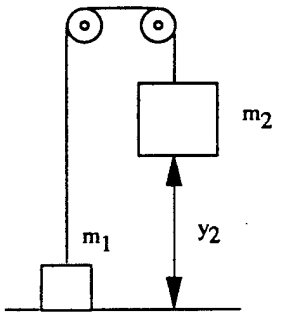
could you measure these quantities?

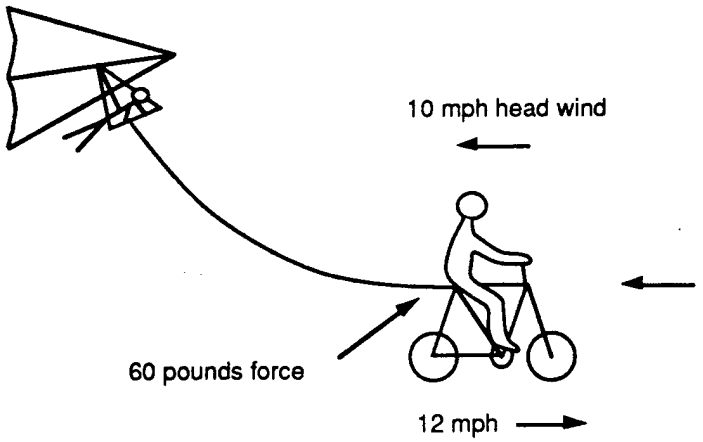
7. Explain how the pulley system shown at right could be used to study the efficiency of a simple machine. Specifically, how could you measure the quantities needed to calculate (a) the Actual Mechanical Advantage of the system, (b) the Ideal Mechanical Advantage of the system, (c) the Efficiency of the system, (d) the energy lost in lifting the weight some specified distance, and (e) the power required to lift the given weight a given distance in a given time.




## PRACTICE

1. A good athlete can sustain a maximum of about 0.25 horsepower performing such tasks as long distance running, bicycling, or human powered flight. (a) Select one or two students to run up the stairs of the physics building. (b) Measure the weight of each student, the height they climb, and the time it takes to climb the stairs. (c) Calculate the power output of each student and compare with the above value. (d) What conclusions can you draw?
2. Set up an Atwood machine as illustrated at the right and release the system from rest. Observe the motion, paying particular attention to the maximum height attained by the lighter mass. (a) How could this system be used to study energy? (b) What quantities would you need to measure? (c) How could you make these measurements?
3. (a) Calculate the power required to keep the hang glider airborne as shown in the figure at right. (b) How could you experimentally measure the quantities required to make this calculation? (c) How could this set up be used to study energy and power?



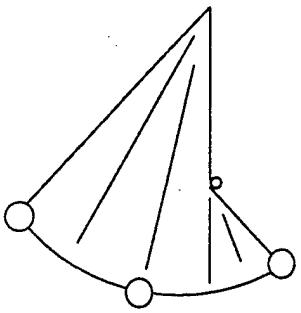




4. Set up at least one example of each of the following simple machines, explain how each one could be put to practical use, and explain how the efficiency of each could be measured: (a) lever, (b) crank and axle, (c) inclined plane, (d) wedge, (e) screw, (f) pulleys.

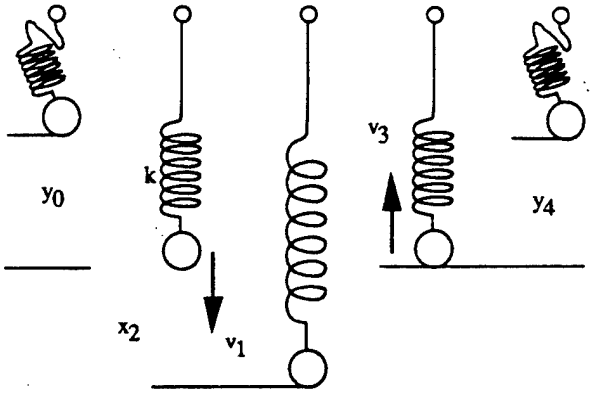
## DESIGN

Design an experiment to quantitatively study energy, the Law of Conservation of Energy, and/or power. Obtain guidance and approval from your lab instructor before setting up your experiment.

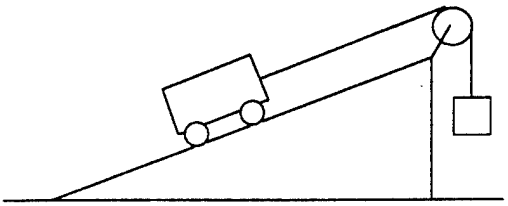
The following illustrations are intended to stimulate your thinking:



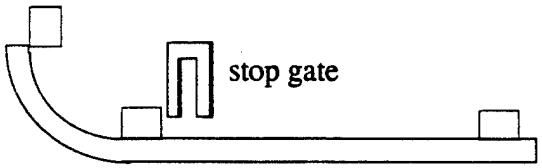
strobe light of an interrupted pendulum




videotape bouncing mass on light flexable string.



rolling cart on an inclined plane




stop gate on sliding ramp

**SET-UP**

After your design has been approved, set up your experiment and practice using the equipment to verify that everything is operating correctly.

**PERFORMANCE**

Once you have verified that everything is functioning properly, perform your experiment, collect your data, do your analysis, formulate your conclusions, and prepare your report.

Experiment 7

# Impulse and Momentum

Impulse is a measure of the effectiveness of a force acting through time. Momentum is a measure of the inertial characteristic of a moving body. The Law of Conservation of Momentum states that the total momentum of an isolated system of particles does not change.

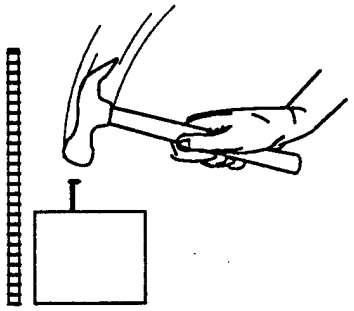
These concepts often allow us to calculate accurately the result of an interaction without knowing all of the details of the situation. This is particularly important when collisions are involved (whether between football players in a stadium or between automobiles on the highway) because during a collision everything usually happens so fast that a detailed time analysis of the situation is virtually impossible (and totally unnecessary).

The **purpose** of this experiment is to study impulse and momentum and to explore the relationship between them, particularly during the collision process.

The **equipment** needed for this experiment includes: Camcorder system, hammer, nail, wood, yard stick, ballistic pendulum apparatus, air table apparatus, air track, stop gates, weights, spring, pendulum.

## OBSERVATION

1. Video tape your lab instructor hammer a nail into a block of wood located beside a yard stick as shown at right.
2. Use stop action to measure the velocity of the hammer before and after each stroke, the distance the nail moves, and the time of impact.
3. Determine the mass of the hammer in slugs.



## ANALYSIS

1. **Momentum:** From your data, calculate (a) the downward momentum $p_o$ of the hammer immediately before impact, (b) the upward momentum $p_f$ immediately after impact, and (c) the net change of momentum $\Delta p$ during the impact.
2. **Impulse:** Use this result to calculate (a) the impulse required to reverse the hammer's velocity and (b) the average force exerted by the hammer on the nail.
3. **Kinetic Energy:** From your data, calculate (a) the kinetic energy of the hammer before impact, (b) the kinetic energy after impact, and (c) the change in kinetic energy.
4. **Work:** Use this result to calculate the work done by the hammer in moving the nail and (b) the average force exerted by the hammer on the nail.
5. **Conclusions:** Compare your answers from Analysis 2 with Analysis 4 and formulate conclusions.

## THEORY

1. **Impulse:**

$$\mathbf{J} = \int \mathbf{F}\, dt$$

$$\mathbf{J} = \mathbf{F}\, t$$

2. **Momentum:**

$$\mathbf{p} = m\, \mathbf{v}$$

3. **Newton's Second Law:**

$$F = \frac{dp}{dt}$$

$$J = \Delta p$$

4. **Law of Conservation of Momentum:**

$$p_o = p_f$$

5. **Collisions:**

(a) Coefficient of restitution:

$$e = \frac{v_{sep}}{v_{app}} = \frac{v_{f2} - v_{f1}}{v_{o1} - v_{o2}}$$

(b) Elastic:

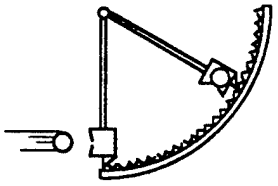
$$e = 1$$

(b) Inelastic:

$$e = 0$$

## CONCEPTS

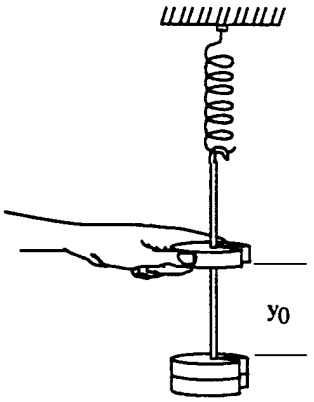
1. (a) Under what conditions is $J = F t$ ? (b) $J = \Delta p$ ? (c) $p = m v$ ?
2. (a) Is impulse a vector or a scalar? (b) Can impulse be negative? Explain. (c) Under what conditions does impulse equal change in momentum?
3. (a) Is momentum a vector or a scalar? (b) Can momentum be negative? Explain. (c) What is the momentum of a system of particles? (d) Under what conditions is momentum conserved?
4. (a) Write the energy equation for an elastic collision. (b) For an inelastic collision.
5. Explain how the ballistic pendulum apparatus shown at right could be used to determine the velocity of a projectile. (a) What are the equations that would be used? (b) What quantities would have to be measured experimentally? (c) How would you go about measuring these quantities?



## PRACTICE

1. Set up the air table apparatus and observe some two-dimensional collisions. Watch both two- and three-body collisions, collisions between equal and different masses, elastic and inelastic collisions. Explain how this system could be used to study the Law of Conservation of Momentum.
2. Set up the stop gates on the air track and observe various one-dimensional collisions. Practice taking and analyzing data until you can make a preliminary verification of the Law of Conservation of Momentum.

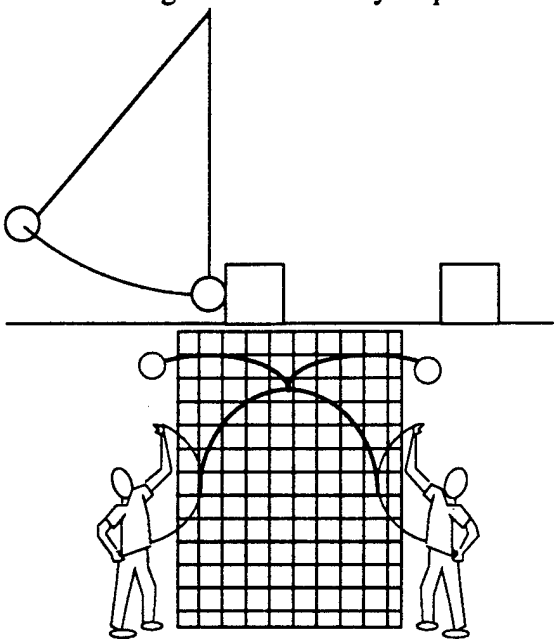
3. Drop a slotted weight from a given height onto another weight suspended by a spring as shown in the figure at right. (a) Explain how this system could be used to study momentum and energy. (b) What quantities would you have to measure? (c) How could you measure them?




## DESIGN

Design an experiment to quantitatively study impulse, momentum, or collisions. Obtain guidance and approval from your lab instructor before setting up your experiment.

The following illustrations may help stimulate your creativity:



## SET-UP

After your design has been approved, set up your experiment and practice using the equipment to verify that everything is operating correctly.

## PERFORMANCE

Once you have verified that everything is functioning properly, perform your experiment, collect your data, do your analysis, formulate your conclusions, and prepare your report.

Experiment 8

# Rotational Dynamics

There are angular equivalents for almost every concept of vector dynamics. Rotational dynamics is the study of these quantities and their relationships with one another.

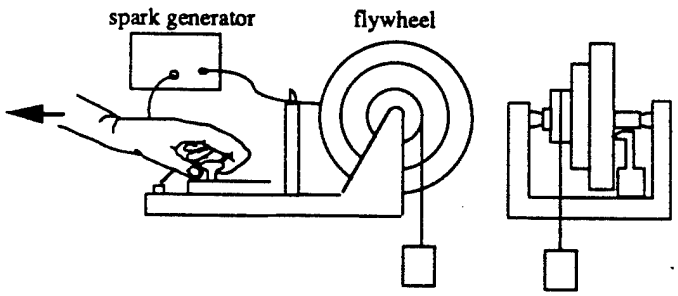
The concepts of rotational dynamics allows us to consider a whole new class of physical applications, namely those that involve some kind of rotational motion (whether it be a rolling ball or a spinning flywheel).

The **purpose** of this experiment is to study these rotational concepts and to explore the relationships between them.

The **equipment** needed for this experiment includes: Angular momentum apparatus, spark generator, computer spreadsheet program, introductory rotational apparatus, smart pulley system, and camcorder system.

## OBSERVATION

1. Watch carefully as your lab instructor sets up the angular momentum apparatus as shown at right. Assist as necessary to record the angular motion of the system when released from rest. List some of the problems encountered in collecting this data. Why did the instructor move the spark needle as the system rotated?




2. Record the time interval $\Delta t$ between sparks and enter the time t for each data point into a computer spreadsheet.
3. Remove the spark disk from the flywheel, read the angular position $\theta$ (in degrees) of each data point, and enter these values into the spreadsheet.
4. Measure the mass m of the hanging weight, and the mass M of the flywheel.
5. Measure the length L and radius r of each component cylinder that makes up the flywheel.

## ANALYSIS

1. **Angular Displacement:** (a) Program the spreadsheet to calculate the angular displacement $\Delta\theta$ (in radians) from its original angular position $\theta_0$ for each data point. (b) Plot a graph of $\Delta\theta$ versus t and describe the type of motion.
2. **Angular Velocity:** (a) Program the spreadsheet to calculate the angular velocity $\omega$ at each data point. (b) Plot a graph of $\omega$ versus t and describe the type of motion.
3. **Angular Acceleration:** (a) Program the spreadsheet to calculate the angular acceleration $\alpha$ at each data point. (b) Plot a graph of $\alpha$ versus t and describe the type of motion.
4. **Graphical Analysis:** (a) Program the spreadsheet to calculate $\Delta\theta/t$ at each data point and plot a graph of $\Delta\theta/t$ versus t. Why plot $\Delta\theta/t$ versus t instead of simply $\Delta\theta$ versus t or $t^2$? (b) From your graph determine the initial angular velocity $\omega_0$ and the acceleration $\alpha$ of the system.
5. **Moment of Inertia:** Calculate the moment of inertia of the flywheel. (a) Show theoretically that it should be given by

$$I = \frac{M \sum r^4 L}{2 \sum r^2 L} .$$

(b) Substitute the measured values of M, r, and L into the equation and obtain the value of I.

6. **Torque:** (a) Show theoretically that the torque $\Gamma$ accelerating the flywheel is given by $\Gamma = m g r - m r^2 \alpha$, where r is the radius of the cylinder about which the string was wrapped. (b) Use this equation to calculate the torque $\Gamma$.

7. **Newton's Second Law for Rotation:** Demonstrate that Newton's Second Law $\Gamma = I \alpha$ is valid for this rotating body.

## THEORY

1. **Moment of Inertia:**

$$I = \Sigma m r^2$$

$$I = \int r^2 dm = \int \rho r^2 dV$$

2. **Kinematics:**

$$\theta = s/r$$

$$\omega = d\theta/dt$$

$$a = d\omega/dt$$

$$\theta = \theta_o + \omega_o t + \tfrac{1}{2} \alpha t^2$$

$$\omega = \omega_o + \alpha t$$

$$\omega^2 = \omega_o^2 + 2 \alpha (\theta - \theta_o)$$

3. **Dynamics:**

$$\Gamma = dL/dt = I \alpha$$

$$W = \int \Gamma d\theta$$

$$E_k = \tfrac{1}{2} I \omega^2$$

$$J_\theta = \int \Gamma dt$$

$$L = I \omega$$

4. **Particle Moving in a Circle:**

$$s = r \theta$$

$$v = r \omega$$

$$a_r = r \omega^2$$

$$a_t = r \alpha$$

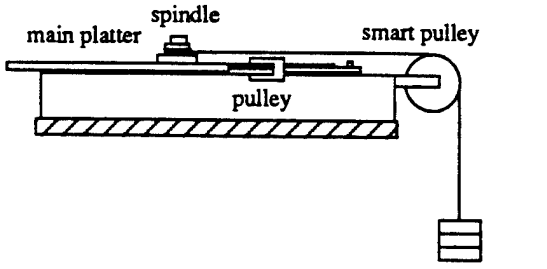
## CONCEPTS

1. Under what conditions are each of the following equations valid?
   (a) $I = M R^2$
   (b) $I = \tfrac{1}{2} M R^2$
   (c) $\Gamma = I \alpha$
   (d) $W = \Gamma \theta$
   (e) $J_\theta = \Gamma t$
   (f) $L = m v r$
   (g) $J_\theta = \Delta L$
   (h) $L_o = L_f$

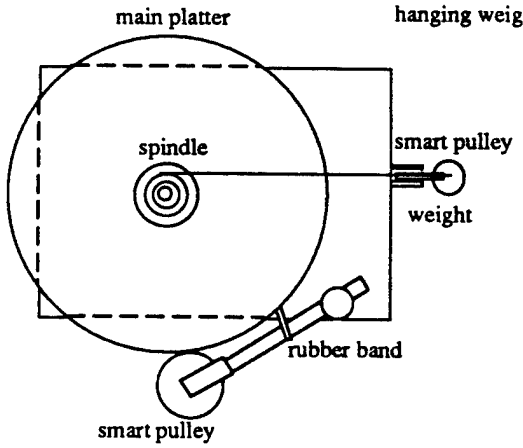
2. A twisting swing has a plank seat 2 feet wide of negligible mass. It takes a force of 20 pounds applied to each side of the seat edge to twist a 180-pound person sitting in the seat. That force is approximately constant as the person is wrapped up five twists. After being released from rest it takes 8 seconds to unwind if the person is extended their full height of 6 feet, and 4 seconds if they are doubled up (to half their height) (a) What is the final angular velocity and acceleration of the person in each case? (b) What is the moment of inertia of the person in each case? (c) How high vertically did the person rise when the swing was being twisted? (d) Approximate the moment of inertia of the person's body by assuming it is a 6-foot rod spinning about its center. Calculate that moment of inertia and compare with the experimental values. (e) Formulate conclusions.

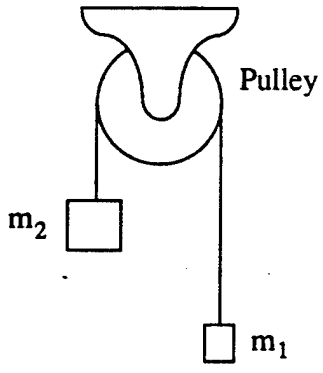
## PRACTICE

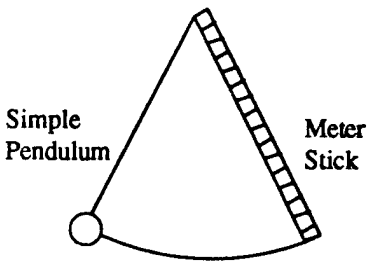
1. (a) Set up the Introductory Rotational Apparatus as shown at right. (b) Practice taking and analyzing data with this system. (c) Discuss possible angular motion experiments that could be studied with this set-up.




2. (a) Set up an inclined plane and have a race between (i) a solid cylinder, (ii) a hollow cylinder, and (iii) a solid sphere. Before the race begins, try to guess which object will win. (b) Change the angle of incline to see if that affects the result. (c) Explain how this set-up could be used to study moment of inertia. (d) What quantities would you have to measured to calculate I? (e) How could you measure each of these quantities?
3. (a) Set up an Atwood machine as illustrated below and observe the result when it is released from rest. (b) How could this machine be used to study the relationship between angular and linear motion? (c) How could you calculate the theoretical acceleration of the falling mass? (d) How could you measure that acceleration experimentally? (e) What could you hope to prove with this machine?




4. Pivot a meter stick at one end and locate it beside a simple pendulum one meter long. (a) If initially displaced by equal amounts, which will oscillate faster? Why? (b) Perform this

experiment and verify your predictions. (c) How could this apparatus be used to study angular motion quantitatively? (d) What would you need to measure and how could you measure it?

**DESIGN**

Design an experiment to quantitatively study some aspect of rotational motion. Obtain guidance and approval from your lab instructor before setting up your experiment.

**SET-UP**

After your design has been approved, set up your experiment and practice using the equipment to verify that everything is operating correctly.

**PERFORMANCE**

Once you have verified that everything is functioning properly, perform your experiment, collect your data, do your analysis, formulate your conclusions, and prepare your report.

Experiment 9

# Periodic Motion

Motion that repeats itself at regular intervals is called periodic motion. The simplest type of periodic motion is simple harmonic motion. It is the result of projecting uniform circular motion onto the diagonal of a circle. Just as linear motion is the foundation of all other types of motion, so is simple harmonic motion the foundation of all other types of periodic motion (whether it be the oscillation of a swinging child or the vibration of a musical instrument).

The **purpose** of this experiment is to study simple harmonic motion and its relationship with other forms of periodic motion.

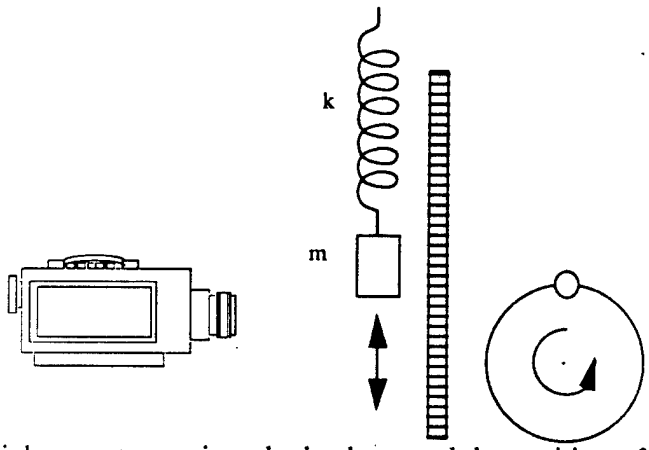
The **equipment** needed for this experiment includes: Strobe light, tuning forks, vibrating string, drum head, rotating wheel, meter stick, mass, spring, stand, pendulum, camcorder with stop action playback, and computer spreadsheet.

## OBSERVATION

1. Watch carefully as your lab instructor uses the strobe light to demonstrate the periodic vibration of tuning forks, vibrating strings, drum head, rotating wheel, meter stick, etc.
2. Set up the simple harmonic demonstration apparatus and notice how the circular rotation of the turntable is related to the simple harmonic motion of the pen and how that is related to the sine wave recorded on the paper.

Such motion is called simple harmonic.

3. Attach a mass to the rim of a wheel and rotate that wheel with uniform circular motion in a vertical plane. Suspend another mass from a spring and set it into vertical oscillation. Adjust the second mass and amplitude and/or the speed of rotation of the above wheel (the first mass) until the projected motion of the wheel and the oscillating spring are in synchronization. Formulate conclusions about the relationship between the two types of motion.



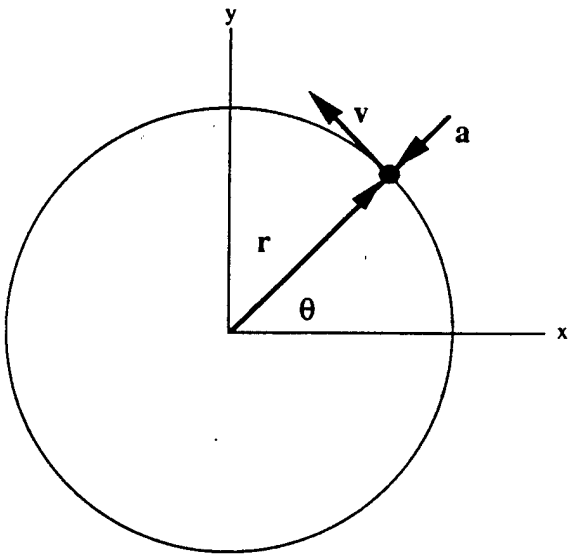

4. Video record the motion of the oscillating spring located beside a meter stick, use stop action playback to read the position of the mass as a function of time, and record your data on a computer spreadsheet. Specifically, measure the time interval $\Delta t$ between data points, the equilibrium height $y_0$, the height y of each data point, and have the spreadsheet calculate the displacement $x = y - y_0$ from equilibrium for each data point.
5. Measure the mass m and spring constant k of the oscillating system.

## ANALYSIS

1. **Position:** (a) Plot a curve of position x versus time t. (b) Determine the amplitude A , the period $\tau$ , frequency $f$ , angular frequency $\omega$, and the initial phase angle $\theta_0$ of oscillation. (c) Program the spreadsheet to calculate the value of x for each data point from the equation $x = A \cos(\omega t - \theta_0)$. (d) Compare the calculated values with the measured values and formulate conclusions.
2. **Velocity:** (a) Program the spreadsheet to calculate the velocity v at each data point. (b) Plot a graph of v versus t . Compare this curve with the previous x versus t curve. (c) Compare the

experimental values of v with those calculated through $v = -\omega A \sin(\omega t - \theta_0)$ and formulate conclusions.

3. **Acceleration:** (a) Program the spreadsheet to calculate the acceleration a at each data point. (b) Plot a graph of a versus t . Compare this curve with the previous x versus t and v versus t curves. (c) Plot a graph of a versus x . Verify that $a = -\omega^2 x$ .
4. **Dynamics:** (a) Combine Newton's second law with the result of Analysis 3(c) to show that theoretically $\omega = \sqrt{k/m}$. (b) Verify this equation experimentally.
5. **Projection:** (a) Redraw the diagram illustrated at right to show the projections of **r**, **v**, and **a** along the x-axis. (b) If the motion is uniform, show that $\theta = \omega t$, $v = r\omega$, and $a = r\omega^2$. (c) If the amplitude of oscillation is A, show that $x = A \cos \omega t$, $v_x = -\omega A \sin \omega t$, and $a_x = -\omega^2 A \cos \omega t$ . (c) Formulate conclusions.




## THEORY

1. **Kinematics**

$$x = A \cos(\omega t - \theta_0)$$

$$v = -\omega A \sin(\omega t - \theta_0)$$

$$a = -\omega^2 x$$

2. **Linear Dynamics:**

$$F = ma = -kx$$

$$\omega = \sqrt{\frac{k}{m}}$$

3. **Rotational Dynamics:**

$$\tau = I\alpha = -k'\theta$$

$$\omega = \sqrt{\frac{k'}{I}}$$

4. **Small Amplitude Pendulum:**

$$F = ma = -mgx/L$$

$$\omega = \sqrt{\frac{g}{L}}$$

## CONCEPTS

1. Show that each of the following equations are valid for linear SHM:

(a) $v = \omega\sqrt{A^2 - x^2}$

(b) $E = \frac{1}{2}kA^2$

(c) $\tau = 2\pi\sqrt{\frac{m}{k}}$

(d) $f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$

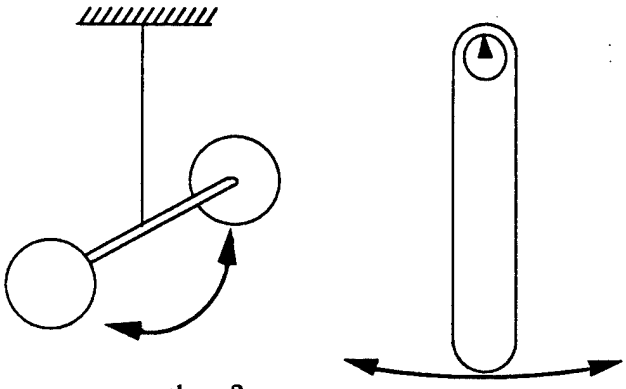
2. Write the equations of motion for rotational SHM. (I.e. for $\underline{\theta}$, for $\underline{\omega} = d\underline{\theta}/dt$, and for $\underline{\alpha} = d^2\underline{\theta}/dt^2$.)

3. (a) What is the equation for the restoring force for a simple pendulum displaced through an arc of length x? (b) What does this become for small angles? (c) How big can a small angle be? (c) What happens to the period of a simple pendulum when the angle becomes large? Check this experimentally. (d) Is the period of a pendulum swinging in a circle the same as swinging in a plane? Why? Check your answer experimentally.

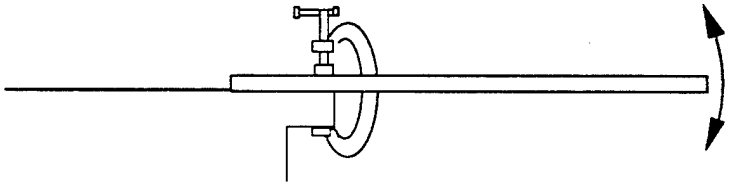
4. Explain how a simple pendulum could be used to determine the acceleration g due to gravity.

## PRACTICE

1. (a) Experimentally verify that the period of a mass on a spring is the same when oscillating vertically as when oscillating horizontally on a frictionless surface. (b) What happens to the period when friction is present?
2. (a) Suspend a barbell from a string observe its oscillation. (b) How could this set-up be used to verify the equations for rotational dynamics (Theory 3)? (c) What quantities would have to be measured and how?
3. (a) Set up a physical pendulum and observe its oscillation. Is it simple harmonic motion? (b) How could you devise an experiment to study this motion? (c) What set of equations should you use? (d) What quantities would you need to measure? (e) How could you measure them?



4. (a) Clamp one end of a meter stick to the table and observe the oscillation of the free end. Is it simple harmonic motion?(b) How could you devise an experiment to study this motion? (c) What set of equations should you use? (d) What quantities would you need to measure? (e) How could you measure them?



## DESIGN

Design an experiment to quantitatively study some aspect of periodic motion. Obtain guidance and approval from your lab instructor before setting up your experiment.

## SET-UP

After your design has been approved, set up your experiment and practice using the equipment to verify that everything is operating correctly.

## PERFORMANCE

Once you have verified that everything is functioning properly, perform your experiment, collect your data, do your analysis, formulate your conclusions, and prepare your report.

Experiment 10

# Fluid Mechanics

Fluids are substances that are capable of flowing. Density is mass per unit volume. Specific gravity is the density of a substance compared with that of water. Pressure is force per unit area. Archimedes' principle asserts that a floating body is buoyed up by a force equal to the weight of the displaced fluid. The Equation of Continuity asserts that matter is neither created nor destroyed but flows consistently through all parts of a stream. And Bernoulli's Equation uses the Law of Conservation of Energy to relate pressure, height, and velocity of a flowing fluid at various locations along its flow path.

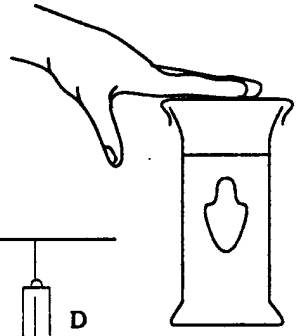
Fluid mechanics is the study of all of these phenomena and their relationships with one another. The concepts and principles contained in fluid mechanics are applicable to wide variety of circumstances including both fluid statics (which considers phenomena ranging from the pressure at the depths of the ocean to the buoyant force suspending a hot air balloon) and fluid dynamics (which considers phenomena ranging from the trickle of a tiny faucet to the circulation of a gigantic hurricane).

The **purpose** of this experiment is to study the principles and concepts of fluid dynamics and to explore their relationships with one another.

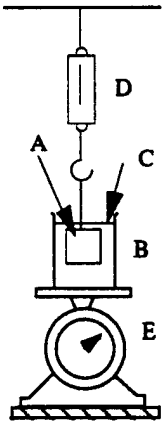
The **equipment** needed for this experiment includes: Cartesian diver, Archimedes' principle apparatus, air blower, ping pong ball, Bernoulli's principle apparatus, small wood block, sinker, large graduated cylinder, meter stick, pyknometer, hydrometer, oil, venturi tube, trash bag.

## OBSERVATION

1. Watch carefully as your lab instructor demonstrates the operation of a Cartesian diver. How does it work? Does a modern nuclear submarine operate on the same principle? Explain.



2. Set up the Archimedes' principle apparatus shown at right and observe the change in readings of the scales as mass A is inserted into the beaker of water. Record the following quantities:
   - $m_A$ - mass of suspended object
   - $m_B$ - mass of beaker
   - $m_C$ - mass of water
   - $m_D$ - apparent mass read by balance D
   - $m_E$ - apparent mass read by balance E

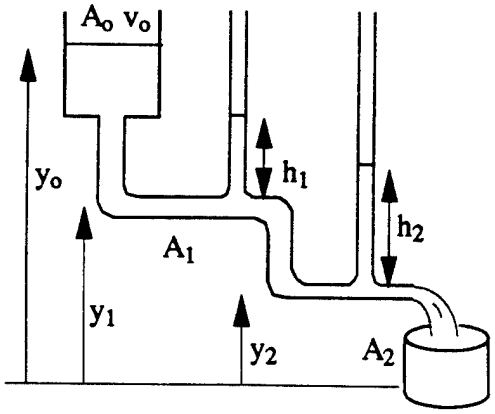



3. Measure the physical dimensions of the mass A and calculate its volume $V_A$.

4. Observe the motion of the ping pong ball in a vertical air stream. Explain why it moves the way it does.



5. Set up the Bernoulli's principle apparatus shown at right and observe what happens to the pressure, velocity, and height of the fluid as the parameters are changed. Record the following quantities:
   - $y_0$ - height of water in reservoir
   - $y_1$ - height of water in large pipe
   - $y_2$ - height of water in small pipe
   - $A_0$ - cross sectional area of reservoir
   - $A_1$ - cross sectional area of large pipe
   - $A_2$ - cross sectional area of small pipe
   - $h_1$ - pressure head for large pipe
   - $h_2$ - pressure head for small pipe
   - $v_0$ - velocity of water in reservoir
   - $R_2$ - volume flow rate out of small pipe




## ANALYSIS

1. **Basics:** (a) What two basic phenomena are illustrated in the above observations? (b) Give examples of each of these phenomena occurring in nature. (c) Describe some practical applications of the principles associated with each of these phenomena.
2. **Density:** (a) Use the equation $\rho_A = m_A/V_A$ and the above data to calculate the density of mass A. (b) What is the specific gravity of A?
3. **Archimedes' Principle:** (a) What is the buoyant force on mass A while submerged? (b) What is the weight of a quantity of water whose volume is $V_A$? (c) Compare these values and formulate conclusions.
4. **Statics:** (a) Use Newton's First Law to show that the specific gravity of mass A is given by $\rho_A / \rho_0 = m_A/(m_A - m_D)$. (b) Use Newton's First Law to show that $m_A + m_B + m_C = m_D + m_E$. (c) Are these equations verified by the data?
5. **Equation of Continuity:** (a) What is the volume flow rate $R_0$ out of the reservoir? (b) Compare with $R_2$ and formulate conclusions.
6. **Bernoulli's Equation:** (a) What is the pressure at each flow point? (b) Calculate the value of $p + \rho g y + \frac{1}{2} \rho v^2$ for each flow point. (c) Formulate conclusions.

## THEORY

1. **Density:**

$$\rho = m/V$$

$$w = \rho g V$$

$$\text{Sp. Gr.} = \rho/\rho_0$$

$$\rho_0 = 1 \text{ g/cm}^3 = 1000 \text{ kg/m}^3$$

2. **Archimedes' Principle:**

$$B = w_{df} = \rho_f g V_d$$

3. **Equation of Continuity:**

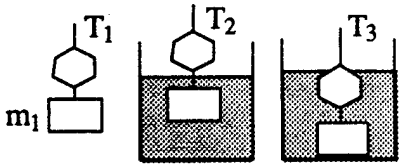
$$R = A_1 v_1 = A_2 v_2$$

4. **Bernoulli's Equation:**

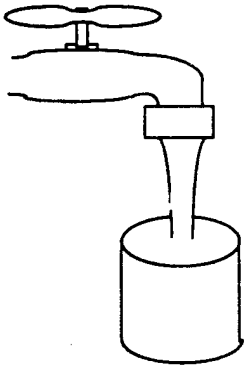
$$p_1 + \rho g y_1 + \tfrac{1}{2} \rho v_1^2 = p_2 + \rho g y_2 + \tfrac{1}{2} \rho v_2^2$$

## CONCEPTS

1. A small block of wood floats in a large graduated cylinder. When it was first placed there the water level rose by a volume $V_1$. When pushed further down until totally submerged the water level rose by an additional volume $V_2$. (a) Find an expression that gives the density of the wood in terms of these two numbers. (b) How could this experiment be used to verify Archimedes' principle? (c) What additional quantities would need to be measured?
2. A weight of mass $m_1$ is attached to the bottom of an unknown mass of unknown volume which normally would float. The combined system is supported by a tension $T_1$ when both masses are in air, by $T_2$ when the bottom mass in in water, and by $T_3$ when both are submerged. (a) How could this data be used to determine the specific gravity of the unknown mass? (b) How could this system be used to verify Archimedes' principle? (c) What additional data would be required and how could you measure this data?

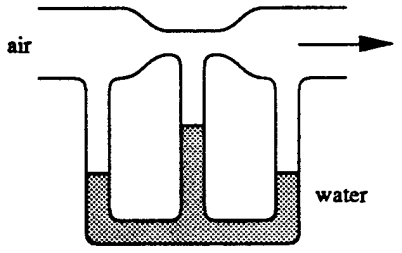



3. Water flows out of the tap of a faucet as shown at right and is collected in a beaker for a certain length of time. (a) How could this system be used to determine the volume flow rate of the water? (b) The velocity of the water at various heights? (c) The validity of Bernoulli's equation?



## PRACTICE

1. Determine the specific gravity of a liquid (a) by using a pyknometer, (b) by measuring the loss of weight of a known mass when suspended in it, and (c) by using a hydrometer.
2. Suppose you squirt your landlord's nozzle at a 45 degree angle and find the water reaches 50 ft horizontally. How high would the nozzle squirt if pointed straight up? How high would you expect it to go based on the height of the Kingsville water towers? How could you measure the Kingsville tower height if the law forbids climbing it? How does all this relate to this experiment?
3. Determine the density of air by blowing it through a venturi tube as shown to the right. (a) Measure the heights of the water columns. (b) Measure the volume flow rate of the air. (c) Calculate the density of the air. (d) Compare your result with the accepted value. (e) Formulate conclusions (including what you have learned, how the experiment could be improved, and how it could be modified for a practical application).




## DESIGN

Design an experiment to quantitatively study some aspect of fluid mechanics. Obtain guidance and approval from your lab instructor before setting up your experiment.

## SET-UP

After your design has been approved, set up your experiment and practice using the equipment to verify that everything is operating correctly.

## PERFORMANCE

Once you have verified that everything is functioning properly, perform your experiment, collect your data, do your analysis, formulate your conclusions, and prepare your report.

Experiment 11

# Elasticity and Thermal Expansion

Elasticity is the phenomenon associated with the deformation of objects due to forces. Stress is the force per unit area causing the deformation. Strain is the relative amount of deformation. Young's modulus is the ratio of the stress to the strain. These concepts are useful in describing phenomena ranging from the stretch of the strings on a violin to the compression of the air in a bicycle tire.

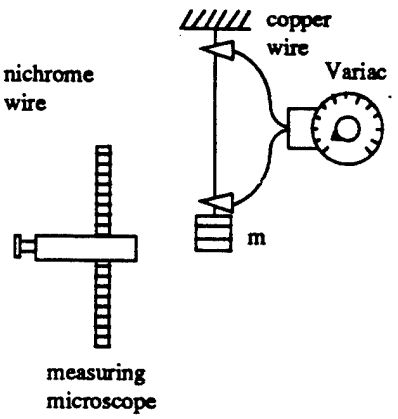
Thermal expansion is the phenomenon associated with the deformation of objects due to a change of temperature. The amount of thermal expansion is proportional to the size of the object and to the change in temperature. The constant of proportionality is called the thermal coefficient of expansion. These concepts are useful in describing phenomena ranging from the sagging of telephone lines in the summer to the bursting of water pipes in the winter.

The **purpose** of this experiment is to study elasticity and thermal expansion and to explore their relationships with one another.

The **equipment** needed for this experiment includes: Nichrome wire, weights, measuring microscope, meter stick, micrometer, Variac, Young's modulus apparatus, thermal expansion apparatus.

## OBSERVATION

1. Watch your instructor set up the apparatus shown at right and observe through the measuring microscope how the wire stretches as weights are added. (a) Record the mass m and stretch $\Delta L$ as weights are added.(b) Use a meter stick to measure the original length L of the wire and a micrometer to measure its diameter D.
2. Watch your instructor plug in the Variac and adjust its voltage until the nichrome wire glows red-orange. (a) Measure the stretch $\Delta L$ of the wire. (b) Estimate the temperature of the wire by the color it glows. (c) Notice what happens when the electricity is shut off. How long does it take for the wire to cool off? Does the weight return to its original position?




## ANALYSIS

1. **Basics:** (a) What two basic phenomena are illustrated in the above observations? (b) Give examples of each of these phenomena occurring in nature. (c) Describe some practical applications of the principles associated with each of these phenomena.
2. **Elasticity:** (a) What is the cross sectional area of the wire? (b) Calculate the stress in the wire as the weights were added. (c) Calculate the strain in the wire as weights were added. (d) Plot a graph of stress versus strain and determine Young's modulus for the wire. (e) Formulate conclusions and suggest some practical applications of what you have learned.
3. **Thermal Expansion:** (a) Estimate the coefficient of thermal expansion for the nichrome wire. (b) Formulate conclusions and suggest applications.
4. **Thermal Stress:** (a) Estimate the amount of weight necessary to stretch the unheated wire by the same amount as was observed for the heated wire. (b) What would have been the tension in the wire had it not been allowed to contract as it cooled.

## THEORY

1. **Elasticity:**

   (a) Stress $\quad p = \frac{F}{A}$

   (b) Strain $\quad s = \frac{\Delta L}{L}$

   (c) Young's modulus $\quad Y = \frac{p}{s}$

2. **Thermal Expansion:**

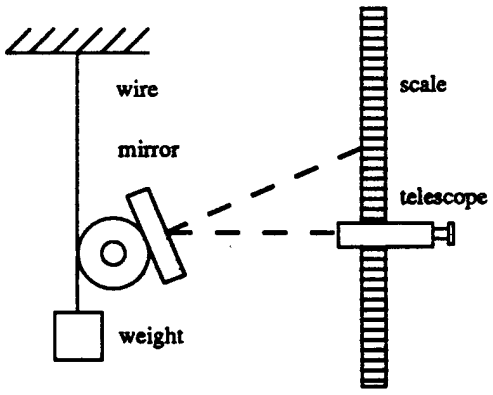
   $\Delta L = \alpha L \Delta T$

## CONCEPTS

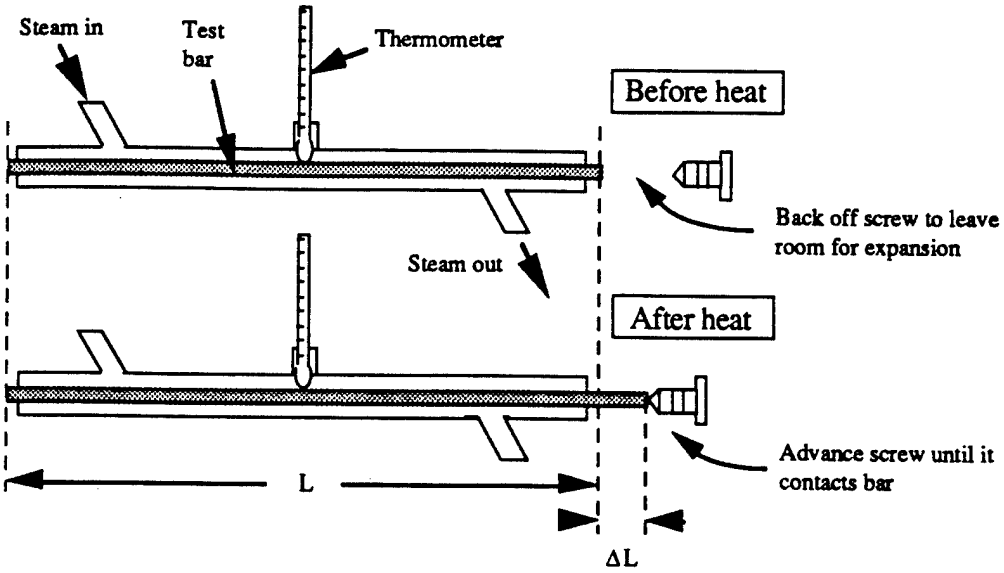
1. The above quantities associated with elasticity were defined for the linear stretching case (or tensile case). Explain the meaning of the following similar or related quantities: (a) area strain, (b) volume strain, (c) pressure, (d) bulk modulus, (e) compressibility, (f) shear stress, (g) shear strain, (h) shear modulus.
2. Explain the meaning of the following quantities associated with elasticity: (a) Hook's law, (b) proportional limit, (c) yield point, (d) elastic limit, (e) breaking stress, (f) Poisson's ratio.
3. The above thermal expansion equation represents the linear case. Write the corresponding equation for (a) the area case and (b) the volume case. (c) How is the coefficient of volume expansion related to the coefficient of linear expansion?
4. When a solid object expands thermally, what happens to any holes contained within it? Do the holes expand or contract? By how much?
5. A wire of length L and coefficient of linear expansion $\alpha$ is bent into a circle and then heated until it expands by an amount $\Delta L$. (a) What happens to the enclosed area? (b) Express the change in area $\Delta A$ in terms of $\Delta L$. (c) Show that the coefficient of area expansion for this loop is equal to $2\alpha$.
6. (a) What is thermal stress? (b) Express the thermal stress of a wire not allowed to contract upon cooling in terms of its Young's modulus, coefficient of linear expansion, and change in temperature.

## PRACTICE

1. Set up the Young's modulus apparatus as illustrated at right and observe its operation. (a) How could this apparatus be used to measure Young's modulus? (b) What quantities would you need to measure? (c) How could you measure them? (d) How could a laser be used instead of a telescope? (e) What conclusions could you draw from this experiment?




2. Set up the thermal expansion apparatus as illustrated below and describe its operation. (a) How could this apparatus be used to measure the coefficient of linear expansion? (b) What quantities would you need to measure? (c) How could you measure them? (d) How many rods would need to be used? (e) What conclusions could you draw from this experiment?




3. Place some oil in a flask and observe how it expands up the neck when heated. (a) How could this apparatus be used to measure the coefficient of volume expansion of the oil? (b) What quantities would you need to measure? (c) How could you measure them? (d) How could you compensate for the expansion of the glass flask itself? (e) What conclusions could you draw from this experiment?
4. Describe an experiment which could demonstrate quantitatively the phenomenon of thermal stress and explain why a quantitative understanding of thermal stress is important.

## DESIGN

Design an experiment to quantitatively study some aspect of elasticity and/or thermal expansion. Obtain guidance and approval from your lab instructor before setting up your experiment.

## SET-UP

After your design has been approved, set up your experiment and practice using the equipment to verify that everything is operating correctly.

## PERFORMANCE

Once you have verified that everything is functioning properly, perform your experiment, collect your data, do your analysis, formulate your conclusions, and prepare your report.

Experiment 12

# Heat

Heat is a form of energy which manifests itself through a change of temperature, through a change of phase, or through a transfer process that does not involve macroscopic work. Specific heat capacity is a measure of the amount of heat required to increase a unit mass of substance by a unit change in temperature. Latent heat is the amount of heat required to change the phase of a unit mass of substance. These concepts are useful in describing phenomena ranging from the heating of coffee in kitchen to the melting of icebergs in the arctic.

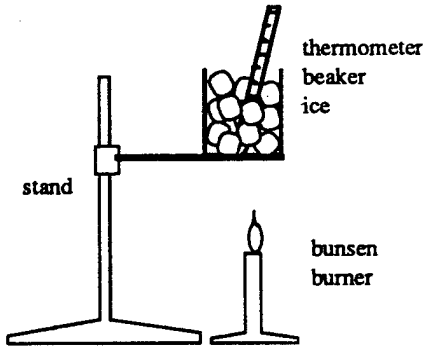
Heat can be transferred by conduction, convection, and/or radiation. Conduction occurs in material substances when higher energy molecules collide with their slower moving neighbors. Convection occurs in fluids when the warmer part of the fluid flows to the cooler region. Radiation occurs in a transparent material or a vacuum by the transmission of electromagnetic waves. These concepts are useful in describing phenomena ranging from the operation of a thermos bottle to the collection of solar energy.

The **purpose** of this experiment is to explore all of these concepts and their relationships with one another.

The **equipment** needed for this experiment includes: Thermometer, beaker, Bunsen burner, stand, ice, Styrofoam cup, calorimeter, heat conduction apparatus, two parabolic reflectors, radiometer.

## OBSERVATION

1. Watch your instructor set up the apparatus shown at right and heat a sample of ice. Record the temperature of the ice as it heats, melts, heats, and boils away.
2. Watch your instructor place some ice in a Styrofoam cup containing water. Measure and record the following quantities:
   - $m_1$ - mass of ice (small enough to melt completely)
   - $m_2$ - mass of water
   - $m_3$ - mass of cup
   - $T_1$ - initial temperature of ice
   - $T_2$ - initial temperature of water
   - $T_f$ - final temperature of system




## ANALYSIS

1. **Basics:** (a) What two basic phenomena are illustrated in the above observations? (b) Give examples of each of these phenomena occurring in nature. (c) Describe some practical applications of the principles associated with each of these phenomena.
2. **Temperature versus Time:** (a) Plot a curve of the temperature versus time for Observation 1 above. (b) What do you notice about the rate of change in temperature? (c) What do you conclude about the rate of heat flowing into the system? (d) How can you reconcile these two answers? (e) How could this set-up be used to acquire quantitative answers regarding the quantity of heat and the process of heat flow?
3. **Heat Capacity:** For Observation 2: (a) Calculate the amount of heat $Q_2$ lost by the water when the ice was added to it. (b) How much heat $Q_3$ was absorbed by the cup? (c) Formulate conclusions.
4. **Latent Heat:** For Observation 2: (a) Calculate the amount of heat $Q_1$ gained by the ice as it melted and warmed up to the final temperature. (b) Formulate conclusions.

5. **Conservation of Energy:** For Observation 2: (a) What can you conclude regarding the total heat gain and heat loss of the system? (b) Explain how you could improve the accuracy of this experiment. (c) How could the result of this experiment be put to practical use?

## THEORY

1. **Quantity of Heat:**

   (a) Heat capacity $Q = m c \Delta T$

   (b) Latent heat $Q = m L$

2. **Heat Transfer:**

   (a) Heat current $H = \frac{dQ}{dt}$

   (b) Conduction $H = \frac{k A \Delta T}{L}$

   (c) Convection $H = h A \Delta T$

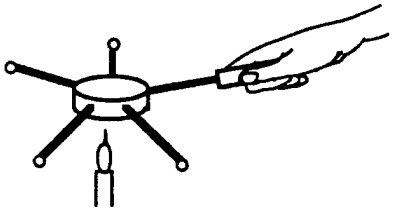
   (d) Radiation $H = A e \sigma T^4$

## CONCEPTS

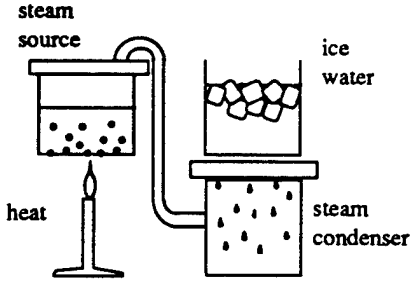
1. Explain the meaning of the following quantities associated with heat and describe how they are used: (a) calorie, (b) Btu, (c) heat capacity, (d) specific heat capacity, (e) molar heat capacity.
2. Explain the meaning of the following quantities associated with change of phase: (a) melting point, (b) boiling point, (c) heat of fusion, (d) heat of vaporization, (e) heat of sublimation, (f) heat of combustion.
3. Explain the meaning of the following quantities associated with heat transfer: (a) thermal conductivity, (b) temperature gradient, (c) thermal resistance, (d) convection coefficient, (e) emissivity, (f) Stefan-Boltzmann constant.

## PRACTICE

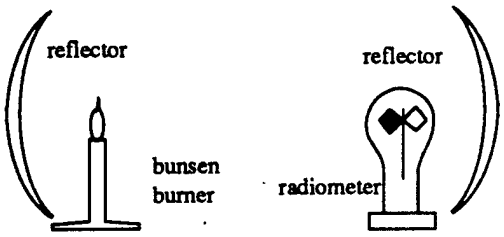
1. Set up a calorimeter and discuss how it could be used to determine the specific heat capacity of some material such as copper or the heat of fusion of something like ice. (a) What would you need to measure experimentally in each case? (b) How could you do this? (c) What conclusions could you expect to formulate?
2. Use the heat conductivity demonstrator shown at right to observe heat transfer by conduction. (a) How could this unit be used to take quantitative data? (b) What could you measure with such a set-up? (c) What conclusions could you formulate?



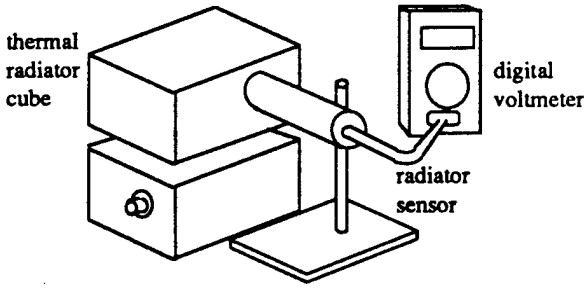
3. Set up the thermal conductivity apparatus shown below and explain how it could be used to measure the conductivity of various materials.

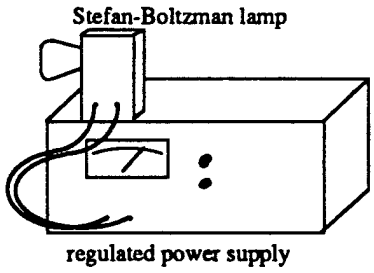


4. Demonstrate the phenomenon of heat transfer by radiation by using two parabolic reflectors as shown below. (a) How could this set-up be modified to take quantitative data? (b) What could you measure with such a set-up? (c) What conclusions could you formulate?




5. Set up the thermal radiation apparatus and explain how it could be used to study emissivity and the Stefan-Boltzmann law.




## DESIGN

Design an experiment to quantitatively study some aspect of calorimetry and/or heat transfer. Obtain guidance and approval from your lab instructor before setting up your experiment.

## SET-UP

After your design has been approved, set up your experiment and practice using the equipment to verify that everything is operating correctly.

## PERFORMANCE

Once you have verified that everything is functioning properly, perform your experiment, collect your data, do your analysis, formulate your conclusions, and prepare your report.

Experiment 13

# Thermodynamics

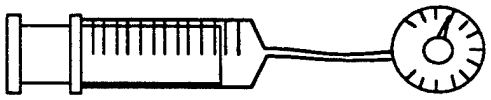
Thermodynamics is the study of the interactions between heat and other forms of energy. The equation of state of a substance specifies a relationship between its pressure, volume, and temperature. The simplest equation of state is that of an ideal gas.

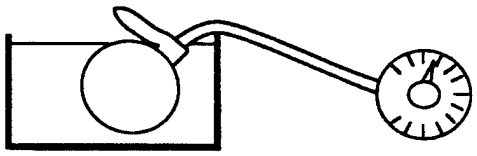
The first law of thermodynamics is a statement of the law of conservation of energy applied to a thermal system. The second law of thermodynamics is a statement of the law of probability that a system will naturally move toward increasing disorder. Entropy is a measure of that disorder.

These principles of thermodynamics can be used to predict a wide variety of phenomena (from the conditions under which clouds form to whether or not it is possible to build a 100% efficient gasoline engine). The **purpose** of this experiment is to study these principles and to explore their relationships with one another.

The **equipment** needed for this experiment includes: Boyle's law and absolute zero apparatus, Sterling engine, pT-apparatus, Gay-Lussac's law tube, Boyle's law apparatus, gas thermometer apparatus, mechanical equivalent of heat apparatus, steam engine with electric generator.

## OBSERVATION





1. Watch your instructor set up the Boyle's law apparatus shown at right and demonstrate its operation. Notice what happens to the pressure as the volume of the trapped air changes. Record the values of pressure as a function of volume at a constant temperature.
2. Watch your instructor replace the variable volume chamber with a constant volume chamber and immerse it in various temperature baths. Notice what happens to the pressure as the temperature changes. Record the values of pressure as a function of temperature at a constant volume.
3. Watch your instructor set up and operate the Sterling engine. (a) Is the engine self-starting or does it need a push? (b) Will it run backwards? (c) Does it run better when just started or when it warms up? (d) What happens as the heat source increases? Decreases? (e) What happens when the cooling fins get hot? Cool?

## ANALYSIS

1. **Basics:** (a) What basic thermodynamic phenomena are illustrated in the above observations? (b) Give examples of each of these phenomena occurring in nature. (c) Describe some practical applications of the principles associated with each of these phenomena.
2. **Boyle's Law:** (a) Plot a curve of pressure versus volume from the data in Observation 1. (b) Plot a curve of pressure versus the reciprocal of the volume. (c) Formulate conclusions.
3. **Pressure versus Temperature:** (a) Plot a curve of pressure versus temperature from the data in Observation 2. (b) At what temperature does this curve extrapolate to zero pressure? (c) Formulate conclusions.
4. **Equation of State:** (a) What would happen to the pressure if you doubled the number of moles of the gas keeping volume and temperature constant? Why must the result be the same as keeping the temperature and number of moles constant while compressing the volume to one-half? (b) By combining all of these results, deduce the equation of state for air. (c) Is air an ideal gas? (d) Reconcile your answers and formulate conclusions.
5. **Sterling Engine:** (a) What is the source of power for a Sterling engine? (b) Could it run on a cold source instead of a hot source? (c) Could the engine be used as a refrigerator? (d) How

could you measure the efficiency of this engine? (e) Would it be possible to build a more efficient engine than this one? (f) Could a heat engine be built with an efficiency approaching 100% ? Why?

## THEORY

1. **Ideal Gas Law:**

$$pV = nRT \qquad R = 8.314 \text{ J/mol·K}$$

$$m = nM$$

2. **First Law of Thermodynamics:**

$$dU = dQ - dW$$

$$dW = p\,dV$$

3. **Second Law of Thermodynamics:**

$$e = \frac{W_{out}}{Q_{in}}$$

$$e = \frac{T_H - T_C}{T_H}$$

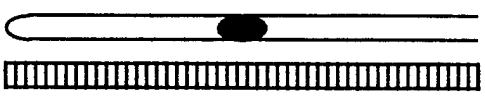
$$dS = \frac{dQ}{T}$$

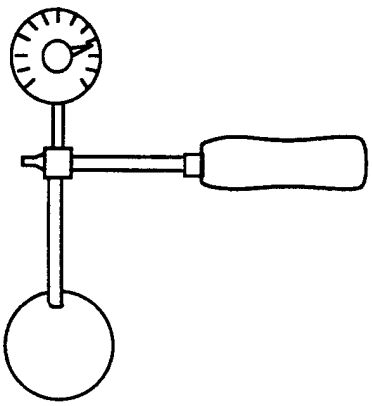
## CONCEPTS

1. Explain the meaning of the following quantities associated with the thermal properties of matter: (a) thermal equilibrium, (b) mole, (c) STP, (d) solid, (e) liquid, (f) vapor, (g) gas, (h) pV-diagram, (i) isotherm, (j) triple point, (k) critical point, (l) pVT-surface.
2. Explain the meaning of the following quantities associated with the first law of thermodynamics: (a) thermodynamic system, (b) path dependent work, (c) path dependent heat, (d) internal energy of a system, (e) adiabatic process, (f) isochronic process, (g) isobaric process, (h) isothermal process.
3. Under what conditions are the following equations valid: (a) $C_p = C_v + R$, (b) $\gamma = C_p/C_v$, (c) $p_1V_1^{\gamma} = p_2V_2^{\gamma}$.
4. Explain the meaning of the following quantities associated with the second law of thermodynamics: (a) reversible process, (b) irreversible process, (c) heat engine, (d) cyclic process, (e) thermal efficiency of a heat engine, (f) refrigerator, (g) Carnot cycle, (h) Sterling cycle, (i) entropy, (j) Kelvin temperature scale.

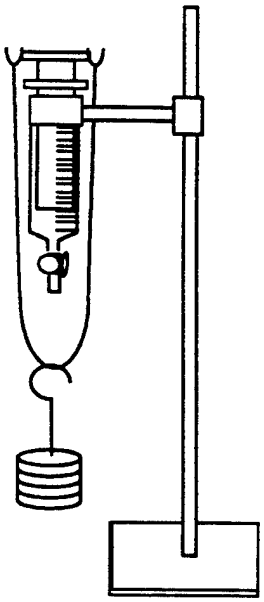
## PRACTICE

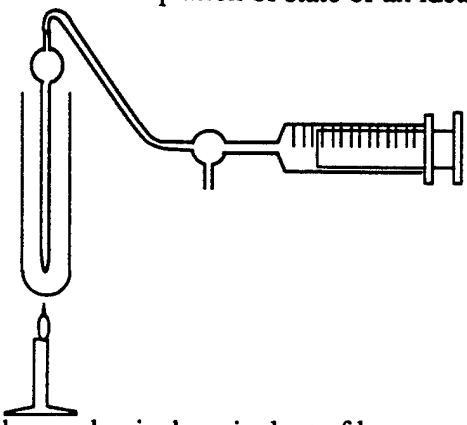
1. Set up the pT-apparatus and practice taking readings. How could this apparatus be used to determine the temperature of absolute zero?
2. Set up the Gay-Lussac's law tube as shown below and explain how it could be used to verify Gay-Lussac's law.



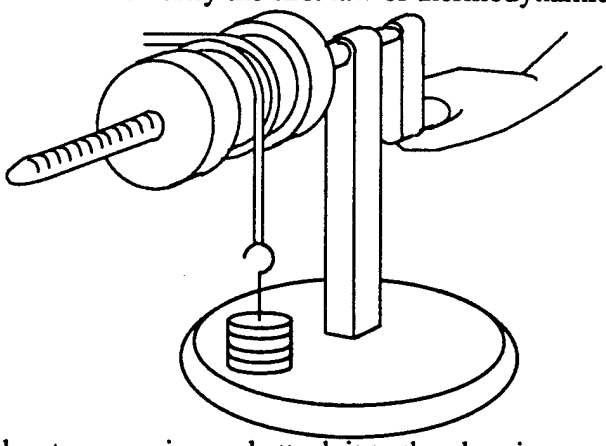


3. Set up the Boyle's law tube as shown to the right and explain how it could be used to verify Gay-Lussac's law.
4. Set up the gas thermometer apparatus and explain how it could be used to obtain the equation of state of an ideal gas.





5. Set up the mechanical equivalent of heat apparatus and explain how it could be used to verify the first law of thermodynamics.



6. Set up the steam engine and attach it to the electric generator. Explain how its efficiency could be measured and compared to the ideal Carnot efficiency.

**DESIGN**

Design an experiment to quantitatively study some aspect of thermodynamics. Obtain guidance and approval from your lab instructor before setting up your experiment.

**SET-UP**

After your design has been approved, set up your experiment and practice using the equipment to verify that everything is operating correctly.

**PERFORMANCE**

Once you have verified that everything is functioning properly, perform your experiment, collect your data, do your analysis, formulate your conclusions, and prepare your report.

Appendix 1

# Experimental Measurements

The foundation of all quantitative sciences is the ability to take and interpret experimental measurements. Because of errors and uncertainties in the measuring process, repeated experiments do not always yield exactly the same result. Statistical analysis may be used to help derive useful and meaningful information from such fluctuating data. The result of such analysis allows one to express experimentally measured quantities clearly and to interpret such expressions meaningfully.

The **purpose** of this experiment is to acquaint the student with the terminology and calculations required for properly expressing an experimentally measured quantity, to explore some of the statistical properties of measurement, and to help the students recognize both the implications and limitations of their measurements.

The **equipment** needed for this experiment includes: various meter sticks, a vernier caliper, micrometer caliper, protractor, mass balance, spring balance, graduated cylinder, small right circular cylinders of various metals, and a set of 10 to 25 standard dice.

## OBSERVATION

1. Use a meter stick to measure the surface area of a given table as accurately as possible. More specifically, each lab group should take one of the meter sticks, carefully measure the length and width of the surface, and calculate the area.
2. Tabulate the data for the class:

| Group Number | Meter stick Number | Length (m) | Width (m) | Area ($m^2$) |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

# CALIBRATION

## ANALYSIS

1. Notice the inconsistency in the measurements. Since everyone measured the same quantity as accurately as possible, why didn't everyone get the same value?
2. Notice the similarities and differences in the results. See if you can identify any patterns and/or relationships in the data. Does the data seem to clump into groups?
3. Compare the meter sticks with one another. Does the fact that they are not of the same length explain some of the discrepancies in your data? What should you do with your data now that you know your measuring instrument is wrong? Throw out the bad data? Re-measure the values with a good meter stick? Correct the data for its errors?

## THEORY

**Calibration** is the improvement of the **accuracy** of a measurement by eliminating the **systematic errors** which are responsible for the consistent differences between the **measured value** and the **true value**. It is accomplished by checking the measuring instrument against a

known **laboratory standard** and making whatever adjustments are necessary to obtain correct readings.

In general there are two ways to make such adjustments:

1. **Adjust the instrument** itself (so it reads correctly).
2. **Correct the readings** through calculations (to compensate for the defective instrument).

## CONCEPTS

1. Is it important to use calibrated instruments when making experimental measurements? What happens if you don't? How can you tell whether or not your instrument is calibrated? Can you always tell? What should you do if you can't tell? What should you do if you know it is not calibrated?

## PRACTICE

1. Quickly calibrate your meter stick and re-calculate the length, width, and area of the surface you measured. Correct the tabulated data and compare the results again.
2. Does calibrating the instruments remove all the discrepancies in the measurements? Why or why not?
3. Are all of the calibrated readings equally reliable? Which ones are most likely to be "correct"? Should you throw the others away? Is discarding data dishonest and likely to invalidate your results? How can you possibly justify throwing out any of your data?

# EXPERIMENTAL VALUE

## ANALYSIS

From your data, what would you say is the "correct" value for the area of the surface you measured experimentally? Is there any uncertainty in this value? About how much? How many significant figures should you retain in each of these values? Record your **estimated experimental value** $A_{est}$ in the spaces below:

$A_{est}$ = _____ ± _____ $m^2$.

## THEORY

The only way to improve the **precision** of a measurement is to reduce the **random errors** which cause the **measured value** to fluctuate about the **true value.**

In general there are three ways to do this:

1. Use **better instrumentation** (to make the readings more reliable).
2. Use **improved laboratory techniques** (to make more careful readings).
3. Take a large number of readings and use **statistical analysis** (to compensate for the fluctuations). In this case, the following mathematical definitions are useful:

   (a) The **mean value or average value** $\overline{V}$ of a set of N numbers $V_1, V_2, \ldots V_N$ is:

$$\overline{V} = \frac{\Sigma V}{N} = \frac{1}{N}\sum_{i=1}^{N} V_i = \frac{V_1 + V_2 + \cdots + V_N}{N}$$

   (b) The **mean squared value** $\overline{V^2}$ is:

$$\overline{V^2} = \frac{\sum V^2}{N} = \frac{V_1^2 + V_2^2 + \cdots + V_N^2}{N}$$

(c) The **tolerance** or **uncertainty** $\delta V$ of a measurement is:

$$\delta V = \sqrt{\frac{\overline{V^2} - \overline{V}^2}{N - 1}}$$

(d) The **percent tolerance** $\delta V\%$ is:

$$\delta V\% = \frac{\delta V}{\overline{V}} \times 100\%$$

(e) The **experimental value** V of a measurement is defined to be:

$$V = \overline{V} \pm \delta V = \overline{V} \pm (\delta V\%)$$

## CONCEPTS

1. When expressing an experimental value, only the "significant" digits should be retained. (a) Explain why only one (or at most two) digits should be retained in the tolerance. (b) Why should the mean value itself be rounded off to the same decimal place as the tolerance? (c) In general will the mean value and the tolerance of a measurement have the same number of significant digits?
2. Explain why the average value is the *best possible estimate* for the "correct" value of an experimental measurement.
3. Why is an experimental value incomplete without including the tolerance?
4. What is the advantage in using percent tolerance instead of the tolerance?
5. What is the difference between accuracy and precision? Between systematic errors and random errors? What should one do to reduce systematic errors? Random errors?
6. How would you define **probability**? How can it be predicted theoretically? How can it be measured experimentally? What is its minimum value? What is its maximum value? If p is the probability of something happening and q is the probability of it not happening, what is p + q?
7. What is the difference between a reading and a measurement?

## PRACTICE

1. Calculate the mean value and tolerance of your measurement of the surface area of the table and record your **calculated experimental value** in the space below:

   $A =$ _____ $\pm$ _____ $m^2$

2. What is the percent tolerance of your measurement?

   $\delta A\% =$ _____ %

3. Compare your calculated experimental value A above with your estimated experimental value $A_{est}$ obtained earlier. Which of the two is more precise? Which was easier to obtain? Is it worth the effort of calculating the experimental value rather than simply estimating it?
4. Some calculators automatically calculate the mean value and standard deviation of a set of entered values. The **standard deviation** $\sigma$ is defined to be: $\sigma = \sqrt{\frac{\sum(V - \overline{V})^2}{N - 1}}$. Show that the tolerance of our measurement can be obtained from this standard deviation through the equation: $\delta V = \frac{\sigma}{\sqrt{N}}$.

# EXPERIMENTAL EQUIVALENCY

## ANALYSIS

1. Compare your original reading $A_o$ for the area, your estimated mean value $\overline{A_{est}}$, and your calculated mean value $\overline{A}$. Are these three values equal to each other? Why not? Are they close to each other? How close? Are they experimentally equivalent? Why or why not? Could you form any experimentally valid conclusion based solely upon these numbers?
2. Compare your estimated experimental values $A_{est}$ with your calculated experimental value A. Are they experimentally equivalent? Could you form any experimentally valid conclusion based solely upon these results?

## THEORY

1. The **percent difference** %Diff between two quantities is defined to be:

   $$\%\text{Diff} = \frac{V_2 - V_1}{V_2} \times 100\% ,$$

   where $V_2$ is the **larger** of the two quantities and $V_1$ is the **smaller**.
2. It is impossible to determine the **true value** of any physical quantity because of the uncertainties of the measurement. However, the **error** between the true value and the measured mean value can be expressed in terms of probabilities. Specifically, about
   2/3 of the time the error will be less than the tolerance,
   95% of the time the error will be less than twice the tolerance, and
   99.7% of the time the error will be less than three times the tolerance.
   Therefore, two experimental values are essentially **equivalent** if their regions of uncertainty significantly overlap. Conversely, if two quantities differ by more than three times their tolerances, they almost certainly are **not** equivalent. If they differ by one or two times the tolerance, only tentative conclusions can be formulated (additional, higher precision experimentation really need to be made before any firm conclusions can be justified).

## CONCEPTS

1. What is the largest possible percent difference for an experimental measurement? What is the largest acceptable percent difference for a valid experimental conclusion? (In other words, can you form a valid conclusion based upon a percent difference of 1%? 10%? 100%? 1000%?)
2. **Percent error** is sometimes used to describe the accuracy of an experimental measurement. How would you define percent error? How is percent error related to percent difference? What is the maximum acceptable percent error for a valid experiment?
3. If the tolerances of two measurements are not equal, which one of the two tolerances should be used to determine whether or not the values are equivalent? Why?
4. What should you do if two experimental values differ by one or two times the tolerance and you do not have time to repeat the experiment to obtain higher precision?

## PRACTICE

1. What is the percent difference between your estimated average reading $\overline{A_{est}}$ and the calculated average value $\overline{A}$ of the surface you measured? Between your original value $A_o$ and your calculated average value?

   $\%\text{Diff}(A_{est} - \overline{A})$ = _____ %  $\%\text{Diff}(A_o - \overline{A})$ = _____ %

   Which, if any, of these are experimentally equivalent? What conclusions can you form in either case?
2. Compare your two experimental values $A_{est}$ and A. What conclusions can you form?

3. Compare your original value $A_o$ and your experimental value A. What conclusions can you form?
4. When making **calculations with experimental values**, there are two ways to determine the resulting tolerance. (a) The most accurate method consists of calculating the tolerance of the sum or difference through the equation $\delta(+,-) = \sqrt{\sum \delta^2}$ and the percent tolerance of the product or quotient through the equation $\delta\%(\times,/) = \sqrt{\sum \delta\%^2}$. (b) But a crude approximation to these tolerances can be obtained simply by adding the tolerances when taking the sum or difference between experimental values, and adding the percent tolerances when taking the product or quotient of experimental values.

   Use these equations to calculate the experimental value $A_{cal}$ of the area from the experimental values of your length and width. (You will have to think back and estimate the tolerances of the length and width of your original measurement if you did not include this information with that measurement.)

   L = _____ ± _____ m (± _____%)

   W = _____ ± _____ m (± _____%)

   $A_{cal}$ = _____ ± _____ $m^2$ (± _____%)

   Compare this calculated value $A_{cal}$ with that calculated earlier through statistical methods A. What conclusions can you draw?
5. Practice using the following instruments to measure the appropriate quantities until you are certain you can read the instruments properly.
   1. meter stick
   2. vernier caliper
   3. micrometer caliper
   4. protractor
   5. mass balance
   6. spring balance
   7. graduated cylinder

# EXPERIMENT

## DESIGN

Design an experiment to verify some aspects of the theory of measurement described previously. Clearly explain the PURPOSE and the PROCEDURE you intend to follow. Obtain the approval of your lab instructor before actually proceeding with the experiment.

The following illustrations are included to help stimulate your creativity:

1. **Statistics:**

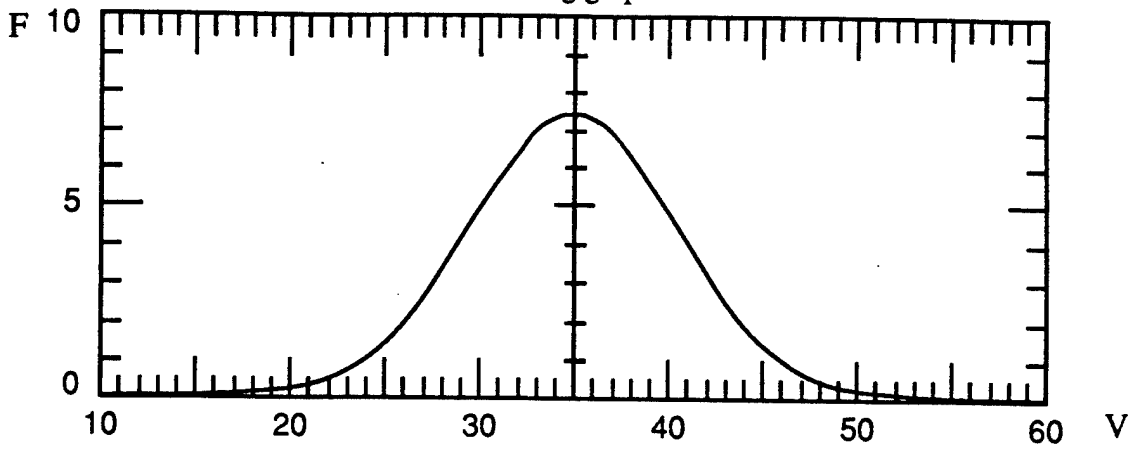
   Explore the statistical fluctuations of a random phenomenon by repeating a measurement many times and observing the scatter in the data. Appropriate phenomena might include the roll of a set of dice, background radiation, or any other digital measurement with significant fluctuations.

   For example:

   (a) The theoretical distribution of random scatter is given by the **normal distribution function** $F = \frac{N}{\sigma}\phi(x)$, where $\phi(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2}}$ is the **normal curve of error** (which may be looked up in a mathematics handbook), and $x = \frac{V - \overline{V}}{\sigma}$ is the **deviation** of each of the N readings V from the mean $\overline{V}$ in units of the standard deviation $\sigma$. The probability of obtaining a value V between two limits ($V_1$ and $V_2$) is the

corresponding area under the normal curve of error. In particular, the probability of obtaining readings which differ from the mean by one, two, and three standard deviations are 31.7%, 4.5%, and 0.2%, respectively.

(b) Show that if 10 dice are rolled 100 times then theoretically N = 100, $\overline{V}$ = 35, $\delta V$ = 0.54, $\sigma$ = 5.4, and F can be read from the following graph:




Theoretical frequency F versus value V rolled for 10 dice in 100 rolls.

(c) Roll a set of 10 dice 100 times. Record the values rolled. Calculate the mean value, tolerance, and standard deviation of this data. Compare your experimental results with the theoretical predictions.

(d) Count how many of your readings fall outside of one, two, and three times the standard deviation. How do these numbers compare with the theoretical probabilities?

(e) Plot a histogram of your data. On the same graph as your histogram plot the smooth curve of the normal distribution function shown above. Compare the two curves and explain any discrepancies.

(f) Formulate your final conclusions.

2. **Loaded Dice:**

Determine experimentally whether or not a set of regular dice are "loaded" by rolling them a large number of times and analyzing the result. More specifically:

(a) Prove theoretically that if a true die (non-loaded die) is rolled six times, the mean value should be 3.5, the tolerance should be 0.76376, and the standard deviation should be 1.8708. Therefore the tolerance of 2500 rolls of the dice should be 0.0374 (and the tolerance of 10000 rolls should be 0.0187)

(b) Roll a set of 25 dice 100 times (or a set of 100 dice 100 times) and record each reading.

(c) Notice the scatter in your data and calculate the average value and tolerance for the roll of 25 dice (or 100 dice). Use this information to calculate the average value and tolerance for the roll of a single die and compare your result with the theoretical predictions.

(d) Formulate your final conclusions based upon your results.

3. **Pi:**

Suppose someone developed a theory which predicted that the value of $\pi$ was exactly 22/7 and you wanted to test that theory experimentally. Design an experiment to do just that. Specifically:

(a) Show that a precision of better than 0.1% is required to distinguish between $\pi$ = 3.1415926 and 22/7.

(b) Devise a method of measuring the circumference and diameter of a circle to within about one part in a thousand and use this information to calculate $\pi$. Repeat the measurement enough times to calculate an experimental value of $\pi$ adequate to formulate a valid conclusion.

4. **Densities:**

Measure the densities of several materials using various methods and compare the result with each other and with the accepted values.

(a) DIRECT MEASUREMENT: Measure the mass, length, and diameter of several small right circular cylinders and calculate the densities of the material from which they are made.

(b) DISPLACEMENT METHOD: Use a graduated cylinder filled with water to determine the volume displaced by each mass and calculate the densities.

(c) SPECIFIC GRAVITIES: Weigh each of the objects in air and in water, calculate their specific gravities, and use this information to calculate their densities.

(d) Look up the accepted densities for each material and compare it with each of your measurements. What conclusions can you draw?

## SET-UP

After obtaining the approval of your laboratory instructor to perform the experiment you designed, utilize the equipment available in the laboratory to set up the experiment.

In the process of setting up the experiment you will have to take some preliminary data and do some preliminary analysis to make certain that the setup is functioning as intended. Failure to do this may result in your having to repeat the whole experiment because of worthless data.

As you are checking out the setup, you may find it necessary to make adjustments which you did not originally anticipate. (You may even have to go back and redesign certain aspects of your original experiment.) This is all part of the scientific method of investigation.

Experience such as this is also the only way to improve one's experimental technique and to gain a feel for what actually happens in the real world.

## PERFORMANCE

Once you have finished setting up your equipment and verified that everything is functioning as intended, proceed with the actual performance of the experiment you designed.

Remember to keep an open mind as the experiment is progressing to see for yourself how the theory does or does not correlate with the real world. Again, if circumstances warrant it, you should adjust and/or modify your experiment as necessary. If something totally unexpected occurs, you may even have to decide whether to continue on your original experimental course of action or to pursue a new course in the direction indicated by your new experience.

As you accumulate more data, begin your analysis, and formulate your conclusions, you may notice that you are actually continuing along your own personal path around the scientific cycle of investigation. How far you continue depends upon your interests, your time and your lab instructor. Eventually, of course, as you begin to master the material, you will have to break the cycle and finalize everything. This is accomplished by assimilating all that you have learned about the phenomenon and arranging it into an informative report of some kind.

Your lab instructor will explain the type of report expected from you for this experiment.

Appendix 2

# Graphical Analysis

Appendix 1 considered the experimental measurement of a quantity whose value remained constant, but there are many physical phenomena that relate quantities that vary with one another. One of the most powerful tools for analyzing the relationship between two variables is to plot them graphically. When done properly considerable information can be obtained from the plot and valid conclusions can be drawn.

The **purpose** of this experiment is to acquaint the student with the techniques, terminology, and calculations required properly to plot and analyze graphical data.

The **equipment** needed for this experiment includes: graph paper, meter stick, set of masses, spring, mass balance, spring balance.

## OBSERVATION

1. Determine the relationship between the elongation x of a spring and the force F used to stretch the spring by suspending various masses m and measuring the resulting lengths L of the spring. Record (a) the length L of the spring and (b) the mass m required to stretch it in the table below:

| Reading | m (kg) | L (m) | $F = m g$ (N) | $x = L - L_o$ (m) | $k = F/x$ (N/m) |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |

## ANALYSIS

1. Determine the force stretching the spring by calculating the weight of each suspended mass through the equation $F = w = m g$ and record that value in your table. ($g = 9.8$ m/s$^2$)
2. Subtract the original length $L_o$ from each length L to obtain the elongation $x = L - L_o$ and record these values in your table.
3. Determine the ratio of the force per unit elongation $k = F/x$ for each case and list that value in the table. Is k a constant? What is its experimental value? (See Appendix 1.)

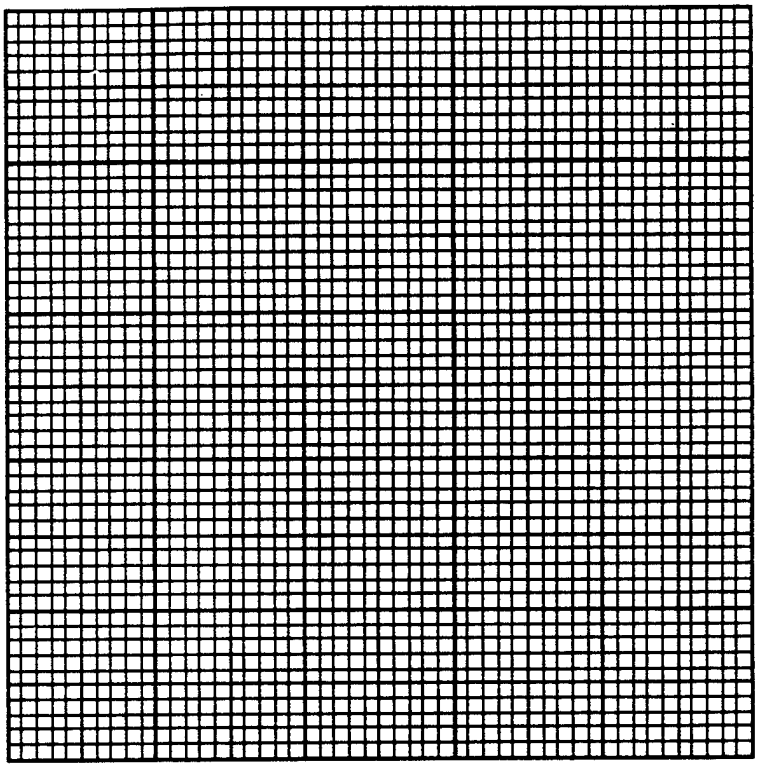
k = _____ ± _____ N/m.

4. Plot a graph of F versus x on the graph to the right. (a) Select convenient units to fill most of the graph. (b) Draw a smooth curve through the data points. (c) Is it a straight line? (d) Does it go through the origin? (e) What is its slope?

slope =

_____ N/m

(f) How does this slopes compare with the value of k obtained previously?

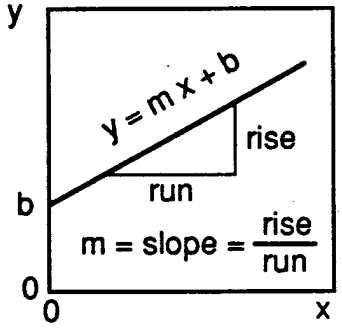



## THEORY

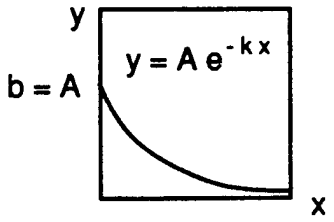
1. The general equation of a **straight line** is:

   $y = m x + b$ ,

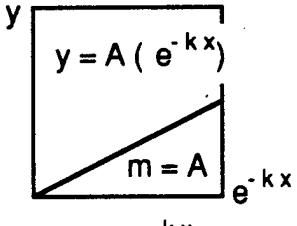
   where y is the **dependent variable**, x the **independent variable**, m the **slope**, and b the **y-intercept**. The graph of this curve is illustrated at the right.



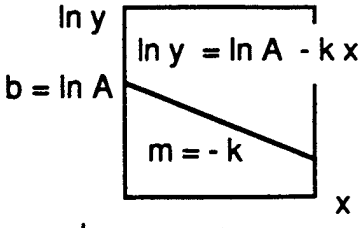

2. Any relationship between two variables can be converted to **linear form** by a proper conversion of the variables. (For example, the exponential relationship $y = A e^{-kx}$ can be made linear by plotting either y versus $e^{-kx}$ or ln y versus x rather than y versus x.)




y versus x




y versus $e^{-kx}$




ln y versus x

The last of these curves is the most useful because it allows both A and k to be determined directly from the graph. (The first curve is non-linear and allows only A to be read. The second curve also allows only A to be determined and even requires a knowledge of k before it can be constructed.)

3. **Hook's Law** states that :

   $F = k x$ ,

where F is the force stretching a spring, $x = L - L_o$ is the elongation of the spring, L is the length of the spring, $L_o$ the unstretched length of the spring, and k is the spring constant.

## CONCEPTS

1. What two constants can be determined directly from a plot of a straight line? How are each of these determined?
2. Consider two variables y and x whose relationship is to be determined experimentally. When plotted as y versus x, the curve obviously is not linear, but when plotted as log y versus x, the curve appears to be a straight line. (a) Which of the two plots better depicts the relationship between the variables? (b) Which of the two better allows us to compare any deviation between observation and theory? (c) Which better allows us to deduce an equation that best fits the data? (d) Which of the two plots is generally the most useful analytically?
3. (a) Is Hook's Law a linear relationship? If not, make it linear. (b) What is the slope? (c) What is the y-intercept?

## PRACTICE

1. Convert each of the following equations into a linear form and identify the slope and y-intercept in each case:

   (a). $x = A \cos \omega t$ , (variables are x and t).

   (b). $L - L_o = \alpha (T - T_o)$ , (variables are L and T).

   (c). $\omega = \sqrt{\frac{g}{L}}$, (variables are L and $\omega$)

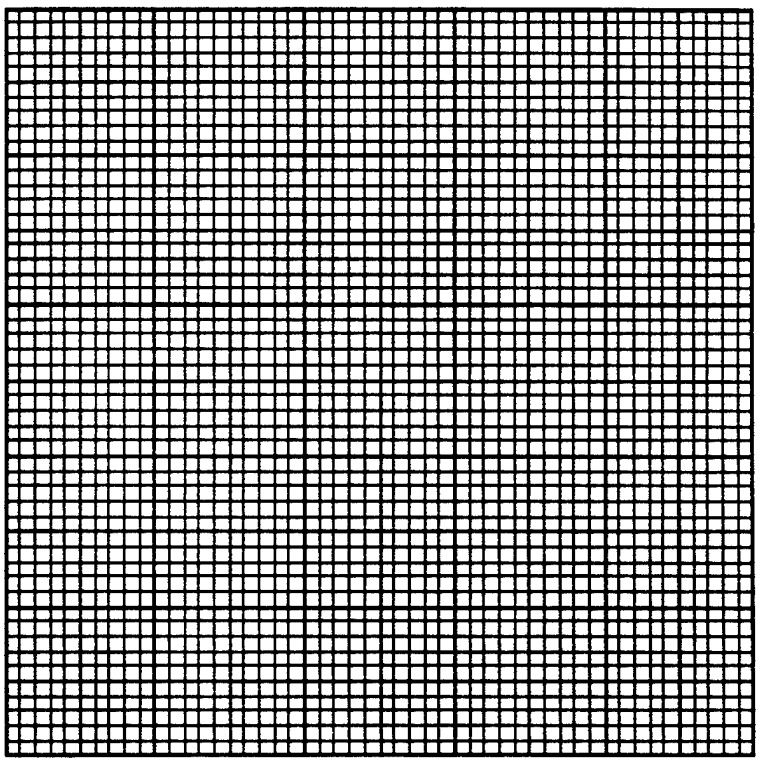
   (d). $x = x_o + v_o t + \frac{1}{2} a t^2$, (variables are x and t).

2. Use Hook's Law to find the theoretical relationship between the force F and the length L of a spring. Solve this equation for L in terms of F. Is this relationship linear? What is the slope? What is the y-intercept?

3. Plot a curve of L versus F for the spring you used in the laboratory. From this curve determine the spring constant k and the unstretched length $L_o$ of the spring. Estimate the uncertainties in each of these values and record the results below:

   k = _____ ± _____ N/m

   $L_o$ = _____ ± _____ m .



Compare these results with those obtained previously and formulate conclusions. Which values of k and $L_o$ are most reliable? Why?

## DESIGN

Design an experiment to verify some aspects of the theory of measurement described previously. Clearly explain the PURPOSE and the PROCEDURE you intend to follow. Obtain the approval of your lab instructor before actually proceeding with the experiment.

The following illustrations are included to help stimulate your creativity:

1. **Mass -Weight Conversion:**

   According to Newtonian Mechanics the conversion factor between mass and weight should be equal to the acceleration of gravity. A student decides to test this theory by using a spring balance to determine the weights (in Newtons) of several know masses (in kilograms). From this data he/she calculates the conversion factor and compares the result with the accepted value of g.

2. **Period of a Pendulum:**

   Determine experimentally the relationship between the length L and the period $\tau$ of a simple pendulum.

   (a) Accurately measure the length and period of a pendulum for several different lengths.

   (b) Plot a graph of t versus L, t versus $L^2$, L versus $t^2$, and any other curve that might seem likely to render a straight line.

   (c) From your curves, determine an **empirical equation** that relates the length and period. (An empirical equation is an equation that is determined purely through experimentation without considering any theoretical cause and effect.)

   (d) Now do some research on the simple pendulum and derive a **theoretical equation** that relates the length and period. (A theoretical equation is an equation derived from clearly defined, basic assumptions regarding the situation.) Are the theoretical and empirical equations the same?

   (e) By comparing theory with experiment, determine an experimental value for the acceleration g due to gravity.

   (f) Formulate whatever conclusions seem appropriate.

## SET-UP

After obtaining the approval of your laboratory instructor to perform the experiment you designed, utilize the equipment available in the laboratory to set up the experiment.

In the process of setting up the experiment you will have to take some preliminary data and do some preliminary analysis to make certain that the setup is functioning as intended. Failure to do this may result in your having to repeat the whole experiment because of worthless data.

As you are checking out the setup, you may find it necessary to make adjustments which you did not originally anticipate. (You may even have to go back and redesign certain aspects of your original experiment.) This is all part of the scientific method of investigation.

Experience such as this is also the only way to improve one's experimental technique and to gain a feel for what actually happens in the real world.

## PERFORMANCE

Once you have finished setting up your equipment and verified that everything is functioning as intended, proceed with the actual performance of the experiment you designed.

Remember to keep an open mind as the experiment is progressing to see for yourself how the theory does or does not correlate with the real world. Again, if circumstances warrant it, you should adjust and/or modify your experiment as necessary. If something totally unexpected occurs, you may even have to decide whether to continue on your original experimental course of action or to pursue a new course in the direction indicated by your new experience.

As you accumulate more data, begin your analysis, and formulate your conclusions, you may notice that you are actually continuing along your own personal path around the scientific cycle of investigation. How far you continue depends upon your interests, your time and your lab instructor. Eventually, of course, as you begin to master the material, you will have to break the cycle and finalize everything. This is accomplished by assimilating all that you have learned about the phenomenon and arranging it into an informative report of some kind.

Your lab instructor will explain the type of report expected from you for this experiment.

Appendix 3

# Prerequisite Review

This appendix is designed to be used in an eight-hour review course to strengthen the background of students who are weak in the prerequisites for Physics 104/231 at Texas A&I University. It assumes that the student has already met the legal prerequisites for the course by having previously passes (a) MTH 108 College Algebra, (b) MTH 131 Trigonometry, (c) MTH 133 Analytic Geometry and (d) PHY 111 Elementary Physics, and (in the case of PHY 231) being currently enrolled in (e) MTH 205 Calculus I. Any student failing to meet these legal prerequisites (or their equivalents at some other school) should drop this course immediately and complete the prerequisites before enrolling in this course.

The material covered in this manual quickly reviews what the student should already know and briefly summarizes those aspects of the prerequisites that are essential for understanding the material presented in PHY 104/231 and for working the numerous problems assigned in that course. It is hoped that this brief review of the prerequisites will provide the working knowledge needed to begin PHY 104/231 with a reasonable chance of passing it.

# 1. Algebra

Algebra is the mathematics of symbols which are used to represent numbers. The primary advantage of algebra over arithmetic is that it allows us to express relationships between quantities even when the actual values of some or all of those quantities are completely unknown. Furthermore, it allows us to do this in a compact manner and lets us explore those relationships in a manner independent of the values of the variables.

## EVALUATING EQUATIONS

In order to be useful in the practical sense, algebraic expressions must eventually be evaluated by substituting the appropriate numerical values into the equations and carrying out the indicated arithmetic operations.

**Addition** and **subtraction** are represented the same way in algebra as they are in arithmetic (i.e. by + and -, respectively). When evaluating such expressions, like signs add and unlike signs subtract (with the result taking on the sign of the larger quantity).

**Multiplication** is represented by writing quantities adjacent to one another.(Only rarely is the multiplication sign x used in algebra.) **Division** is indicated the same way as in arithmetic (by / or by writing the numerator over the denominator in the form of a fraction). When evaluating such expressions, the product and quotient of like signs is positive and of unlike signs is negative.

**Exponents** are used to indicate how many times a quantity is multiplied by itself. It obeys the following rules:

$a^3 = aaa = a \times a \times a$

$a^2 = aa = a \times a$

$a^1 = a$

$a^0 = 1$

$a^{-1} = 1/a = \frac{1}{a}$

$a^{-2} = 1/a^2 = \frac{1}{a^2}$

$(ab)^n = a^n b^n$

$(a^n)^m = a^{nm}$

$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n} = a^n b^{-n}$

$\sqrt[m]{a^n} = (a^n)^{1/m} = a^{n/m}$

In an algebraic expression, exponentiation is performed before multiplication or division which are performed before addition or subtraction. Parenthesis are used to alter this normal order of things and indicate that those operations within the parenthesis are to be performed before those outside the parenthesis.

1.1. Evaluate the expression $w = 2(x + y) - 3\left(\frac{y^2 - z}{x}\right)$, where $x = 2$, $y = 4$, and $z = -5$.

1.2. Evaluate the expression $w = \frac{xy}{x + y} - (x - y)\,x^3$, where $x = -2$ and $y = 3$.

## SOLVING SINGLE EQUATIONS

The secret to solving algebraic equations is to **manipulate the equations** (a) by replacing an expression with its equivalent or (b) by doing the same thing to both sides of the equation. The objective of the manipulation is to eventually express the unknown quantity on one side of the equation with everything else on the other side. Examples of common manipulation are illustrated below:

| | |
|---|---|
| Original Expression | $\frac{3}{2x - 1} = \frac{4}{x + 2}$ |
| Gross Multiply | $3(x + 2) = 4(2x - 1)$ |
| Expand | $3x + 6 = 8x - 4$ |
| Transpose | $3x - 8x = -6 - 4$ |
| Contract | $-5x = -10$ |
| Divide | $x = \frac{-10}{-5}$ |
| Answer | $x = 2$ |

1.3. Solve the equation $\frac{8x - 1}{2} = 3x$ for x.

1.4. Solve the equation $\frac{4A - 3}{1 - A} = \frac{1}{2}$ for A.

1.5. Solve the equation $2z^3 + 54 = 0$ for z.

1.6. Solve the equation $2x\sqrt{2x} = 8$ for x.

1.7. Solve the equation $c = \frac{a + b}{a - b}$ for a.

1.8. Solve the equation $\frac{18}{p} = \frac{2}{p^3}$ for p.

1.9. Solve the equation $(a\,b)^3 \left(\frac{b^2}{a^3}\right)^2 = 1$ for a.

1.10. Solve the equation $\omega^2 x^2 + v^2 = \omega^2 A^2$ for v.

The **Quadratic Equation** is a useful tool for solving equations of the form

$$A x^2 + B x + C = 0.$$

The solution is

$$x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}.$$

1.11. Solve the equation $x^2 - 10x + 21 = 0$ for x.

1.12. Solve the equation $x = x_o + v_o t + \frac{1}{2} a t^2$ for t when x = 57 ft, $x_o$ = 9 ft, $v_o$ = 64 ft/s, and a = - 32 ft/s$^2$.

## SOLVING SIMULTANEOUS EQUATIONS

Most problems in physics require the simultaneous solution of several equations with several unknowns. Most of the time it is possible to **solve one equation at a time** for the numerical answer and substitute the result into the other equations until all are solved.

1.13. Solve the following set of equations for each variable.

$p_1 = p_2$ $\qquad$ $m_1 = .005$ kg

$p_1 = m_1 v_1$ $\qquad$ $m_2 = 3$ kg

$p_2 = m v_2$ $\qquad$ $\mu = 0.2$

$m = m_1 + m_2$ $\qquad$ $x = 0.25$ m

$E_2 = W$

$E_2 = 1/2\ m V_2$

$W = f x$

$f = \mu N$

$N = w$

$w = m g$

At other times it is necessary to solve the equations one at a time **algebraically** and **substitute** into the remaining equations until all are solved.

1.14. Solve the following set of equations for each variable.

$$A + B = 100$$

$$A / B = 2/3$$

And finally, there are times when using **determinants** is the easiest way to solve simultaneous equations.

1.15. Solve the following set of equations for each variable.

$$3x - y + z = 0$$

$$y - z = 10$$

$$2x + 3z = 2$$

## SOLVING WORD PROBLEMS

The secret to solving word problems is (1) to read the problem, (2) to list the given quantities, (3) define symbols to represent each of the unknowns, (4) to translate the words into algebraic equations, and (5) to solve the equation simultaneously.

1.16. If a hen and a half lays an egg and a half in a day and a half, how long does it take 2 hens to lay 8 eggs?

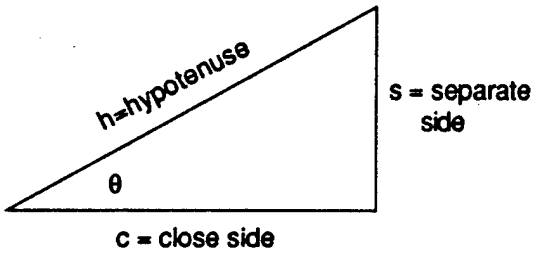
1.17. Bob can run 20% faster than Tom . If Tom get a 20 ft head start and Bob overtakes him in 10 seconds, how far does Bob have to run?

# 2. Trigonometry

Trigonometry is the mathematics of right triangles and their relationships. Since any geometrical shape, in principle can be constructed from right triangles, trigonometry is a useful tool for calculating and representing many geometrical and physical phenomena.

## TRIGONOMETRIC FUNCTIONS

The three most important trigonometric functions along with the Pythagorean theorem are defined below for an arbitrary right triangle in terms of one of its interior angles:



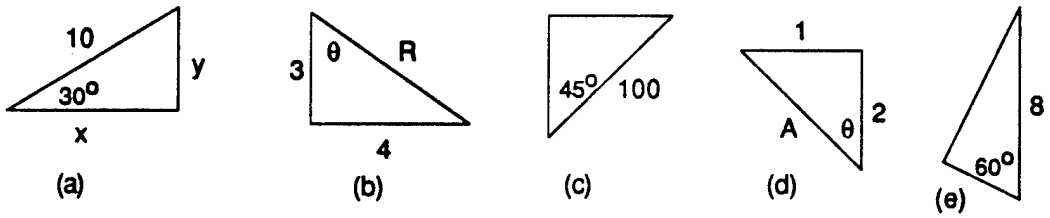

$$\sin\theta = \frac{s}{h}$$

$$\cos\theta = \frac{c}{h}$$

$$\tan\theta = \frac{s}{c}$$

$$h^2 = s^2 + c^2$$

2.1. Find the unknown quantities in each of the triangles shown below.




## TRIGONOMETRIC IDENTITIES

Some of the more important trigonometric identities are listed below:

$$\sin^2\theta + \cos^2\theta = 1$$

$$\sin(\alpha+\beta) = \sin\alpha\cos\beta + \cos\alpha\sin\beta$$

$$\cos(\alpha+\beta) = \cos\alpha\cos\beta - \sin\alpha\sin\beta$$

2.2 Prove the following trigonometry identities.

(a) $\sin 2\theta = 2 \sin\theta \cos\theta$

(b) $\cos 2\theta = \cos^2\theta - \sin^2\theta$

(c) $\cos^2\theta = \frac{1}{2}(1 + \cos 2\theta)$

2.3 Find (a) $\sin(120^o)$, (b) $\cos(-30^o)$, (c) $\tan(135^o)$, (d) $\sin^{-1}(-.5)$, (e) $\cos^{-1}(-.8)$, (f) $\tan^{-1}(-1)$.

2.3 Plot graphs of (a) $\sin\theta$ versus $\theta$, (b) $\cos\theta$ versus $\theta$, (c) $\tan\theta$ versus $\theta$, for $-360^o < \theta < +360^o$.

2.4 Solve the following set of equations for each unknown.

$f = w \sin\theta$

$N = w \cos\theta$

$f = \mu N$

$w = m g$

$m = 10\ kg$

$g = 9.8\ m/s^2$

$\mu = 0.3$

2.5 Solve the following set of equations for each unknown.

$m_1 v_o = m_o v_1 \cos\theta_1 + m_2 v_2 \cos\theta_2$

$m_1 v_1 \sin\theta_1 = m_2 v_2 \sin\theta_2$

$m_1 = 2\ kg$

$m_2 = 3\ kg$

$v_o = 1.25\ m/s$

$v_1 = 1\ m/s$

$\theta_1 = 37^o$

# 3. Calculus

Calculus is the mathematics of changing variables. It is extremely useful in describing relationships between changing variables and the consequences of those changes.

**DERIVATIVES**

The rate of change of one variable with respect to another is called the derivative and is defined below:

$$y = f(x)$$

$$\frac{dy}{dx} = \lim_{\Delta x \to 0} \frac{\Delta y}{\Delta x} = \lim_{\Delta x \to 0} \frac{f(x + \Delta x) - f(x)}{\Delta x}$$

3.1 Find the derivative of each of the following functions.

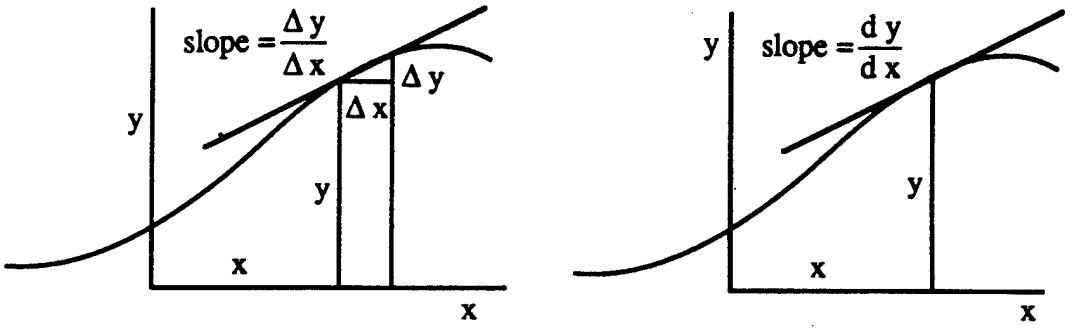
(a) $y = 3x$

(b) $y = x^2$

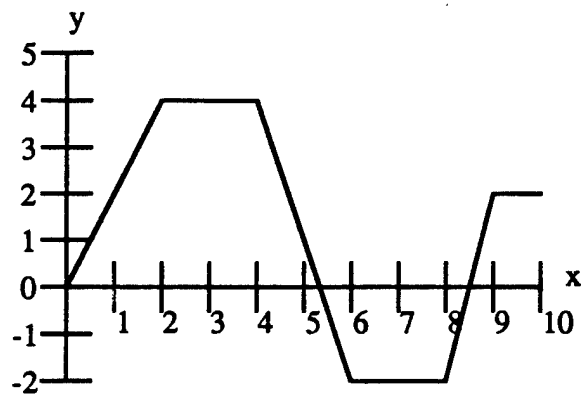
(c) $y = 2x^3$

(d) $y = y_o = \text{const.}$

Graphically, the derivative is represented by the slope of the curve at a given point.




3.2 Determine the derivative of y with respect to x for the following curve at x = 1, 3, 5, 7, and 9.




The derivative of a variable raised to any power is given by the following rule:

$y = c\,x^n$

$$\frac{dy}{dx} = n\,c\,x^{n-1}$$

3.3 Find the derivative of each of the following functions.

(a) $y = 2x^5$

(b) $y = -3x^{-3}$

(c) $y = \sqrt{x}$

The derivative of a sum of terms is the sum of the derivatives.

3.4 Find the derivative of each of each of the following functions.

(a) $y = 3x^2 + 2x^3 + 5$

(b) $y = x/3 - 3/x$

(c) $x = x_0 + v_0t + \frac{1}{2}at^2$

3.5 The derivative of the derivative is called the second derivative $\left(\frac{d\left(\frac{dy}{dx}\right)}{dx} = \frac{d^2y}{dx^2}\right)$, etc. Find the fourth derivative of each of the following functions.

(a) $y = A + Bx + Cx^2 + Dx^3 + Ex^4 + Fx^5$

(b) $y = x^{-1} + x^{3/2}$

3.6 The derivative of sin θ is cos θ and the derivative of cos θ is - sin θ (when θ is expressed in units of radians). What is the second derivative of $y = A \sin \theta + B \cos \theta$ with respect to θ ?

3.7 The derivative of a function of a function is obtained by the chain rule

$$\frac{dz}{dx} = \frac{dz}{dy}\frac{dy}{dx}$$

Find the derivative of each of the following.

(a) $z = (1 + x^3)^5$

(b) $y = \sqrt{r^2 - x^2}$

(c) $x = A \cos(\omega t + \theta)$

## INTEGRATION

Integration is the inverse of taking the derivative. If the derivative of z is y, the the integral of y is z. This is symbolized as follows:

For $y = \frac{dz}{dx}$

then $dz = y\,dx$

and $z = \int dz = \int y\,dx$ .

Because the derivative of a constant is zero, integrations always introduces an unknown, arbitrary constant.

3.8 (a) Show that both $z = x^3 + 5$ and $z_2 = x^3 - 5$ have the same derivative. (b) What is the integral of $y = 3x^2$?

3.9 Integrate each of the following functions.

(a) $y = x$

(b) $y = K + 3x^2$

(c) $y = ax^n$

(d) $y = \sqrt{x}$

(e) $y = A \sin x + B \cos X$

The constant of integration may be evaluated by evaluating the result under specified boundary conditions.

3.10 Given the fact that $v = v_0$ when $t = 0$, integrate $a = \frac{dv}{dt} = b\,t$ to find the equation for v at any time.

Another way to evaluate the constant of integration is through the definite integral illustrated below:

For $z = z(x) = \int y\,dx$

then $\int_{x_1}^{x_2} ydx = z(x) = z(x_2) - z(x_1)$

3.11 Solve problem 3.9 using the definite integral.

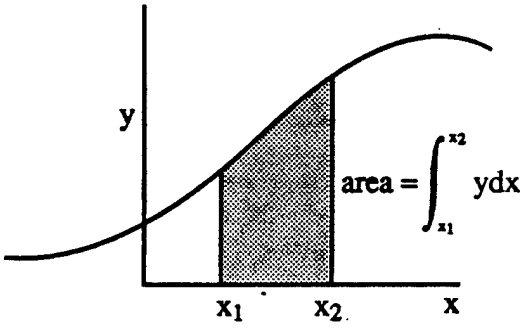
3.12 Evaluate each of the following integrals.

(a) $y = \int_0^1 x^2\,dx$

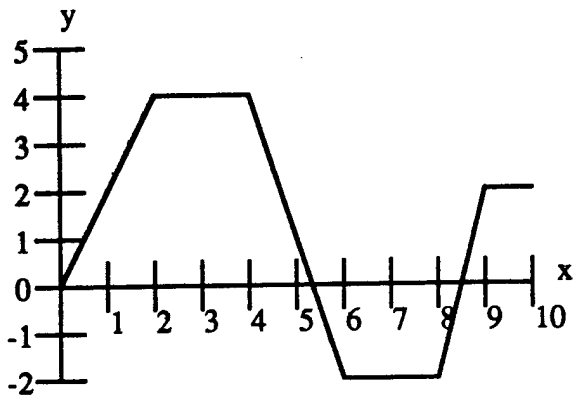
(b) $z = \int_0^{\pi} A \sin\theta\,d\theta$

(c) $x = \int_0^t (v_0 + at)\,dt$

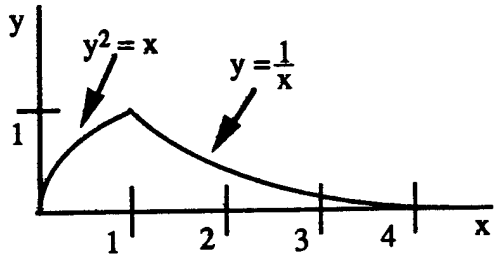
Graphically, the integral is represented by the area under a curve.



3.13 Find the integral of the function plotted below from x = 0 to x = 2, 4, 6, 8, 10.




3.14 Find the area under the curve illustrated below:




# 4. Physics

Physics is the study of the most fundamental phenomena of nature. It is the foundation of all other science and all branches of engineering.

## EXPRESSING PHYSICAL QUANTITIES

All physical quantities are expressed in terms of some unit of measurement. These units must be included in the specification of that quantity and may be treated in algebraic expression as normal algebraic symbols.

4.1 Solve the following set of equations for each unknown quantity and show that the units work out.

| | |
|---|---|
| $P = \frac{E}{t}$ | m = 100 kg |
| E = mgy | g = 9.8 m/s$^2$ |
| y = L sin 37$^o$ | L = 10 m |
| L = vt | v = 2 m/s |

To convert from one set of units to another, all one has to do is multiply or divide by the appropriate conversion factor.

4.2 (a) One mile contains how many feet. Write this as an equation. (b) What is the conversion factor between feet and miles? (c) How many feet are in 0.4 miles? (d) How many miles is 10,000 ft ?

4.3 (a) Convert 60 mi/hr to ft/s.

(b) Convert 100 $cm^2$ to $m^2$.

(c) How many seconds are in a year ?

4.4 The metric system of units uses prefixes to indicate multiples of 10. Complete the following table:

| Symbol | Prefix | Power | Example | | |
|---|---|---|---|---|---|
| | tera - | $10^{12}$ | 1 TJ | = | = $10^{12}$ Joules |
| | giga - | $10^{9}$ | 1 GW | = | = |
| | mega - | $10^{6}$ | 1 MΩ | = | = Ohms |
| k | | 103 | | = kilograms | = |
| | centi - | $10^{-2}$ | | = | = $10^{-2}$ meters |
| m | | $10^{-3}$ | | = milliamperes | = |
| μ | | $10^{-6}$ | | = microcolumb | = |
| | nano - | $10^{-9}$ | | = | = $10^{-9}$ seconds |
| | pico - | $10^{-12}$ | 1pF | = | = Farad |

4.5 When expressing a physical quantity, the number should be rounded off to eliminate the uncertain digits. The remaining digits are said to be significant. How many significant digits are contained in each of the following numbers?
(a) 4.056 kg
(b) .0021 m
(c) 12,000 ft.

4.6 Round off the following numbers to 3 decimals places:
(a) 12.4937 N
(b) .001605 J
(c) 9200 lb

4.7 Scientific notation is used to eliminate the ambiguity of the significance of trailing zeros and to express very large and very small numbers. Express each of the following numbers in decimal notation (a) $1.602 \times 10^{-19}$ C, (b) $1.013 \times 10^{5}$ Pa. Express each of the following in scientific notation. (c) .000000130 m, (d) 9,807,000,000 mi.

## GEOMETRY

Listed below are several geometrical relationships which are frequently used in physical applications.

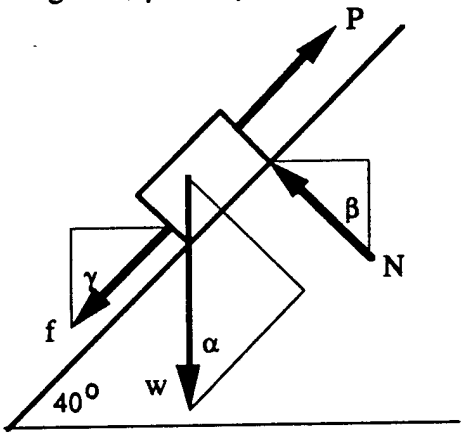
| | |
|---|---|
| Diameter of a circle | $D = 2r$ |
| Circumference of a circle | $C = 2\pi r$ |
| Area of a rectangle | $A = LW$ |
| Area of a triangle | $A = \frac{1}{2} bh$ |
| Area of a circle | $A = \pi r^2$ |

| | |
|---|---|
| Area of a sphere | $A = 4\pi r^2$ |
| Volume of a rectangular solid | $V = LWH$ |
| Volume of a cylinder | $V = \pi r^2 h$ |
| Volume of a sphere | $V = \frac{4}{3}\pi r^3$ |

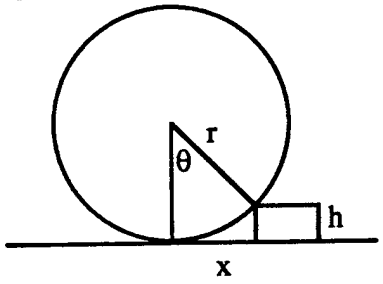
4.8 What fraction of the volume of a cube is contained in an inscribed sphere?

4.9 How many feet of wall paper 1.5 ft wide would be needed to completely cover the top and sides of a drum 6 ft high and 6 ft in diameter.

4.10 What are the values of the angles $\alpha$, $\beta$, and $\gamma$ in the figure below.




4.11 What is the distance x and angle $\theta$ in the figure below, if h = 2 cm and r = 10 cm?




## KINEMATICS

Kinematics is the study of motion. Some important kinematics equation for linear motion are:

| | |
|---|---|
| Constant velocity | $x = vt$ |
| Constant acceleration (starting from rest) | $x = \frac{1}{2}at^2$ |
| | $v = at$ |

4.12 A truck moving at 40 ft/s passes an automobile initially at rest. (a) How long will it take the car to overtake the truck if it accelerates at 10 ft/s$^2$ immediately after being passed? (b) How fast will the car be moving when it catches the truck?

## DYNAMICS

Dynamics is the study of how forces affect the motion of particles. Some important kinematic equation for linear motion are:

| | |
|---|---|
| Newton's second Law | $F = ma$ |
| Work | $w = Fx$ |
| Potential Energy | $U = mgy$ |
| Kinetic Energy | $K = \frac{1}{2} mv2$ |
| Power | $P = \frac{W}{t}$ |
| Momentum | $p = mv$ |

4.13 A force of 10 N is applied to a mass of 2 kg for 10 seconds. (a) If starting from rest, how far does the mass move? (b) How much work is done? (c) What is the final kinetic energy? (d) How much power is required? (e) How far would the mass have to fall to attain the same speed? (f) What is the particle's final momentum?

Some important angular motion equations are:

| | |
|---|---|
| Angle in radians | $\theta = \frac{s}{r}$ |
| Angular velocity | $\omega = \frac{\theta}{t}$ <br> $\omega = 2\pi f$ |
| Tangential speed | $v = 2\pi r f$ |
| Radial acceleration | $a = \frac{v^2}{r}$ |
| Centripetal force | $F = m \frac{v^2}{r}$ |
| Angular momentum | $L = mvr$ |

4.14 A mass of 2 kg moves in a circle of radius 2 m taking 1 second to make 1 revolution. (a) What is its angular velocity? (b) Through what angle does it rotate in 0.1 sec? (c) How far does it travel in 0.1 sec? (d) What force is required to keep it moving in the circle? (e) What is its angular momentum?

Some important laws of conservation are conservation of (a) mass, (b) energy, (c) momentum, and (d) angular momentum.

4.15 A truck of mass 6000 kg moving with velocity of 20 m/s collides head-on with a 2000-kg car moving in the opposite direction. After the collision the two stick together at rest. (a) What was the speed of the car before collision? (b) How much energy went into deforming the vehicles during the collision?

## MATTER

Some important equations involving fluids are:

weight $w = mg$

density $\rho = \frac{m}{v}$

pressure $p = \frac{F}{A}$

4.16 A column of mercury (density 13.6 g/cm$^3$) is 2 cm in diameter and 50 cm high. (a) What is its total mass? (b) What is its weight? (c) What is the pressure at the bottom of the column?

Some important equations involving molecular matter are

atomic number A = # protons or # electrons

molecular mass M = sum of atomic masses of constituents
= # grams/mole

Avagadro's Number $N_A = 6.023 \times 10^{23} \frac{\text{molecules}}{\text{mole}}$

4.17 How many electrons are contained in one liter of water?

# APPENDIX K

# THE CASET DATABASE ON NASA RECON

The CASET Database was created and is maintained by the Center for the Advancement of Science, Engineering and Technology (CASET) in Houston, Texas. The CASET Database was installed on the NASA RECON system in 1992 and is accessed through File Collection K. Check availability field (SAP NOTE) for information on ordering documents. If availability field is blank, contact CASET for information regarding document availability. Please refer any inquiries regarding the database or general information about CASET to:

CASET
P.O. Box 580405
Houston, TX 77258-0405
Telephone: (713) 280-4875
FAX: (713) 280-4871

The following material provides the history of the CASET Database, the criteria for data inclusion, a Navigator description of the database in RECON, and the CASET Thesaurus.



## Table of Contents

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Navigator . . . . . 3

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CASET Thesaurus Hierarchical Listing . . . . . 8

## HISTORY AND DESCRIPTION OF CASET DATABASE

The CASET database has evolved from a small, computerized database developed by the Center for the Advancement of Science, Engineering, and Technology (CASET) with funds and support from the Department of Defense, the National Security Agency, the National Aeronautics and Space Administration (NASA)/Johnson Space Center (JSC), and the Department of Labor.

The database was initiated as part of a larger research project : A Study to Determine and Test Factors Impacting on the Supply of Minority and Women Scientists, Engineers, and Technologists for Defense Industries and Installations, conducted by CASET, a research adjunct of Huston-Tillotson College, Austin, Texas.

The overall goal of the Study was to determine and test strategies for removing barriers and encouraging the success of American Indians, Blacks, Hispanics and women in quantitative studies and careers in the United States. CASET's mission is to support the recruitment and retention of American national minorities and women as a means of enlarging the scientific, engineering, and technological (SET) work force.

The CASET database is designed to provide information on the activities, status, and progress of underrepresented minorities and women in the quantitative fields of engineering, chemistry, physics, mathematics, computer science, geology, environmental science, and biotechnology. Of particular interest are the more than 600 intervention programs on the database. These are programs which operate to benefit the recruitment, retention and performance of underrepresented minorities and women in SET study and careers.

Through the database, users have access to an extensive resource of literature, documents, dissertations, conference papers, and other print and non-print materials, providing links to academia, industry, government, foundations, and other researchers.

CRITERIA FOR DOCUMENT INCLUSION IN THE CASET DATABASE:

1. It must relate to a minority group or women and a quantitative field of study or careers.

2. The focus is on American nationals.

3. It is preferably the original document rather than a review or commentary.

4. A legal or legislative document must relate to these groups' education and/or training or employment.

**File Name:** Center for the Advancement of Science, Engineering, and Technology

**Series Indicator:** J-10,000

**Also Called:** CASET

**Coverage:** 1952 to present

**Frequency of Update:** Semiannually

The CASET database contains references to articles, reports, books, and other literature concerning factors affecting the supply of women and minorities in science, engineering, and technology fields. References are supplied by the Center, which is located at the Huston-Tillotson College field office in Houston, Texas.

**Publisher:** Center for the Advancement of Science, Engineering, and Technology

**File Collection:** K

**Searching Information:** Catalogued, indexed, and abstracted. Descriptors are indexed.

**Sample Citation:**

```
      91J11292
UTTL: The relative effectiveness of performance practice and formal
      study on acquisition of aptitude in engineering in precollege
      engineering programs for ** minorities. **
PRGM: Minority Introduction To Engineering (MITE) and RCA Minority
      Engineering Program (MEP)
AUTH: FISHER, H. E.
SORC: (University Microfilms No. 82-22544)
DATE: 1982/00/00
SAP:  Avail: University Microfilm International (UMI), 300 N. Zeeb
      Road, Ann Arbor, MI  48106, 1-800-521-0600 for pricing and
      delivery information.
POPL: /*MINORITIES/*MALES/*FEMALES/*HIGH SCHOOL/*ENGINEERING
DESR: / INTERVENTION/ PERFORMANCE/ EVALUATION/ HANDS-ON EXPERIENCE/
      INSTRUCTION/ TEACHING (PERSON/METHOD)/ CURRICULUM/ APTITUDE/ SEX
      DIFFERENCES/ ABSTRACT
```

| Text Searchable Fields | Search Mnemonic | Specify Format (SF)/ Sort Mnemonic | Output Label |
|---|---|---|---|
| Abstract | AX | AX | ABS |
| Program Notes | TPN | TPN | PRGM |
| Source Note | SRN | SRN | SORC |
| Subject Terms (default)* | SUB | | |
| Unclassified Title | UTP | UTL | UTTL |
| **Term Searchable Fields** | **Search Mnemonic** | **Specify Format (SF)/ Sort Mnemonic** | **Output Label** |
| Descriptor | DES | DES | DESR |
| Document Type | DOC | DOC | TYPE |
| Personal Author | AU | AU | AUTH |
| Population Characteristics | POP | POP | POPL |
| Publication Date | PDT | PDT | DATE |
| **Nonsearchable Fields** | **Search Mnemonic** | **Specify Format (SF)/ Sort Mnemonic** | **Output Label** |
| Availability (SAP Note) Sales Agency and Pricing | | SAP | SAP |

* also searches Descriptor and Population Characteristics

**KEY:**

GS Indicates the field within the **General Structure** of the CASET database file that contains the term of interest. There are two such fields:

**POP** - the **Population Characteristics** field. This field contains information on ethnicity, sex, educational level, and science, engineering, and technology (SET) area. See listing on following pages for all entries in POP fields.

**DES** - the **Descriptor** field. This field contains subject descriptors as assigned by CASET indexers. See listing on next page for all entries in DES fields.

**RT** **Related Term** - a pointer to other descriptors in the DES field which are closely related conceptually.

**UF** **Used For** - indicates a synonym or equivalent for the term.

Ability
Abstract
Academic Preparedness
Achievement
Adaptation
Anxiety
Aptitude
Aspirations
Attitudes
Bibliography
Career Awareness
Career Choice
Career Information
Case Study
Counseling
Curriculum
Curriculum Materials
Data Collection Methods
Empirical Study
Encouragement
Enrollment
Ethnic Differences
Evaluation
Expectations
Experimental
Field Trip
Financial Aid
Gender Differences
Hands-On Experience
Internship
Intervention
Institutional Characteristics
Instruction
Interests
Language
Locus of control
Mentoring
Motivation
Parental Involvement
Peer Support
Perceptions
Performance
Program Inventory
Psychotherapy
Race Bias
Recruitment
Retention
Role Model
Selection
Self Concept
Sex Bias
Socioeconomic Status
Statistical Data
Stereotyping
Study Habits
Survey
Teaching (Person/Method)
Tutoring
Work Conditions
Work Experience
Values

American Indians
Anglos
Asian Americans
Basic Skills
Below 9th Grade
Biotechnology
Blacks
Chemistry
Computer Science
Elementary School
Engineering
Environmental Science
Females
Geology
Graduate
Hearing Impairments
High School (9th-12th)
Hispanics
Learning Disabilities
Males
Mathematics
Middle School
Minorities
Mixed Ethnic Group
Mobility Impairments
Non-Traditional Careers
Organic Disorders
Pacific Islanders
People With Disabilities
Physics
Professional
Science
Speech Impairments
Statistics
Technology
Undergraduate
Visual Impairments
Vocational/Technical School

**Ability** - The power to perform an act, either physical or mental, whether innate or acquired by education and/or practice.
GS DES
RT APTITUDE

**Abstract** - This descriptor indicates that the document contains an abstract, even if it is not available in the CASET database. Abstracts contained in the CASET database are found in the ABSTRACT (AX) field and may be searched for significant words, or displayed on the screen or printed out.
GS DES

**Academic Preparedness** - Academic background and competence in the basic SET courses necessary for student participation in or pursuit of SET-related careers.
GS DES

**Achievement** - Accomplishment, success in bringing about a desired end. The degree or level of success in some specified area or in general. The level of proficiency attained in scholastic or professional work.
GS DES
RT PERFORMANCE

**Adaptation** - Relates to some aspect of socialization and acculturation such as adjusting to an unfamiliar environment. A process of modification of individual and social activity in adjustment to cultural surroundings. Adjustment, modification, or alteration in response to the environment.
GS DES

**African Americans** - See Blacks.

**Afro-Americans** - See Blacks.

**American Indians** - Native Americans, including Alaskans, Eskimos, and Aleuts.
GS POP

**Angina** - See Organic Disorders.

**Anglos** - Caucasian inhabitants of the United States, of non-Hispanic origin.
GS POP
UF WHITES
WHITE AMERICANS

**Anxiety** - A state of uneasiness or fear; for example, one specifically relating to either mathematics, science, or test performance.

GS DES

**Aptitude** - The capacity or potential to perform a task, skill, or act; implies that one can develop by training the ability to perform a certain act.

GS DES
RT ABILITY

**Asian(s)** - See Asian Americans.

**Asian Americans** - American nationals originally from or with descent from the Southern and Eastern Asian countries, designated by the U.S. Bureau of the Census as individuals from Chinese, Filipino, and twenty other types of Asian descents.

GS POP
UF ASIANS
ASIAN
CHINESE
FILIPINO
JAPANESE

**Aspirations** - Strong desire to achieve a particular goal or ambition; more often than not, this is future oriented.

GS DES
RT EXPECTATIONS

**Asthma** - See Organic Disorders.

**Attention Deficit Disorder (ADD)** - See Learning Disabilities.

**Attention Deficit Syndrome (ADS)** - See Learning Disabilities.

**Attitudes** - A study characteristic that describes a person's opinions and feelings; for example, specifically toward a given SET area.

GS DES

**Basic Skills** - Fundamental skills required for advancement into the SET fields, such as those skills included in introductory courses in mathematics and general science.

GS DES

**Below 9th Grade** - An educational level. Used when the author indicates "before high school," but does not specify a grade or grade range.

GS POP
RT ELEMENTARY SCHOOL
MIDDLE SCHOOL

**Bibliography** - Indicates that the document itself is a bibliography or that a compiled bibliography is included. Does not refer to an included list of references for a book or paper.

GS DES

**Biotechnology** - A SET field. The field which applies the principals of engineering and technology to the life sciences. An applied biological science, such as bioengineering.

GS POP

**Black-Americans** - See Blacks.

**Blacks** - African Americans, Afro-Americans, Black Americans, Negroes.

GS POP
UF AFRICAN AMERICANS
AFRO-AMERICANS
BLACK AMERICANS
NEGROES

**Blind** - See Visual Impairments.

**Cancer** - See Organic Disorders.

**Career Awareness** - A state of being informed on career opportunities and career planning.

GS DES
RT CAREER CHOICE
CAREER INFORMATION

**Career Choice** - An individual's preference or selection of an academic major or career.

GS DES
RT CAREER AWARENESS

**Career Information** - A study that increases a participant's knowledge of SET-related careers and fields. A lecture, discussion, field trip, or handout intended to increase awareness of career opportunities, commonly used as an intervention mechanism.

GS DES
RT CAREER AWARENESS

**Case Study** - A method of research in which the certain chosen experiences of a person, or a group of people, are recorded and analyzed, in order to understand the particular case that was studied and to gain insights into a type of social conduct that is common to a whole group or category of people.

GS DES

**Chemistry** - A SET field. The science that deals with or investigates the composition, properties, and changes of properties of substances and various elementary forms of matter.

GS POP

**Chicanos** - See Hispanics.

**Chinese** - See Asian Americans.

**Computer Science** - A SET field. The science that deals with the theory, design, analysis, and applications of computers and computer-based systems.

GS POP

**Co-Op Program** - See Internship.

**Counseling** - An analysis of an individual's characteristics and a recommendation about a course of action. Includes both academic counseling (to discuss course options in relation to a student's program), and career counseling (to define an individual's potential for career choices). Does not include psychological counseling (see Psychotherapy).

GS DES

**Cultural Differences** - See Multiculturalism. Search for this term in the Abstract (AX) field.

(NOT USED IN EITHER POP FIELD OR DES FIELD)

**Cultural Diversity** - See Multiculturalism. Search for this term in the Abstract (AX) field.

(NOT USED IN EITHER POP FIELD OR DES FIELD)

**Cultural Pluralism** - See Multiculturalism. Search for this term in the Abstract (AX) field.

(NOT USED IN EITHER POP FIELD OR DES FIELD)

**Curriculum** - In education and/or training, the plan of courses and experiential learning comprising a study area, particular specialization, or grade level (CASET def.)

GS DES
RT CURRICULUM MATERIALS
UF CURRICULUM DEVELOPMENT

**Curriculum Development** - See Curriculum.

**Curriculum Materials** - The materials, print and nonprint, used in implementing a given curriculum.

GS DES
RT CURRICULUM

**Data Collection Methods** - Any technique or mechanism which results in the systematic gathering of information for purposes of data analysis.

GS DES

**Deaf** - See Hearing Impairments.

**Dialysis** - See Organic Disorders.

**Diversity** - See Multiculturalism. Search for this term in the Abstract (AX) field.

(NOT USED IN EITHER POP FIELD OR DES FIELD)

**Dyslexia** - See Learning Disabilities.

**Elementary School** - Educational unit providing instruction for grade kindergarten through grade five; in some instances may include grade six.

GS POP
RT BELOW 9TH GRADE
UF PRIMARY SCHOOL

**Emphysema** - See Organic Disorders.

**Empirical Study** - A research project whose data is gathered directly from subjects.

GS DES

**Encouragement** - Support that enhances self-concept or provides a substantial influence specifically in SET fields. May include positive influence of parents, mentors, role models, and teachers or counselors, and may relate to incentives in career activities.

GS DES

**Engineering** - A SET field; specifically, practical application of the knowledge of pure sciences such as physics or chemistry.

GS POP
UF ANY FIELD OF ENGINEERING (ELECTRICAL, CHEMICAL, CIVIL, ETC...)

**Enrollment** - Increased enrollment can either be the outcome or the goal of a given project. Often used as a measure of recruitment success.

GS DES
RT RECRUITMENT

**Environmental Science** - A SET field. Study of the earth, the ocean, and the earth's atmosphere; includes the fields of geophysics, geology, seismology and meteorology.

GS POP

**Epilepsy** - See Organic Disorders.

**Ethnic/Racial Differences** - A study characteristic that describes any differences in data between ethnic/racial groups. An independent research variable that may influence the outcome of a research study; used only when specific results are obtained for the ethnic/racial group.

GS DES

**Evaluation** - An assessment of the effectiveness of an intervention.

GS DES

**Expectations** - Anticipation of or looking forward to a future event. Less long-term than aspirations.

GS DES
RT ASPIRATIONS

**Experimental Study** - A study in which there is a control group and an experimental group, often called the intervention group, with the purpose of measuring the relationship among variables.

GS DES

**Females** - Women or girls.
GS POP

**Field Trip** - A site visit, as to a research or industrial facility or museum, to enable students to learn more about SET-related jobs and technological equipment, in addition to observing people at their work; often used as an intervention mechanism.
GS DES

**Filipino** - See Asian Americans.

**Financial Aid** - All forms of financial support, including grants, scholarships, and work study/cooperative education programs.
GS DES

**Gender Differences** - A study characteristic that describes any differences in data between females and males.
GS DES
UF SEX DIFFERENCES

**Geology** - A SET field. The science that studies the physical history of the earth, the rocks which compose the earth, and the physical changes of the earth over time.
GS POP

**Graduate** - An educational level beyond the baccalaureate degree, leading to an M.A., M.S., or Ph.D. degree.
GS POP

**Handicapped** - See People With Disabilities.

**Hands-on Experience** - A direct learning technique that provides practical experience, specifically in connection with academic courses.
GS DES

**Hard-of-Hearing** - See Hearing Impairments.

**Hawaiian** - See Pacific Islanders.

**Hearing Impairments** - Functional limitations of hearing ranging from mild to total hearing loss.
GS DES
UF DEAF
HARD - OF - HEARING

**Hemophilia** - See Organic Disorders.

**High School** - A secondary educational level consisting of the 9th through the 12th grades.

GS POP

**Hispanics** - As defined by the U.S. government, Americans of Spanish origin, comprising Mexican Americans, Puerto Ricans, former Cubans, South or Central Americans, or others of Spanish ancestry or descent. Hispanics may share common bonds of language, culture, religion, and history.

GS POP
UF CHICANOS
LATINOS
PUERTO RICANS
SPANISH
SPANIARDS

**Institutional Characteristics** - Descriptive characteristics of a university or other institution such as history, funding, location, enrollment size, and student body.

GS DES

**Instruction** - A structured learning activity, sometimes with an assessment of what is being learned.

GS DES

**Interests** - A study characteristic that describes a person's level of concern; for example, in a given SET field or study.

GS DES

**Intermediate School** - See Middle School.

**Internship** - A training program that provides experience in the participant's field. May include a stipend.

GS DES
UF CO-OP PROGRAM
WORK STUDY PROGRAM

**Intervention** - A special program applied to expose women and ethnic/racial minorities to career information, and to raise their interests, opportunities, and academic readiness, for example in a SET career. Focus may include any of the following related terms: evaluation, performance, program inventory, recruitment, retention, and selection.

GS DES
RT EVALUATION
PERFORMANCE
PROGRAM INVENTORY
RECRUITMENT
RETENTION
SELECTION

**Japanese** - See Asian Americans.

**Junior High School** - See Middle School.

**Language** - A cultural factor which may enhance or impede a student's performance or ability to learn; often used in studies of bilingual students.

GS DES

**Latinos** - See Hispanics.

**Learning Disabilities** - Conditions or functional limitations which affect learning or disorders in one or more of the processes involved in understanding, perceiving, or using language or spoken or written concepts.

GS POP
UF ATTENTION DEFICIT DISORDER (ADD)
ATTENTION DEFICIT SYNDROME (ADS)
DYSLEXIA

**Leukemia** - See Organic Disorders.

**Locus of Control** - A term that describes the measurement of the level of self-determination that people perceive that they have over their own lives as opposed to how much they feel outside influences (fate) control their lives.

GS DES
RT ENCOURAGEMENT
MOTIVATION
PARENTAL INVOLVEMENT
PEER SUPPORT
ROLE MODEL
SELF CONCEPT

**Males** - Men or boys.
GS POP

**Mathematics** - A SET field. The study of the operations and relationships of numbers, and of the structure, measurement, and transformations of space configurations.
GS POP

**Mathematics Anxiety** - Apprehension caused by participation in mathematical and related activities. See Anxiety.
(NOT USED IN EITHER POP FIELD OR DES FIELD)

**Mentoring** - Performing the role of guide or advisor for a student's education or selection of a career.
GS DES

**Middle School** - Usually refers to the 6th through the 8th grades.
GS POP
RT BELOW 9TH GRADE
UF INTERMEDIATE SCHOOL
JUNIOR HIGH SCHOOL

**Minorities** - Population subgroups in the United States with distinctive characteristics such as ethnicity, race, heritage, or culture; used when the specific minority classification is not mentioned by the author.
GS POP

**Missing Extremities** - See Mobility Impairments.

**Mixed Ethnic/Racial Groups** - A combination of two or more cultural groups, e.g., Blacks, Hispanics, and American Indians; Anglos and Asian Americans.
GS POP

**Mobility Impairments** - Conditions which affect or limit partial or total body movement or functioning.
GS POP
UF PARALYSIS
PARTIAL PARALYSIS
NONPARALYTIC ORTHOPEDIC IMPAIRMENT
MISSING EXTREMITIES

**Motivation** - A force that causes one to act; may be an internal self-generated process.
GS DES

**Multiculturalism** - More than one culture, generally referring to differences based on ethnicity, race, or culture assuming that these cause a group to have shared values, opinions, attitudes, behaviors which affect education, training, and occupation. Search for this term in the Abstract (AX) field.

(NOT USED IN EITHER POP FIELD OR DES FIELD)
RT CULTURAL DIFFERENCES
CULTURAL DIVERSITY
CULTURAL PLURALISM
DIVERSITY

**Negroes** - See Blacks.

**Nonparalytic Orthopedic Impairment** - See Mobility Impairments.

**Nontraditional Careers** - A career that is not customary for a particular population; for example, a male nurse or a female engineer.

GS DES

**Organic Disorders** - Functional limitations caused by conditions such as allergies, birth defects, cystic fibrosis, convulsive disorders, blood diseases, heart disease, pulmonary or respiratory disorder, renal disease, or wounds.

GS POP
UF ANGINA
ASTHMA
CANCER
DIALYSIS
EMPHYSEMA
EPILEPSY
HEMOPHILIA
LEUKEMIA
SICKLE CELL ANEMIA
TUBERCULOSIS

**Paralysis** - See Mobility Impairments.

**Pacific Islanders** - American citizens who are descendants of the indigenous peoples of Micronesia, Polynesia, and Melanesia.

GS POP
UF HAWAIIAN
POLYNESIAN
SAMOAN

**Parental Involvement** - Assistance or influence from parents in activities related to their children's educational programs or career choice.
GS DES

**Partial Paralysis** - See Mobility Impairments.

**Peer Pressure** - See Peer Support.

**Peer Support** - Usually the positive assistance individuals give each other to increase their performance, self-esteem, and motivation; may also refer to pressure from peers who discourage their friends from pursuing SET education and careers.
GS DES
UF PEER PRESSURE

**People With Disabilities** - A person with a physical disability.
GS POP
UF HANDICAPPED
PHYSICALLY CHALLENGED

**Perceptions** - Individual interpretations, ideas, discernments, and observations obtained through the senses or mind.
GS DES

**Performance** - Behavior in a given task or area; an intervention outcome measure which may indicate an improvement or not.
GS DES

**Physically Challenged** - See People With Disabilities.

**Physics** - A SET field. The study of the interactions of matter and energy.
GS POP

**Polynesian** - See Pacific Islanders.

**Primary School** - See Elementary School.

**Primary Study** - A study in which the author reports his/her original research methods and results; a primary source which provides firsthand data.
GS DES

**Professional** - One working in a chosen profession, or may be one who goes back to school to brush up on skills.
GS POP

**Program Inventory** - A listing of programs, usually those undertaking intervention studies; often includes data such as sponsoring organization, contact person, program summary, and bibliography.

GS DES

**Psychotherapy** - Psychological counseling; often used as an attempt to overcome learning problems such as mathematics anxiety; may include various group and/or individual techniques such as relaxation training, desensitization, and anxiety management training.

GS DES

**Puerto Ricans** - See Hispanics.

**Race Bias** - A prejudiced outlook to another's race/ethnicity; related to documented discrimination.

GS DES

**Recruitment** - An effort to enlist students or professionals in a program or course of study; for example, persons may be recruited for participation in a SET-related intervention.

GS DES

**Retention** - Keeping students in SET fields; covers a broad range of goals, such as those of increasing graduation rates and reducing the dropout/attrition rates.

GS DES

**Role Model** - One who has a positive influence in encouraging students or professionals for example, to engage in SET careers.

GS DES

**ROTC** - Reserve Officers' Training Corps. Search for this term in the Abstract (AX) field.

(NOT USED IN EITHER POP FIELD OR DES FIELD)

**Samoan** - See Pacific Islanders.

**Science** - A SET field. The systematic search for insights and knowledge about the physical world and general laws of nature.

GS POP

**Secondary Study** - A study which contains no original (primary) research, but which analyzes and reports on another's data.

GS POP

**Selection** - A technique of identifying students with the potential for SET careers; it is an activity leading to the recruitment of students.

GS DES
UF IDENTIFICATION OF STUDENTS WITH SET POTENTIAL

**Self-concept** - The mental image or perception one has of oneself.

GS DES
UF SELF-CONFIDENCE
SELF-ESTEEM

**Self-confidence** - See Self-concept.

**Self-esteem** - See Self-concept.

**Sex Bias** - A prejudiced outlook and discriminatory practices toward a person because of her/his sex.

GS DES

**Sex Differences** - See Gender Differences.

**Sickle Cell Anemia** - See Organic Disorders.

**Socioeconomic Status** - A study characteristic that describes a person's educational and economic background as compared to the rest of society.

GS DES

**Spaniards** - See Hispanics.

**Spanish** - See Hispanics.

**Speech Dysfunction** - See Speech Impairments.

**Speech Handicap** - See Speech Impairments.

**Speech Impairments** - Functional limitations, defects, or disturbances which affect oral communication.

GS POP
UF SPEECH DYSFUNCTION
SPEECH HANDICAP
SPEECH MALFUNCTION

**Speech Malfunction** - See Speech Impairments.

**Statistical Data** - A study characteristic that denotes any type of statistical analysis that is given in any form in a document.

GS DES

**Statistics** - A SET field; the branch of mathematics which deals with quantitative data.

GS POP

**Stereotyping** - The assignment of certain characteristics to a person or a group, representing an oversimplified opinion, affective attitude, or uncritical judgment based upon a single type of individual.

GS DES

**Study Habits** - A study characteristic that describes the method that a person uses or is encouraged to use while studying; may be the methods used by students to enhance achievement as in an intervention mechanism.

GS DES

**Survey** - A method used to collect information in an empirical study, i.e., a research design in which no experimental groups were set up, but employed instruments such as questionnaires to obtain data.

GS DES

**Teaching (Person/Method)** - A study characteristic which refers to the style or proficiency of teaching. May refer to either the teacher or the method of teaching, or both.

GS DES

**Technology** - A SET field. The body of knowledge and techniques which pertain to and support applied science, engineering, and productivity.

GS POP

**Tuberculosis** - See Organic Disorders.

**Tutorial** - Intensive instruction in some subject given by a tutor to an individual student or a small group of students. See Tutoring.

(NOT USED IN EITHER POP FIELD OR DES FIELD)

**Tutoring** - Educational assistance outside of the regular classroom which provides remediation or other supportive sessions in an academic subject area.

GS DES
UF TUTORIAL

**Undergraduate** - Educational level in a college or university which leads to the associate or baccalaureate degree.

GS POP

**Values** - The beliefs and standards that determine people's attitudes, behavior, and how they rank the merit of ideas and actions.

GS DES

**Visual Impairments** - Functional limitations of eyesight ranging from mild to total loss.

GS POP
UF BLIND
VISUALLY HANDICAPPED

**Visually Handicapped** - See Visual Impairments.

**Vocational/Technical** - An educational or training level where students are primarily being trained for work in a nonprofessional technology-related field.

GS POP

**White Americans** - See Anglos.

**Whites** - See Anglos.

**Work Conditions** - Characteristics of the workplace which detract from or enhance one's ability to work effectively; includes environmental considerations as well as interpersonal relationships among co-workers and supervisors.

GS DES

**Work Experience** - A study characteristic referring to the acquiring of first-hand experience and knowledge of some particular career field; may be obtained before, during, or after completion of educational and training requirements.

GS DES

**Work Study Program** - See Internship.

# APPENDIX L

# THE CASET DATABASE
July, 1995

# CASET Database

**July 1995**
**2,640 Documents**

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**APPENDIX M**

**INTERVENTION REPORT**
**January 12, 1988**

# INTERVENTION

# REPORT

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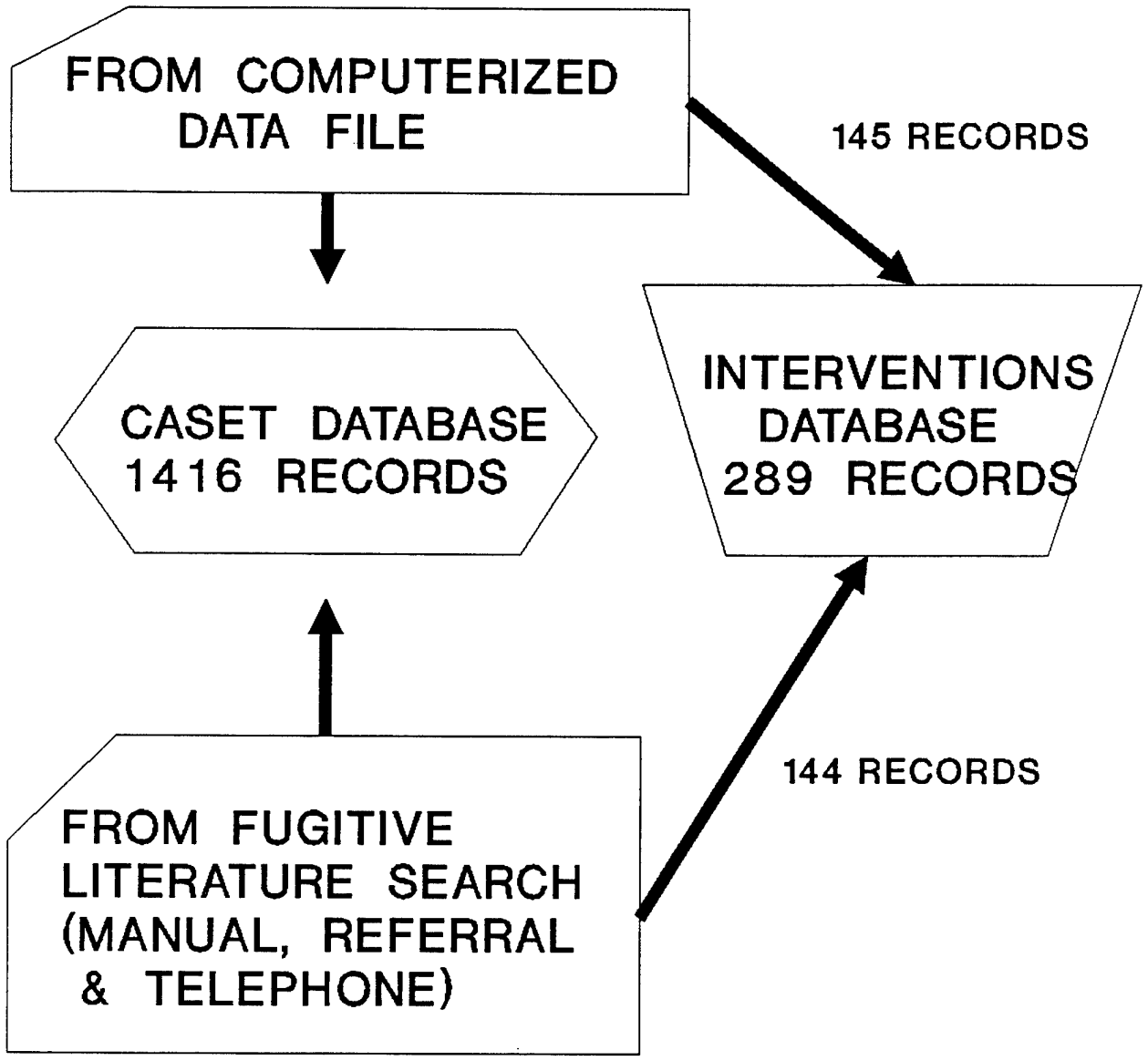
Appendix C.....Description of mechanisms

## PROCEDURE

Two hundred and eighty nine records (289) were coded and entered into an interventions database. One hundred and forty-five of these (145) were confirmed from the CASET database. The remaining 144 documents came from a fugitive literature search. The interventions database file which was called INTERV.DBF was set up using the Dbase II software program.

Components of the entire database were analyzed using frequency distributions and cross-tabulations. The tables and graphs are presented.

# INTERVENTIONS DATABASE
## FIGURE 1



## ETHNICITY AND GENDER OF PARTICIPANTS

The specifity of the target population in terms of gender and ethnicity does not seem to be a priority of these interventions. A large proportion of documents did not specify the gender and/or ethnicity of participants (Table 1).

This observation is particularly relevant to the ethnic component since mixed ethnicity and unspecified ethnicity characterize most of the target population (Figure 2). Very few interventions were done with specific ethnic groups regardless of gender characteristics. Even when a distinct ethnic group was specified, very seldom was it of a single gender; for example, of the 289 interventions, only one was done on Black females.

In summary, as the interventions present a specific ethnicity of interest, they are less specific in terms of gender of their target population. The converse is also true - interventions concerned with a particular gender (in this case women), generally disregard the ethnicity of their population.

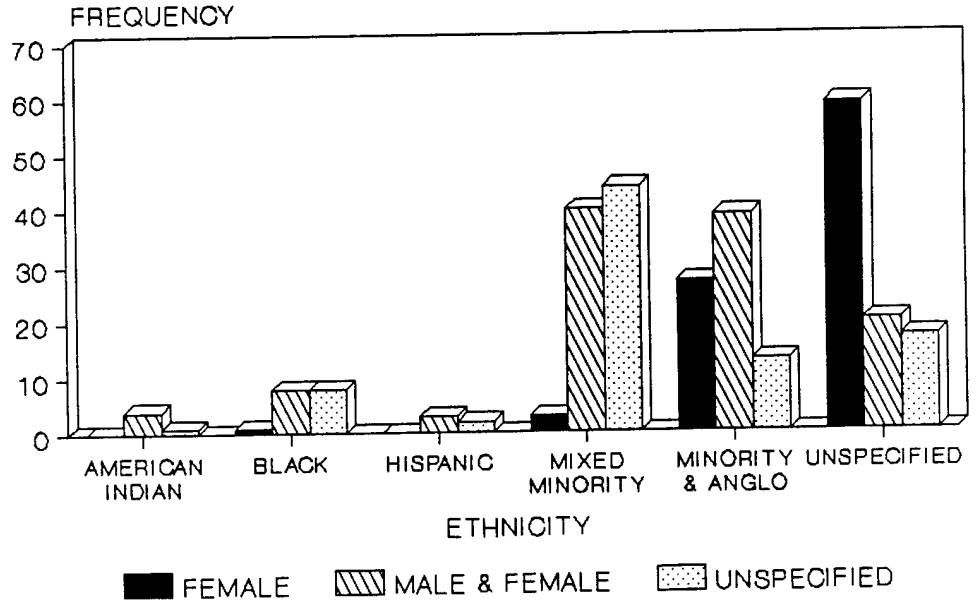
About 31% of interventions were focused on women alone. Most of these pertained to the "Women In Science" or the "Women In Engineering" organizations. No interventions were implemented on men alone.

About 40% of the studies were specifically aimed at minority target populations - either as a specific ethnic minority or as mixed minority groups. No interventions were focused on Asian Americans alone.

TABLE 1
ETHNICITY AND GENDER OF PARTICIPANTS

| ETHNICITY | GENDER | | | TOTAL | % |
|---|---|---|---|---|---|
| | F | MF | U | | |
| AMERICAN INDIAN | - | 4 | 1 | 5 | 2% |
| BLACK | 1 | 8 | 8 | 17 | 6% |
| HISPANIC | - | 3 | 2 | 5 | 2% |
| MIXED MINORITY | 3 | 40 | 44 | 87 | 30% |
| MINORITY & ANGLO | 27 | 39 | 13 | 79 | 27% |
| UNSPECIFIED ETHNICITY | 59 | 20 | 17 | 96 | 33% |
| TOTAL | 90 | 114 | 85 | 289 | |
| % | 31% | 39% | 29% | | |

## ETHNICITY AND GENDER OF PARTICIPANTS
FIGURE 2



## PURPOSE OF INTERVENTIONS

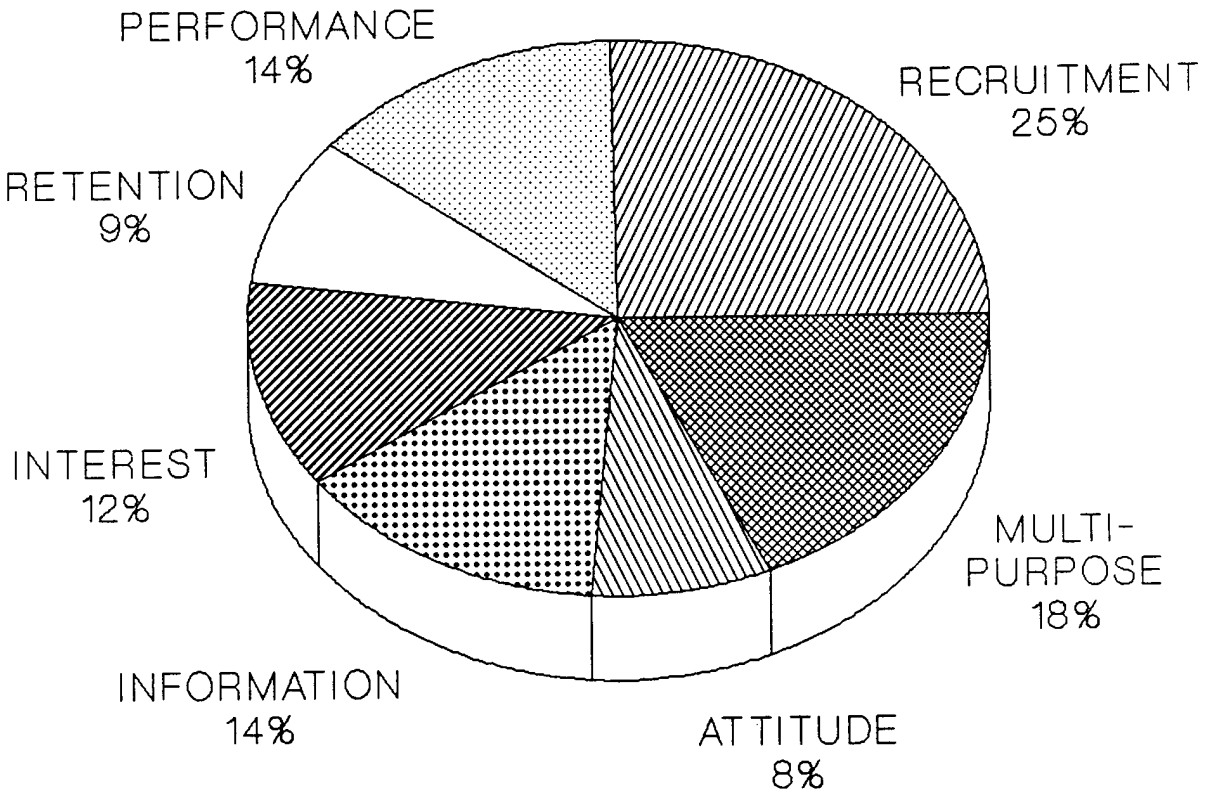
The intervention's purpose conveys the objective attained as a result of the experiment being implemented or the program's activities. Broad objectives of some interventions were reflected in the percentage with multiple purpose (18%). See Table 2 below.

TABLE 2
PURPOSE OF INTERVENTIONS

| PURPOSE | N | % |
|---|---|---|
| RECRUITMENT | 73 | 25% |
| RETENTION | 25 | 9% |
| INFORMATION/AWARENESS | 40 | 14% |
| PERFORMANCE | 40 | 14% |
| INTEREST/MOTIVATION | 35 | 12% |
| ATTITUDE | 23 | 8% |
| MULTI-PURPOSE | 53 | 18% |
| TOTAL | 289 | |

Among the studies specifying a distinct purpose, recruitment was the most common (25%); followed by performance (14%). Specific academic activities were identified in all interventions designed to increase performance, and in some retention programs (9%). The other studies stated a less formal objective and used less structured techniques to encourage students into SET careers. These interventions provided information (14%); or sought a change in students' attitude (8%); or an increase in their interest and motivation (12%). The expected goal (which was recruitment), was very often presented as a consequence of the stated objective. Figure 3 overleaf shows this information.

# PURPOSE OF INTERVENTIONS
## FIGURE 3



## FIELD OF INTERVENTIONS BY EDUCATIONAL LEVEL OF PARTICIPANTS

The guiding aim of this research is consistent with the fields of science, engineering and technology. Table 3 shows engineering constituting the major field (31%); followed by the combined fields (26%). The latter was a group comprising mathematics & science; engineering & technology; science & technology or more than one area in science. The science field (15%) which comprised the pure sciences, also included computer science.

TABLE 3

FIELD OF INTERVENTIONS BY EDUCATIONAL LEVEL OF PARTICIPANTS

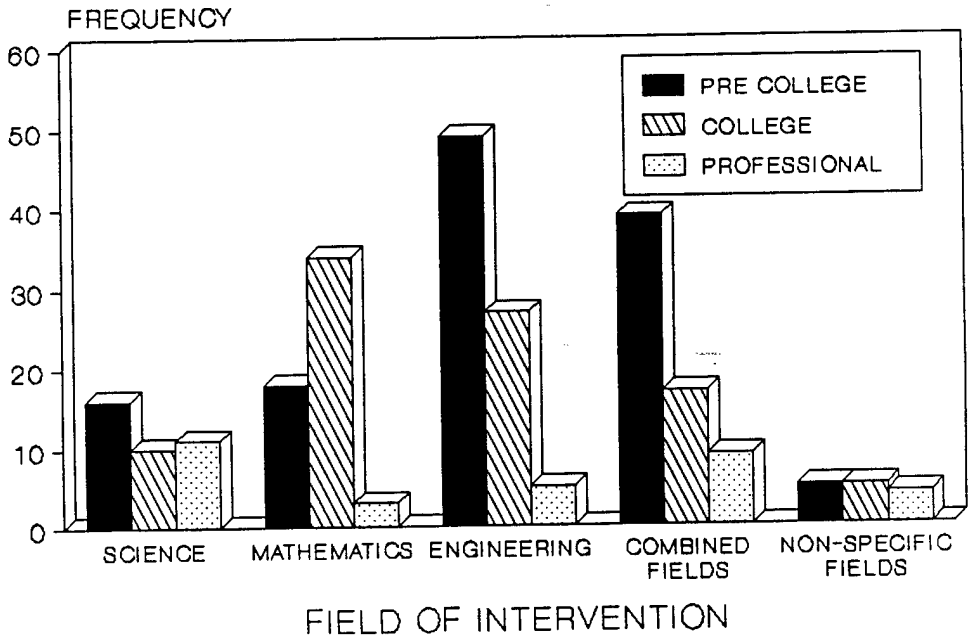
| FIELD | *EDUCATIONAL LEVEL | | | | TOTAL | % |
|---|---|---|---|---|---|---|
| | PRE | COLL | GRAD | OTH | | |
| SCIENCE | 16 | 10 | 11 | 5 | 42 | 15% |
| MATHEMATICS | 18 | 34 | 3 | 2 | 57 | 20% |
| ENGINEERING | 49 | 27 | 5 | 10 | 91 | 31% |
| COMBINED FIELDS | 39 | 17 | 9 | 11 | 76 | 26% |
| NON-SPECIFIC FIELDS | 5 | 5 | 4 | 9 | 23 | 8% |
| TOTAL | 127 | 93 | 32 | 37 | 289 | |
| % | 44% | 32% | 11% | 13% | | |

*EDUCATIONAL LEVEL: PRE - Pre college COL - College GRAD - Graduate OTH - Other

The non-specific fields (8%), comprised those interventions done in were generally to attract students into non-traditional careers. The "other" field category included rural youth programs; on-the-job training programs for disadvantaged students; apprenticeship and opportunity programs.

Looking at the distribution of educational level across fields (Figure 4), we find that the graduate level was a small group (11%) and had most of its interventions in the field of science. The most common educational level was the pre-college group 9th - 12th grade (44%). These students formed the main target population for interventions in engineering and the combined fields. At the college level (32%), interventions were more often done in the fields of mathematics and engineering. In general the setting of all interventions explained the academic background of the participants.

FIELD OF INTERVENTIONS BY EDUCATIONAL LEVEL OF PARTICIPANTS. FIGURE 4



## MECHANISMS OF INTERVENTIONS

Mechanisms constitute the operationalization of the intervention purpose. In general, instruction was the most commonly used technique (13%); followed by counseling (10%) and role model (9%).

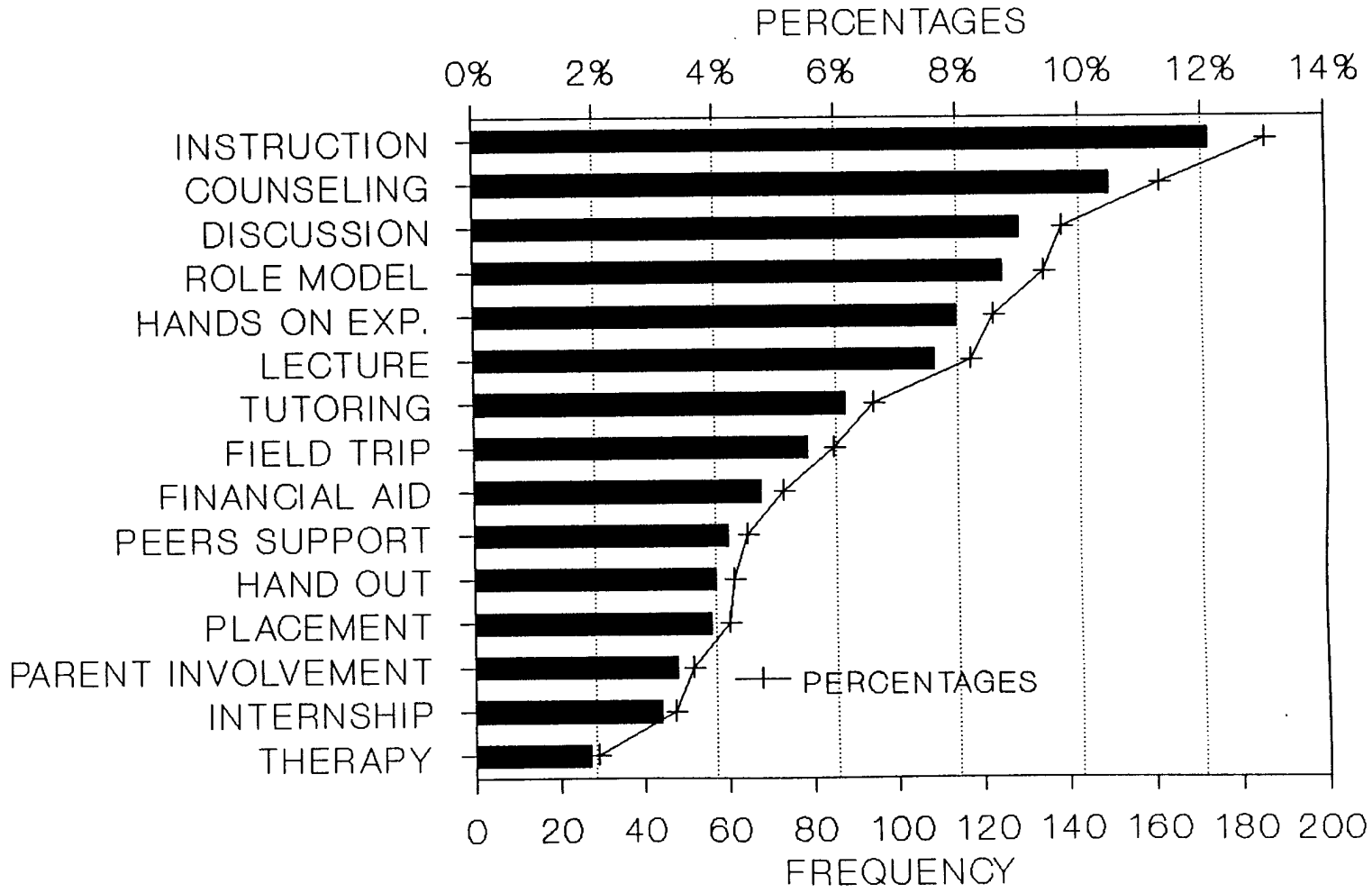
TABLE 4

MECHANISMS OF INTERVENTIONS

| MECHANISM | N | % |
|---|---|---|
| INSTRUCTION | 173 | 13% |
| COUNSELING | 150 | 11% |
| DISCUSSION | 129 | 10% |
| ROLE MODEL | 125 | 9% |
| HANDS ON EXPERIENCE | 114 | 9% |
| LECTURE | 109 | 8% |
| TUTORING | 88 | 7% |
| FIELD TRIP | 79 | 6% |
| FINANCIAL AID | 68 | 5% |
| PEER SUPPORT | 60 | 5% |
| HAND OUT | 57 | 4% |
| PLACEMENT | 56 | 4% |
| PARENT INVOLVEMENT | 48 | 4% |
| INTERNSHIP | 44 | 3% |
| THERAPY | 27 | 2% |
| TOTAL | 1327* | |

*Each of the 289 interventions used more than one mechanism. See Appendix C for a description of these mechanisms.

# MECHANISMS OF INTERVENTIONS
# FIGURE 5



## FOCUS OF INTERVENTIONS

The focus was obtained by regrouping the mechanisms of interventions according to their main features. The four resulting groups are: Educational focus which regroups the mechanisms of instruction, hands on experience, tutoring and field trip; Socio-cultural which regroups counseling, role model, peer support, therapy and parent involvement; Economic focus which includes financial aid, placement and intership; and Informational focus which includes discussion, lecture and hand out.

Table 5 and Figure 6 show that the educational and the socio-cultural foci were the most frequent across interventions (31% each).

TABLE 5

FOCUS OF INTERVENTIONS

| FOCUS | N | % |
|---|---|---|
| EDUCATIONAL | 232 | 31% |
| ECONOMIC | 104 | 14% |
| SOCIOCULTURAL | 232 | 31% |
| INFORMATIONAL | 179 | 24% |
| TOTAL* | 747 | |

*Each intervention hhad more than one focus

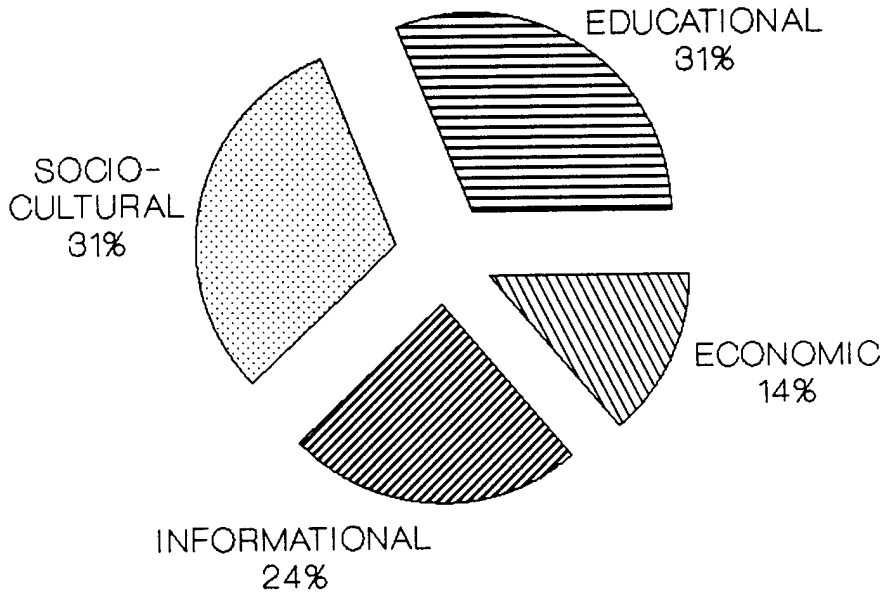
A. The educational focus (31%) directs all the mechanisms suitable for training or formally qualifying a population in specific fields.

B. The socio-cultural focus (31%) appears in those mechanisms suitable for resolving difficulties related to the individual's personality (psycholgical traits) or social environment (values, beliefs, relationship).

C. The economic focus (14%) is revealed in mechanisms that provide some form of monetary support to facilitate the access of disadvantaged populations to a formal education or training.

D. The informational focus (24%) consists of mechanisms whose main feature reside in providing general knowledge in a short period of time. They often do not require any feedback from the participants.

## FOCUS OF INTERVENTIONS
## FIGURE 6



## PURPOSE BY TYPE OF INTERVENTION

Sixty-eight percent of interventions were program type; 18% were research studies; and 14% had both features - with a research design incorporated within the program. (Table 6). Program-type interventions were mainly to recruit students. Both the research-type and the program/research-type interventions applied more frequently to the purpose of improving performance and changing attitude toward SET careers.

TABLE 6

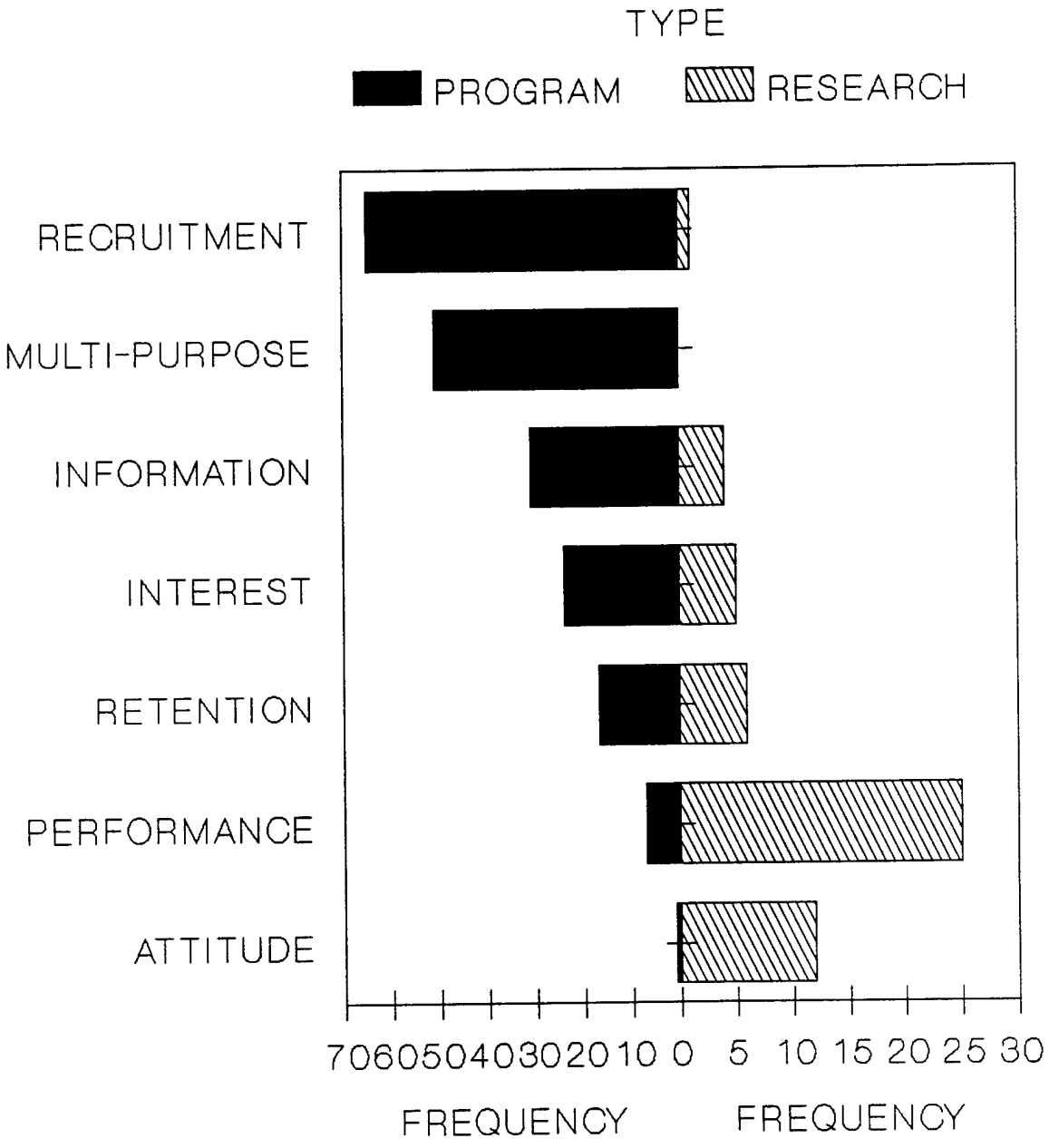
PURPOSE BY TYPE OF INTERVENTION

| PURPOSE | TYPE | | | TOTAL |
|---|---|---|---|---|
| | PROGRAM (P) | RESEARCH (R) | P/R | |
| RECRUITMENT | 65 | 1 | 7 | 73 |
| RETENTION | 17 | 6 | 2 | 25 |
| INFORMATION/AWARENESS | 31 | 4 | 5 | 40 |
| PERFORMANCE | 7 | 25 | 18 | 40 |
| INTEREST/MOTIVATION | 24 | 5 | 6 | 35 |
| ATTITUDE | 1 | 12 | 10 | 23 |
| MULTI-PURPOSE | 51 | - | 2 | 53 |
| TOTAL | 196 | 53 | 40 | 289 |
| % | 68% | 18% | 14% | |

The multi-purpose interventions were sole programs as can be seen in Figure 7.

# PURPOSE BY TYPE OF INTERVENTION

## FIGURE 7

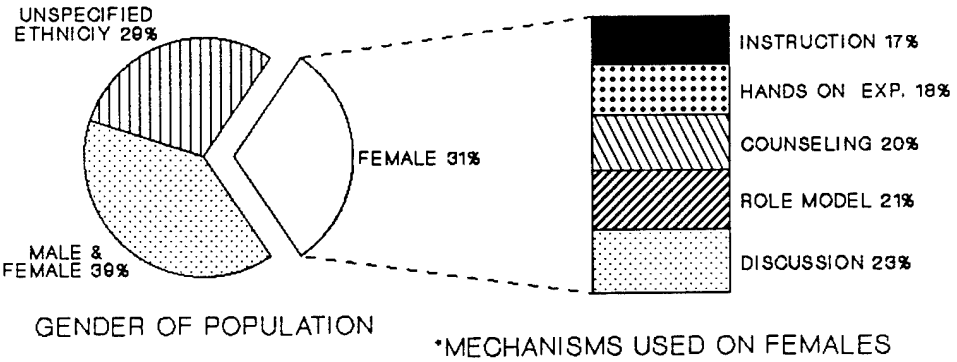


## MECHANISMS BY GENDER

The relevance of the mechanisms as main components of interventions was observed as they appear related to the target populations.

Although the difference in percentages between mechanisms is small, the rank order is of interest, for instance, the distribution for women shows that discussion and role model are the most often used. Both of these mechanisms imply a rather passive involvement of participants and are techniques used in interventions of short time duration, such as workshops and conference.

## MECHANISMS COMMONLY USED ON THE FEMALE POPULATION. FIGURE 8

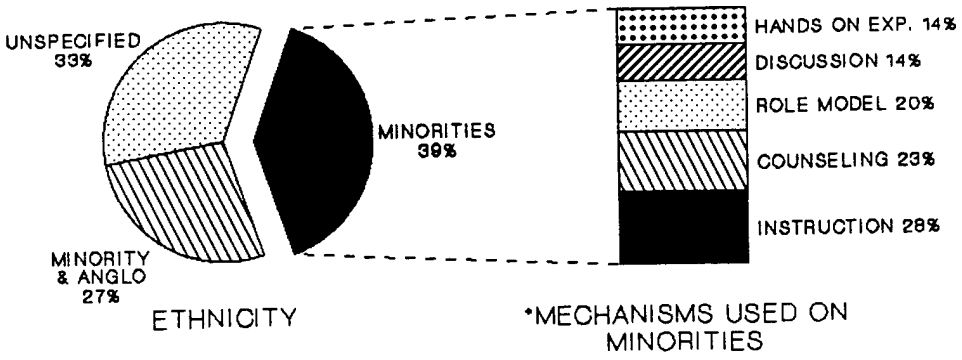



*Percentages are based on the distribution of the five most frequently used mechanisms.

## MECHANIMS BY ETHNICITY

A different observation is obtained according to ethnicity. In this case, instruction and counseling are prominent. These mechanisms constitute formally structured techniques, with active involvement of participants.

## MECHANISMS COMMONLY USED ON MINORITIES
FIGURE 9




*Percentages are based on the distribution of the five most frequently used mechanisms.

## LOCATION OF INTERVENTIONS

The major percentage of interventions (13.8%) were located in California, followed by New York (9.3%), and then Texas (6.9%) Twelve of the interventions were implemented in more than one state. There were no records in our database for interventions in the following states: Alaska, Connecticut, Kentucky, Maine, Nebraska, Nevada, New Hampshire, South Dakota, Utah, Vermont, West Virginia, Wisconsin, Wyoming.

TABLE 7 LOCATION OF INTERVENTIONS

| STATE | N | % |
|---|---|---|
| CALIFORNIA | 40 | 13.8% |
| NEW YORK | 27 | 9.3% |
| TEXAS | 20 | 6.9% |
| NEW JERSEY | 15 | 5.2% |
| MASSACHUSETTS | 14 | 4.8% |
| PENNSYLVANIA | 14 | 4.8% |
| MICHIGAN | 12 | 4.2% |
| INDIANA | 11 | 3.8% |
| COLORADO | 10 | 3.5% |
| ILLINOIS | 10 | 3.5% |
| OHIO | 9 | 3.1% |
| WASHINGTON | 7 | 2.4% |
| DISTRICT OF COLUMBIA | 6 | 2.1% |
| MARYLAND | 6 | 2.1% |
| MINNESOTA | 6 | 2.1% |
| NEW MEXICO | 6 | 2.1% |
| MISSOURI | 5 | 1.73% |

....Cont'd

LOCATION OF INTERVENTIONS (CONT'D)

| STATE | N | % |
|---|---|---|
| NORTH CAROLINA | 5 | 1.73% |
| OKLAHOMA | 5 | 1.73% |
| FLORIDA | 4 | 1.38% |
| GEORGIA | 4 | 1.38% |
| KANSAS | 4 | 1.38% |
| LOUISIANA | 4 | 1.38% |
| SOUTH CAROLINA | 4 | 1.38% |
| TENNESSEE | 4 | 1.38% |
| ARIZONA | 3 | 1.04% |
| IOWA | 3 | 1.04% |
| MISSISSIPPI | 3 | 1.04% |
| VIRGINIA | 3 | 1.04% |
| ALABAMA | 2 | 0.69% |
| DELAWARE | 2 | 0.69% |
| NORTH DAKOTA | 2 | 0.69% |
| OREGON | 2 | 0.69% |
| ARKANSAS | 1 | 0.34% |
| HAWAII | 1 | 0.34% |
| IDAHO | 1 | 0.34% |
| MONTANA | 1 | 0.34% |
| RHODE ISLAND | 1 | 0.34% |
| *MULTIPLE STATES | 12 | 4.15% |
| TOTAL | 289 | |

* Some interventions were implemented in more than one state.

# LOCATION OF INTERVENTIONS

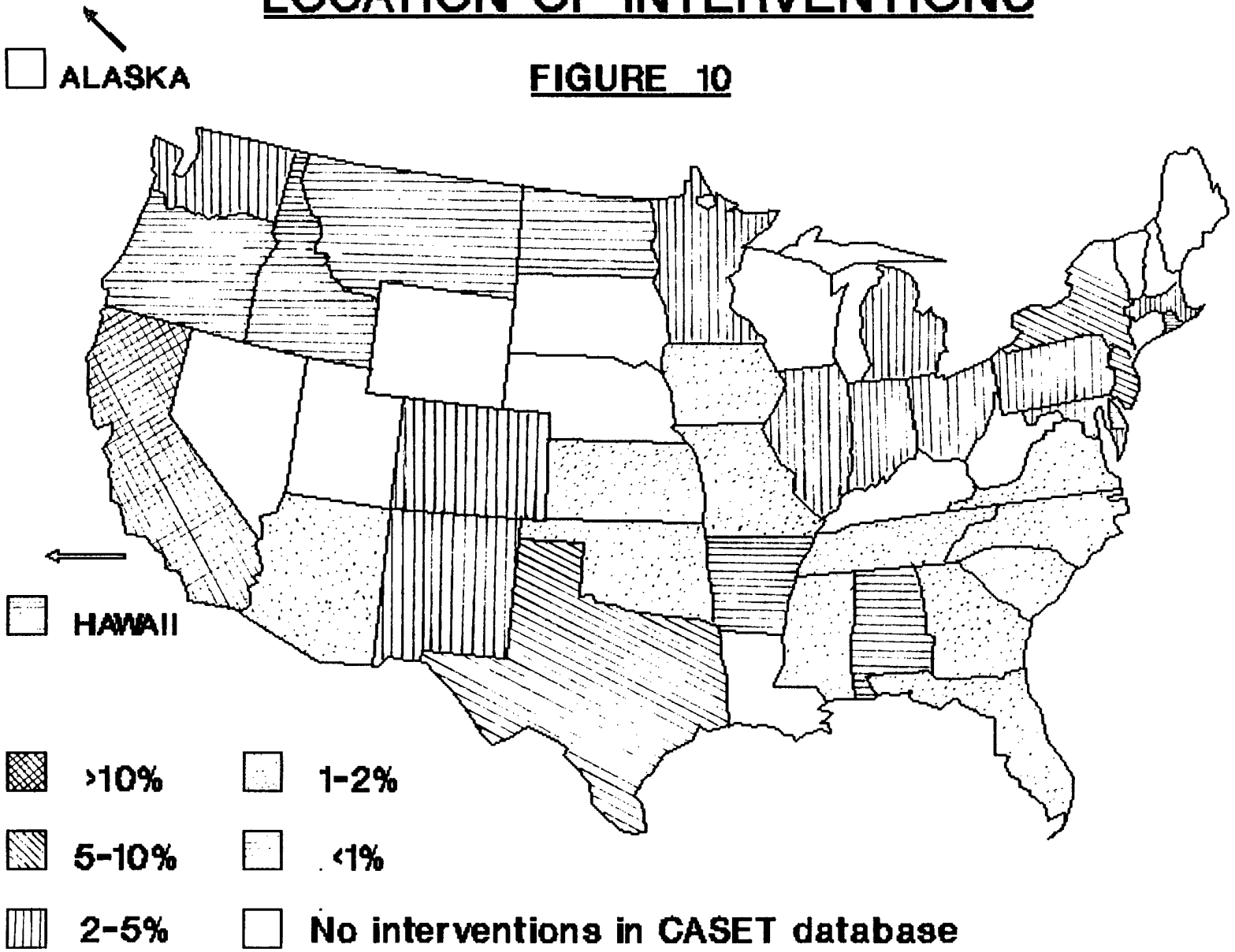



**FIGURE 10**

## SPONSORS OF INTERVENTIONS

The most frequent sponsor was NSF followed by NACME. About 18% were multi-funded (Table 8). Other sponsors included private foundations, education departments and professional societies.

TABLE 8 SPONSORS OF INTERVENTIONS

| SPONSOR | N | % |
|---|---|---|
| NSF | 56 | 26.5% |
| MULTI-FUNDED | 37 | 18.2% |
| NACME | 27 | 19.4% |
| PRIVATE FOUNDATIONS | 11 | 4.7% |
| US DEPARMENT OF EDUCATION | 10 | 6.5% |
| US DEPARTMENT OF ENERGY | 9 | 5.3% |
| INSTITUTIONAL | 8 | 4.7% |
| STATE EDUCATION DEPARTMENTS | 8 | 4.1% |
| PROFESSIONAL SOCIETIES | 5 | 2.4% |
| NASA | 4 | 2.4% |
| AIR FORCE OFF. OF SCI. RESEARCH | 3 | 1.8% |
| US DEPARTMENT OF LABOR | 3 | 1.8% |
| STATE BELL TELEPHONE | 2 | 1.2% |
| ARMY ROTC | 1 | 0.6% |
| LOCAL BANK | 1 | 0.6% |
| US E.P.A. | 1 | 0.6% |
| TOTAL | 186 | |

# APPENDIX A

## INTERVENTIONS CODING SHEET

I ACC _____

I TITLE (TI)_____

_____

_____

IIIa ORGANIZATION (ORG)_____

IIIb STATE _____ IV SPONSOR (SP)_____

V PROGRAM NAME (PN)_____

VI GENDER (GN)

___Female (F) ___Male and Female (MF)

___Unspecified (U) ___ Male (M)

VII ETHNICITY (ETH)

___American Indian (AI) ___Asian American (AA)

___Black (BL) ___Hispanic (HS)

___Mixed Minority (MM) ___Minority & Anglo (MA)

___Unspecified Ethnicity (UE)

VIII OCCUPATION (OCC)

___Pre-College (PRE) ___College (COL)

___Professionals (PRO) ___Other (OTH)

IX FIELD (FLD)

___Science (S) ___Mathematics (M)

___Engineering (E) ___Combined Fields (C)

___Non-Specific Fields (N)

X PURPOSE (PP)

___Recruitment (REC)
___Retention (RET)
___Information/Awareness (INA)
___Performance (PER)
___Interest/Motivation (ITM)
___Attitude (ATT)
___Multi-purpose (MTP)

XI TYPE (TY)

___Program (P)
___Research (R)
___Program/Research (PR)

XII MECHANISMS (MC)

___Instruction (IN)
___Tutoring (TT)
___Placement (PL)
___Counseling (CN)
___Field Trip (FT)
___Hands On Exp. (HO)
___Role Model (RM)
___Discussion (DC)
___Lecture (LT)
___Financial Aid (FA)
___Internship (SH)
___Therapy (TH)
___Parent Involvement (PI)
___Peer Support (PS)
___Hand Out (HD)
___Other (OT)

XIII FOCUS (FC)

___Educational (ED)
___Socio-Cultural (SC)
___Economic (EC)
___Informational (IF)

XIV M-A DATA AVAILABLE (DAT)

___Yes (Y)
___No (N)
___Can be requested (R)

XIV COST _____

# APPENDIX B

## DATA STRUCTURE FOR "INTERV" FILE

## Data Structure for Interv File

STRUCTURE FOR FILE: INTERV.DBF

NUMBER OF RECORDS 00289

DATE OF LAST UPDATE 10/14/87

PRIMARY USE DATABASE

| FLD | NAME | TYPE | WIDTH |
|---|---|---|---|
| 001 | ACC | N | 006 |
| 002 | TI | C | 210 |
| 003 | ORG | C | 100 |
| 004 | STATE | C | 002 |
| 005 | SP | C | 032 |
| 006 | PN | C | 068 |
| 007 | GN | C | 002 |
| 008 | ETH | C | 002 |
| 009 | OCC | C | 003 |
| 010 | FLD | C | 001 |
| 011 | PP | C | 003 |
| 012 | TY | C | 002 |
| 013 | MC | C | 032 |
| 014 | FC | C | 012 |
| 015 | DAT | C | 001 |
| ** TOTAL | ** | | 00477 |

# APPENDIX C

## DESCRIPTION OF INTERVENTIONS MECHANISMS

## DESCRIPTION OF INTERVENTION MECHANISMS

1. COUNSELING implies an academic or a career orientation in which the individual's characteristics are analyzed to define their potential for educational or career choices.

2. DISCUSSION is an informational technique encountered as part of workshops. It usually follows a lecture.

3. FIELD TRIP is a site visit to industry plants, laboratories and construction areas to provide students with direct observation.

4. FINANCIAL AID consists of direct economic aid to a student for the purpose of pursuing an academic program. The extension of this financial assistance varies from one semester to a four year career program.

5. HAND OUT is usually some literature, about a program; a career description, or a school catalog.

6. HANDS ON EXPERIENCE provides practical or laboratory experience usually as part of a larger program.

7. INSTRUCTION implies a structured learning program with some assessment of what is learned.

8. INTERNSHIP is a short training provides experience in the participant's field. It comes with a stipend.

9. LECTURE is an informational mechanism provided during workshops or conferences. It usually precedes a discussion.

10. PARENT INVOLVEMENT in relation to schooling indicates assistance from parents in information sessions; in presentations of workshop topics, or other kinds of activities related to their children's education.

11. PEER SUPPORT is a technique whereby individuals sustain each other in overcoming a broad variety of personal difficulties, such as lack of motivation, low self-esteem or poor academic performance.

12. PLACEMENT is a service to facilitate the location of employment opportunities. In this context it is often a summer job in local industries or a following step to a training program.

13. ROLE MODELING involves the use of knowledgeable high achieving professionals in presentations directed at non-traditional groups - Example, a scientist from an ethnic minority; a female enginneer.

14. THERAPY applies here to the clinical treatment provided to math and science anxious people. It generally consists of relaxation techniques, desensitization methods or modification of study habits.

15. TUTORING is an educational assistance modality which provides remedial or supportive classes.

# APPENDIX N

## CASET DATABASE BIBLIOGRAPHY OF INTERVENTION PROGRAMS
## by
## POPULATIONS, SUBJECTS, AND EDUCATIONAL LEVELS

# BIBLIOGRAPHY OF INTERVENTION PROGRAMS

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The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation; neither do they reflect those of the U.S. Department of Defense, the U.S. Department of Labor, or the National Aeronautics and Space Administration.

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## INTERVENTION STUDIES

### SUBJECT

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# APPENDIX O

# GENDER DIFFERENCES IN MATHEMATICS AND SCIENCE PERFORMANCE: A BIBLIOGRAPHY

# GENDER DIFFERENCES IN MATHEMATICS AND SCIENCE PERFORMANCE:

# A BIBLIOGRAPHY

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# APPENDIX P

# PROCEEDINGS OF SYMPOSIA

# PROCEEDINGS OF THE FIRST AMERICAN INDIAN SYMPOSIUM ON SCIENCE, ENGINEERING, AND TECHNOLOGY CAREERS

May 24 - 27, 1988

# FIRST AMERICAN INDIAN SYMPOSIUM ON SCIENCE, ENGINEERING, AND TECHNOLOGY

Proceedings of the First Symposium
on American Indians in Science Engineering,
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Huston-Tillotson College, Austin, Texas

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# KEYNOTE ADDRESS

**Wilma Mankiller**

**Principal Chief of the Cherokee Nation**
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*In 1987, Wilma Mankiller became the first woman to be elected Principal Chief of the Cherokees, an American Indian tribe which now has 145,000 members. She served as Deputy Chief in 1983. Prior to that, as Director of Community Development, she initiated programs to develop rural water systems and rehabilitate houses. As Principal Chief, she has established a Department of Commerce which oversees all of the tribe's business enterprises, including use of tribal lands. She holds a B.S. degree in Social Work from the University of Arkansas. She is the recipient of numerous awards, including Woman of the Year from Ms. magazine, the John W. Gardner Leadership Award, and a citation for Outstanding Contributions to American Leadership and Native American Culture from Harvard University. As part of her mission to increase minority enrollment in colleges and universities, she has served on the U.S. Commission on Education. Chief Mankiller is dedicated to the promulgation and preservation of traditional Cherokee values and culture while advocating and advancing progressive economic development.*

I am happy to be here today to participate in this symposium. It is very important that these kinds of meetings occur.

I am going to talk to you a little bit about things I think are important for our people to know about our tribe and tribes in general. Then, I shall talk very specifically with you about some things important for people working in the scientific fields to think about.

What is interesting about me is that so much media attention has been paid to me because I am in an unusual role. I think the media have focused their attention on me because most people have a lot of stereotypes about what a chief should look like. Most people's idea, I think, of what a chief should look like is my husband Charlie Silk, or someone with a lot of feathers or on a horse. I certainly don't fit people's vision of what a chief should look like. Also, people are not quite sure what to call me. I have had people who spend their time worrying about such things tell me that *principal chief* is a male term and that they think I should call myself "Chiefette" or "Chiefstess." One woman tried for a long time to convince me that, historically, I should be called "Chieftianess"; I thought that was interesting. One old fellow thought he hit on the right title: "Ms. Chief." He was serious. He told me I was doing a good job, but because *chief* was a male term, I should call myself Ms. Chief. So that title has stuck. It fits my personality.

I will tell you a little bit about our tribe. The Cherokee Tribe is the second largest tribe in the United States. The largest tribe by far is the Navajo Nation, which is in all or part of four states (Arizona, Colorado, New Mexico, and Utah). It has a huge tribal government. We currently have about 87,000 registered tribal members, and there are probably another 20,000 Cherokees who are not registered. Most of our tribal members live in eastern Oklahoma, very near the Arkansas border on one side and the Kansas border on the other side.

We are a tribe without marketable natural resources; our principal natural resource is water. We are in the process of building a hydroelectric generating facility on the Arkansas River, which we own along with the other

tribes. We have an annual operating budget of around $50 million per year, and we employ, either directly or indirectly, around 1,200 people.

Most people wonder what a modern chief does. I spend my time doing many of the same things chief executive officers of medium-sized corporations do - trying to keep revenue coming in. I spend a lot of time worrying about fiscal matters, internal management, long-range planning, and long-range development and trying to figure out how to continue to balance things in the light of a number of budget cuts during the Reagan years. I am trying to listen to our people in eastern Oklahoma, a rural area where most of the people are very poor, and trying to figure out what we need to be doing to move toward finding solutions to our problems. So, the job is like carrying on a war, but our wars today are wars against inadequate housing, poor health care, illiteracy, and those kinds of things, so the war is very different from the wars of the old days.

I think, in order for people from the scientific community or those people who are directing programs to be brought in touch with Native American students, it is very important that we and they understand a little bit about why some of the problems exist today in our communities. With our own people and in our own communities, before we begin to undertake a major project, we put things in a historical perspective. It is important to put things in a historical perspective for you, so you will understand why some of these things exist in our communities, and so you will be able to work better in our communities.

## TRIBAL HISTORY

I am going to touch very briefly on some tribal history, our history of tribes, and the relationship with the United States Government. Many of you, particularly those of you who work in very futuristic scientific fields, probably wonder why tribes exist at all today in the nuclear age. I want to go briefly over our historical relationship and where we are today. The Federal Government deals with us today in a government-to-government relationship. That relationship was defined by our very first contact with the Europeans, with the newly emerging Americans. When we first began to deal with the United States Government, we had a definite government-to-government relationship, and the agreements we made with the United States Government were defined by agreements and treaties. When you hear people talk about treaty rights, they are talking about those agreements that tribes made with a newly emerging America.

A lot of people will argue today that the treaties are no longer valid, that they were written a long time ago, that they are not valid in 1988. That argument makes as little sense as arguing that the United States Constitution is not valid because it was written quite some time ago. Treaties are treaties and agreements are agreements, and those treaties are still valid.

After the early era when we were interacting and agreeing, we went into the war era. What the wars with the American Indian tribes were really about - contrary to what you may have read and what limited amount of American history is available or what you may have seen on movies or that type of thing - was land and land retention. Basically, we Native people were small tribes trying to retain our historical land base - that is what all those wars were about.

During the reservation era, which followed the war era, there was an attempt by the United States Government to take all the tribes and isolate them from the rest of society. When you hear people talking about reservations today, those reservations were created essentially to isolate Native people from the rest of society. There were a couple of reasons for the creation of reservations. One reason, the most obvious one, is that the historical land base of tribes was probably a piece of land, or piece of property, that the United States Government wanted to open up for settlement. The Government would physically remove people from their homeland and put them on a reservation. Another reason - and you can find a lot of discussion of this in historical documents - was that the Europeans did not understand American Indians. Because the Europeans did not understand the Indians, they thought that they should be isolated and put away somewhere removed from the rest of society. One graphic example of the difference in thinking between the Europeans and the Native people was the concept of land ownership. You can look at historical documents on our tribe - and I am sure the same is true for other tribes - and see that our tribal leaders were trying to grasp the European concept of private ownership of land. The Europeans were trying to grasp Native people's understanding that you could

not own a river or a mountain or a lake or a piece of property, that it belonged to everyone and everything. Because there were these misunderstandings between the people, the United States Government felt it was better to isolate the tribes. There, the land issue, the desire for the land of the tribal people, was the overriding issue.

And there was the other issue of cultural misunderstandings. Another cultural misunderstanding that has occurred about our tribe concerns our own constitution. Our tribe has had a constitution since the beginning of time. Our constitution is placed on a *wampum* belt. To a European looking at our wampum belt, it looks like a beautiful beaded belt but has no meaning at all. But to us, the placement of the beads and the color of the beads indicate very complex systems for ordering our society, complex value systems and beliefs, and principles of democracy. There were these kinds of cultural misunderstandings about our people.

## CHEROKEE TRIBAL HISTORY

In relation to the reservation era, every tribe has a history and a story of what happened to its people. I will tell you very briefly what happened to our tribe, for every tribe has a different story.

The Cherokees were in the southeastern part of the United States. We were very prosperous agricultural people. We were fairly sophisticated - we had a very sophisticated political system and a sophisticated military. In the early 1800s gold was discovered on our land - in Georgia, North Carolina, Tennessee, and that part of the country - and discussions began about removing us to Indian territory, to what is now Oklahoma. Our chief then decided to fight this battle in the courts rather than on the battlefield. He took our case to the United States Supreme Court to try to prevent our removal to Indian territory. All the tribes that were being removed to Indian territory were being put on reservations, but our chief was trying to prevent that from happening to our tribe. Our chief took the Cherokees' case all the way to the United States Supreme Court, and won. The United States Supreme Court issued an order saying, basically, that we could not be removed. President Jackson, however, said, "You've made an order - now try to enforce it," and we were removed. The removal to Indian territory (now Oklahoma) ended in 1838. That removal bitterly divided the tribe. About half our tribe wanted to stay in the Smokey Mountains and fight to the death to remain in their homeland. The other half of the tribe said it was inevitable, that these people were all around us, and that we might as well go on to Indian territory. So we went to Indian territory, escorted by the United States Army. On that trail, which we call the *Trail of Tears*, from the Southeast to Oklahoma, we lost one fourth of our tribe - about 4,000 people. When we arrived in Indian territory, we began to immediately revitalize and revise our troubled government.

> ***"When we were in charge of our own school system, in our male and female seminaries we taught Latin, botany, trigonometry, geometry, and many subjects important for the general education of our students."***

From 1838 to the end of the last century, we entered what I would like to call the golden era of the Cherokee Nation. Despite the political division and the fact that families had been torn apart, that our social system was in disarray, and that we had all kinds of problems, we began to revitalize our tribe. We established the first schools west of the Mississippi, Indian or non-Indian. We established institutions of education for women, a very radical idea at that time in that particular part of the world. We established our own newspaper, in Cherokee and in English, and we established our own economic system and our own judicial system. The oldest buildings in Oklahoma are the Cherokees' Supreme Court buildings and other governmental buildings, which are beautiful monuments to our tribal government.

When we went to Oklahoma, we were promised the right to remain there to practice our culture and our tribal government forever. What actually happened is that the Civil War occurred, and much of the Civil War occurred in Arkansas and over into Oklahoma, and divided the United States. When the United States came

out of the Civil War, the Government began to talk about opening up Indian territory to settlement. Thus began the famous Oklahoma Land Run. In 1906, the State of Oklahoma came into being. Our tribe was again completely abolished, our court system was torn apart, and our tribal government was taken apart. Land that we had held in common was given out in individual allotments to individual tribal members. And, for all intents and purposes, our schools were closed and our newspapers were shut down and we had no tribal government.

From 1906 to 1971, our principal chiefs were appointed by the President of the United States. I think that is important for you to know because it puts things in a historical perspective. Our story is not really that different from the story of any other tribe in the country. When you have that kind of history of destruction, and you revitalize and rebuild, you have a little idea of how it came to pass that we are in the situation we are in today.

*"The course in rocketry really caught the attention of the young people, and it increased their interest in math and science."*

During the period when we had no tribal government and our own people were not involved in the education, health, and housing of our tribe, we entered an era of unprecedented decline. When we were in charge of our own school system, in our male and female seminaries we taught Latin, botany, trigonometry, geometry, and many subjects important for the general education of our students. When the state of Oklahoma came into being, the Oklahoma State Legislature, for example, passed a resolution that automatically gave two years of college credit to graduates of our male and female seminaries (our high schools) because of the high level of education we were giving our children. Then we lost control of our educational system and our health system and had no central tribal government per se, we entered an era of unbelievable decline. We became - in eastern Oklahoma - the poorest of the poor, and our educational statistics were terrible. The county I lived in was one of the poorest counties in the United States, not just in Oklahoma. We went on in this downward trend, and we did not begin to dig our way out of it until 1971, when the tribal government began to revitalize itself. Very briefly, what happened is that one of our chiefs, a tribal member and also the Chairman of the Board of Phillips Petroleum, did not like being an appointed chief. He decided he would like to set things in motion for re-establishing an elective system of government. He became our first elected chief in 1971, so we have really been organizing ourselves since 1971.

## FACTORS AFFECTING CHEROKEE REVITALIZATION EFFORTS

In our revitalization efforts to dig our way out from the bottom up and re-establish an economic base and a decent educational system, adequate health care, decent housing, and those kinds of things, we need technical people. We do not have enough technical people. That is a serious problem not only in our tribe, but also in other tribes in the United States. There are a number of reasons why we do not have the technical people we need.

One of the reasons is that many of our young people are educated in rural and reservation schools. The rural and reservation schools do not provide adequate preparation for children to go into scientific fields, so that when they try to get into college and compete and enter programs, they are totally ill-prepared. There are some supplemental programs, post-high-school programs like the summer program operated by the Council of Energy Resource Tribes that you will hear about and a few others, that help children from the rural and reservation areas.

Another problem is there are too few highly visible Native people in scientific areas. There are more and more people in scientific fields, but that trickle-down effect, through which Native students are able to talk to and visit with these people and see them as role models, has not yet occurred. I have run into some very good Native role models, particularly young people. Somehow or another, we need to make sure that Native students

who are thinking about careers in scientific areas are able to interact with those people or at least know something about them, know they exist, and see them as role models.

Another factor I think is important is tribal differences. The counselors and the people who run programs, and who are responsible for recruiting and counseling Native people, do not take into consideration the cultural differences between Native people and the general public, and the cultural differences between tribes. One of the worst misconceptions about Native people I have encountered in traveling around the United States and abroad is that there is an American Indian culture of some kind - that all the tribes can understand one another. People wonder why, for example, Native people do not have a Jesse Jackson or a Martin Luther King. Well, it would be impossible for us to have someone like that because we are still tribal people - we are very different. All our tribes speak different languages. In our tribe, there are thousands of people who are still very fluent in Cherokee, and we have a written language. We also have our own art forms and our own social system. The Navajos have their own language, their own social system. The Sioux have their own language, their own social system, their own art form, their own culture. So I think there needs to be more general education about the cultural factors. It is important for counselors and recruiters to know about Native people in relation to the larger population and inter-tribes.

***"We have always been told that our tribe makes great baskets and does wonderful beadwork and great weavings ... that we are good with our hands but not particularly good with our heads..."***

## PROPOSED SOLUTIONS TO THE PROBLEMS FACING TRIBES

Given these factors, I thought a lot about what can be done. There are several things I would like to talk about briefly that I think are important for all of us to do. One is that individual tribes should be encouraged to develop programs that encourage young people to enter scientific fields. If there are resources or technical assistance, those kinds of things could be made available to tribes as a way of encouraging tribes to get involved in promoting scientific fields to the young people.

In our tribe, we operate a boarding school, which is a former BIA (Bureau of Indian Affairs) boarding school. This school has always been operated as a school for children who were not able to compete academically, children who were not able to stay home because their parents were not there, and that type of thing. It has always been a school for troubled children. We took over the school almost two years ago, and we began to do some different things. We have developed a Saturday Academy at our school. Our school is called Sequoyah Indian School. In the Saturday Academy, for these children who have never been exposed to anything like this before, we introduced rocketry. The course in rocketry really caught the attention of the young people, and it increased their interest in math and science.

One of the things that could really help a lot in getting the attention of Native students would be for NASA to have representatives visit with the tribes. I do not know any Americans who are not fascinated by space, and who would not be intrigued by meeting or hearing from an astronaut or seeing some of the things that are developed here at NASA. Of course, it is physically impossible to visit at intertribal educational meetings. So I think that might be something you might want to consider in your workshop and discussions - just having more representatives from NASA develop relationships with the tribes.

The other thing that is important is that programs like the summer program by the Council of Energy Resource Tribes need to be supported. The summer program is called T.R.I.B.E.S. (Tribal Resource Institute in Business, Engineering, and Science), and the basic intent of the program is to try to encourage people to go into scientific fields. It is an intertribal organization, an intertribal summer program. Some Cherokee students have attended that program. Those kinds of programs around the United States should be supported and provided with both technical assistance and resources, if they are available. More attention should be paid to

post-high-school preparation for getting children who come from reservations and rural colleges ready to enter college.

Finally, we need to continue this kind of dialogue and other forums for cross-cultural education and understanding between counselors and recruiters and people in scientific fields so there is a greater understanding of some of the unique educational needs of Native people.

Within the Native community, it is important for all of us to try to do as much as we can to eliminate stereotypes. The problem with stereotypes is that people tend to believe the stereotypes themselves after a while. We have always been told that our tribe makes great baskets and does wonderful beadwork and great weavings, but I do not think anyone ever really looks at what we are able to do with our own educational system. We hear so often the stereotype that we are good with our hands but not particularly good with our heads that we start to believe negative stereotypes ourselves. So I think it is very important for those of us who get out and about and talk with people to make sure we try to eliminate as many of those stereotypes as possible, by giving concrete positive examples of Native people who are settling in scientific fields.

*"We decided that high school preparation for entering college and being able to compete is not enough - you need to start with good prenatal care."*

## QUESTION AND ANSWER SESSION

Question from the floor:

At what level do you think we need to start preparing our children for higher education pursuits?

We are starting with the children. At this point, for our tribe, we are doing it in high school, but I think that, if the resources are available, it should begin in Head Start. This year, I joined the United States Commission on Education. The group, consisting of minority people from around the country, is trying to find out how to increase minority enrollment in college because minority enrollment is actually declining. We decided that high school preparation for entering college and being able to compete is not enough - you need to start with good prenatal care. Most people do not want to deal with that because it requires a really strong commitment of resources - a lifetime of resources - but that is basically our conclusion. You cannot just begin to talk about higher education when children get to college, and that is what is happening with our kids.

Question from the floor:

How are you approaching the problem of educating the increasing numbers of minorities?

We had a debate about this issue. The people on this committee are Coretta Scott King, Mayor Henry Cisneros from San Antonio, and Dr. Frank H. T. Rhoades, the President of Cornell University. There are a lot of people who are able to influence people in this country. One of the ways we are going to try to sell our idea to the American business community is by telling them that the minority population in this country is increasing and that if we do not make a commitment to education, it is going to negatively affect the entire country. It is not just going to affect reservations and urban areas and Hispanic communities and Black communities and Asian communities - it is going to affect everybody and everything unless we deal with education and minority people in this country. So we are appealing to the selfish rather than the altruistic interests of Americans by saying this is going to be good for the economy. One interesting thing in that same vein is that a lot of Americans look at the increase in

minorities in this country as something bad. Actually, it is our contention, and this group's contention, that it is a cause for celebration - that the increase in the minority population in this country will improve the understanding between cultures, and that it enriches the everyday life of all Americans. People should be celebrating it, not pretending it is not occurring. So we are trying to make a strong positive statement. But it is a serious, serious concern, whether you are in a little tribe in Oklahoma or at NASA, or anywhere. The minority population in this country is increasing, and higher education enrollment of minority people is declining. We have a serious problem that is only going to get more serious if we do not do something about it.

Question from the floor:

Isn't it the tribes' responsibility to educate their own people?

Without a doubt. Well, I think it is up to the tribes to develop the economic base and the interest structure at the tribal land base so we can provide employment for people. It is unrealistic to assume that someone will get a good education in a scientific area and then come home and volunteer their time or work for poverty wages, so it is up to us to try to develop the structure that will bring them home. My father believed that. He was a product of an Indian boarding school; he was a bilingual full-blooded Cherokee. He believed that the way to survive in the world was to leave your culture behind and go out in the world and compete and learn all these skills. What I have been saying for a long time - and I think our history will bear this out - is that you *can* remain a strong tribal person and do and be anything you want to be. I think the next generation feels this even more strongly. So what I try to tell people is that being a tribal Cherokee is having a particular value system - it is not eating specific foods or wearing specific clothes or attending specific tribal ceremonies, but rather a value system you can take with you to NASA to be an astronaut, or to engineering school, or wherever. I think it is an important part of this whole process. I am sure they are telling the children in certain kinds of programs that you can have the best of both worlds - that they should just go out and get a good technical education and go home to help in this whole revitalization effort.

Question from the floor:

Have you made recommendations about minority programs being run by minority people?

There is some language to that effect, but there are no specific recommendations because it is a general statement of the problem - an expression of critical concern, but nothing specific.

Obviously, there is a commitment to making sure that if there are programs designed, they are designed by minority people. But there is no specific set of recommendations because what has happened before throughout all of the different times is that people will disagree with some specific recommendation and spend all of their time arguing it out rather than making a general statement of principles.

Question from the floor:

Do you believe that tribes should have control of their own educational systems?

Sure. I believe very strongly that when we have control of our educational systems, we do much better. We have very good historical evidence that would support that. When we lose control, we run into terrible problems, which is what has happened to us in the last 60 or 70 years.

Question from the floor:

Has there been an effort among the tribes to unite politically?

There have been several attempts, and there are dozens of national Indian organizations with varying degrees of effectiveness in becoming a political voice. The problem comes, again, when you try to get a lot of people with very different agendas to agree to one political platform. If you talk to somebody from Washington State, they don't care about coal or oil or any of those things; what they care about is their desperate battle over fishing-rights issues. They don't want to come to a national conference and talk about what is happening with the BIA in the Royalty or Mineral Office. You talk to somebody from southeast Arizona or New Mexico at a national conference, and they want to talk about what is happening with coal and those kinds of things. So, with certain limitations because of the vast differences between tribes, there are intertribal organizations that are very effective. What I do, personally, is to have an informal alliance with four or five other very powerful tribal chairpeople, and when we have a piece of legislation we would like to pass, rather than doing some kind of national campaign, we just quietly work at our different state delegations and are usually successful. We just tried to get some 8-A legislation, and it passed because of the fact that one of us could go speak for four very large tribes. So there are some coalitions like that in some very good national organizations. We have the National Indian Education Association and the National Indian Health Board, very good organizations and very effective.

Question from the floor:

Do you see education outside the reservation as a threat to family life in the form of abandonment of tribal ways?

Actually, it has been our experience in eastern Oklahoma - and I do not know whether the experience of other tribes is similar - that people are not very willing to leave home to seek employment elsewhere. We have had Ph.D.'s working at the gas station because they did not want to leave their family and their community and their tribal members. So it is not a real threat to our tribe in that sense. We do have though, as do most tribes, a number of people who have received a good education and chosen to live and work elsewhere. I don't think that is the most critical problem facing the tribe. The general state of the economy in Oklahoma and Texas and Louisiana, and all the states affected by the oil situation, has had an impact on our tribe, but only in a peripheral way. We do not have a lot of marketable natural resources ourselves, so some of our people worked in industries that supplied the oil industry. So, it has had a minimal effect on us.

★

# OPENING PRAYER

**Wallace Coffey**
**Chairman, Comanche Tribe**

**Executive Director, 1985-1991**
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**4407 Morrison Road**
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*O Merciful God, Heavenly Father, Creator of all living things, as we come before you on this day we want to continue to give our thanks, not only for the opportunity to come together in fellowship and friendship, but also for the opportunity to come together and share our experiences to ensure opportunity for children and the many different cultures we represent. And, Heavenly Father, we especially want to call upon your guidance and direction to ensure that our Indian people in the future will have opportunities in science, engineering, and technology.*

*And, Heavenly Father, at this time we especially want to give thanks for our hosts who have made our stay enjoyable and comfortable.*

*Our Most Gracious Heavenly Father, as we continue to pursue the process of education, continue to look down upon us. Take pity upon us, O Heavenly Father, and help us to ensure that our future direction for our children will be a high priority, not only in our lives, but also through your direction. Please give us the encouragement, the guidance, and the direction necessary to ensure that our information shared today will be taken into consideration by this organization.*

*For all these things, we come to you, Our Heavenly Father, under your precious Heavenly Name.*

*Amen.*

# WHY "TRIBES" MAKES A DIFFERENCE

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*Lucille A. Echohawk (Pawnee) is Associate Director of the Council of Energy Resource Tribes (CERT) and Vice President of the CERT Education Fund. Lucille Echohawk earned her B.A. from Brigham Young University and her M.Ed. from Loyola University of Chicago. Recognized as a national leader on policy and education issues, Ms. Echohawk is a strong advocate and exemplary role model for Indian youth. She is actively involved in community and national organizations, serving currently on the Board of Trustees for Mile High United Way in Denver and the National Board of Directors for Girl Scouts of the U.S.A., and as Chair of American Indians For Ben Nighthorse Campbell In Congress.*

On behalf of the 43 Indian tribes that comprise the Council of Energy Resource Tribes (CERT), I want to thank the members of the CASET project and all of you, for the opportunity to be here and share the work we have done in education within CERT, and some of our ideas for the future. As you might guess, the fields of science, engineering, and technology are of vital concern to Indian tribes that own energy resources.

## TRIBAL RESOURCES

I am often amazed at the surprise of people in this country who do not know about the tremendous natural resources that Indian tribes still own, although we have a fraction of the land base we began with in our land that we now call the United States. Tribal resource holdings are still substantial. Just a little sampling: Indian tribes own about half of the producible uranium in this country, about 4 percent of the oil and natural gas resources, and a third of the low sulfur coal west of the Mississippi. We read mostly negative things about the early days of Indian resource development - improper royalty accounting and environmental damage. However, many tribes have substantial energy resources yet to be tapped. In 1975, 25 Indian tribes came together to form CERT, not only to better manage their resources, but also to find out more about their resource holdings to protect them or develop them more prudently in the future.

A particular tribe that comes to mind is the Northern Cheyenne in Montana, with tremendous coal reserves, none of which have been developed. In the early 1970s, a number of coal leases were negotiated, mainly by the U.S. Department of the Interior, with various major coal producers. The tribe went to court and to Congress to cancel those coal leases. After a long period, it was successful in canceling them. To date, those coal reserves

are in the ground because that is where the Northern Cheyenne people want them to be. But they continue to study and look at options for prudent development of those coal resources in the future.

And, as the tribes seek to better manage their remaining energy resources, obviously something very important in their minds is Indian technical talent to help in the management of those resources.

## FORMATION OF CERT

When the tribes came together to form the Council of Energy Resource Tribes (CERT) in 1975, Indian human resource development was very high on their list of objectives. CERT began as 25 tribes, and today consists of 43 member tribes. Collectively, these tribes comprise more than 50 percent of the on- or near-reservation Indian population in the United States and about the same percentage of land base. As a coalition, they are an important tribal presence.

## GOVERNING BOARD

The governance of CERT is accomplished through a board of directors. It is one tribe, one vote; regardless of how much energy resources a tribe has, it still has one vote on the CERT Board of Directors. The person who serves on behalf of the tribe is usually the chief elected person in the tribe - the chair, governor, president. It is always an accountable tribal official, and he or she serves on behalf of the tribe, not on behalf of himself or herself as an individual.

## MEMBER COMMITMENT

What makes CERT unique among national Indian organizations is the very real commitment from the members of the organization. Not only do they take seriously the business of governing the organization's activities, but they also spend their own tribal dollars to come to board meetings, seminars, etc. CERT has two full board meetings a year and about four executive committee meetings of the board. It is truly extraordinary that tribes put aside those dollars and spend them to come together. They come together because they recognize their common interests and collective strength. They have a technical advisor who assists them as their tribal governments seek to better their governing capabilities and to manage the land base left to their people.

## CERT'S ACTIVITY IN THE FIELD OF EDUCATION

As I mentioned from the outset, the member tribes of CERT made education a high priority, and to that end, in 1979, they commenced program activity. They chose the precollege period. The first precollege institutes were held in the summer of 1980. These were four-week summer programs held on a number of college campuses, including the University of Idaho and Arizona State University.

## TRIBAL RESOURCE INSTITUTE IN BUSINESS, ENGINEERING, AND SCIENCE (TRIBES)

By 1982, CERT's precollege program became known as the Tribal Resource Institute in Business, Engineering, and Science (TRIBES). We are complimented on our acronym TRIBES. I wish I could say it was an American Indian who named the program, but it was not. It was a professor at Colorado College, where the first TRIBES program was held in 1982. We also worked cooperatively with Winona Simms and many of her colleagues at the University of Oklahoma to sponsor another precollege program, the American Indian Business

and Engineering Education Center (AIBEEC). That effort facilitated recruitment and retention efforts that were already ongoing at Oklahoma University and have since continued.

> *"Eighty-two percent of our student respondents indicated they were underprepared when they entered the TRIBES program and were elated to find later that they could excel in certain areas of study."*

Although CERT was glad to be a part of that effort, we realized we needed to consolidate what CERT was doing in education and make it manageable. So we consolidated the program effort in Colorado at Colorado College to enable the staff to be more involved in the design and the conduct of the summer precollege program. Since 1987, TRIBES has been at the University of Colorado at Boulder. It continues to be an eight-week, highly intensive academic enrichment experience for Indian students interested in career fields in resource management. Students may receive up to 12 semester hours of credit for the experience.

We rather pride ourselves on the fact that CERT's program is funded through private sources. It is important to many of CERT's members that the CERT organization not compete with its own member tribes for money. Since tribes rely so much on Federal monies, CERT's education program is funded strictly through private contributions, and those traditionally have come through an annual fundraising event. It is a black-tie dinner for about 400-600 people called the American Spirit Award Dinner. We are pleased that the event has been held in Houston twice, in 1984 under the sponsorship of Texas Eastern Corporation and then in 1987 under the sponsorship of the Enron Corporation. Both events generated substantial revenue for our program.

## CERT EDUCATION FUND

In 1986, the CERT Board of Directors formed a separate corporation that would ensure that education remained a high CERT priority, called the CERT Education Fund, Inc. The CERT Board of Directors draws, from its 43 members, seven members who govern the activities in education in behalf of all the CERT tribes. The chair of the CERT Education Fund, presently, is the Spokane tribe of Indians. The vice chair is the Yakima Nation, and the other members are the Oglala Sioux, the Northern Cheyenne, the Salish and Koutenai, and the Cherokee Nation of Oklahoma. It is truly a compliment to the dedication of these tribes that, since the formation of the CERT Education Fund, we have never had a problem getting a quorum for meetings of this board. I can only think of a couple of instances where we had absences. If full board members cannot attend, themselves, they send a representative, at their expense as it is with their regular CERT board activities.

They have set out four major goals of the Education Fund, which pretty much mirror those originally set in 1979. The first one is the precollege program that we call TRIBES. The second is scholarship assistance. Our scholarship fund is administered jointly through the American Indian Science and Engineering Society (AISES). CERT raises scholarship monies and transfers it to AISES. AISES handles our application process. We review its recommendations and make the final decisions on awards. It is a great working relationship, and we do not have to hire more staff and incur administrative expense that can better be used in direct scholarships for students. So we plan to continue the relationship with AISES, and hopefully enhance it as the years go by. The third goal of the Fund is to expand the career opportunities of American Indians in science, engineering, and related fields by providing internships - that is, work experience in private industry, federal and state government, as well as tribal governments and enterprises. This is an area we are going to place heavy emphasis on beginning this next year. The last goal is to assist individual tribes to realize their own educational policies through program development. We would like to see that at the tribal level rather than at the CERT level, but how we will accomplish that is the big test. At present, we do not have any specific answers in this area.

The two goals we are actively working on presently are: 1) the continuation of the precollege program, TRIBES, which is for recently graduated Indian students interested in fields related to energy resource management; and 2) scholarships. With the continued cutbacks in Federal funds available to assist Indian people

in higher education programs, our board is very anxious to look seriously at establishing an endowed scholarship fund that will provide full scholarship assistance.

## HAS TRIBES MADE A DIFFERENCE?

In the last year, we have been pulling together information about what has happened to the more than 400 students who have gone through CERT's precollege programs. Where are they? What are they doing? How many of them have graduated and in what fields? Did TRIBES make a difference?

I had the good fortune of having a research assistant for a year who participated in TRIBES and received a B.S. degree in physics from Colorado College in December 1986. I assigned her the task of developing a questionnaire and finding those who had gone through this program since 1980. Through her creativity and stick-to-it-iveness, we have received a 60 percent return on the questionnaires. I do not know exactly what the actual number is, but 60 percent of those surveyed responded to the questionnaire. We are now in the process of compiling the data.

What I have done, for this symposium, is to just get the flavor of that data; but it strongly documents the need for TRIBES, in that the program made a definite difference in the students' success in college. Early on in the process, I was very concerned because we all know how often young people change their mind, and I worried about how many of these students would actually secure a degree in a technical field, even though they expressed an early interest in it. We were very surprised at the great majority who in fact did finish with a degree related to what we gave them money for.

One thing Rick Williams may talk more about is the living arrangements for TRIBES - whether they make a difference. Since 1987, TRIBES participants at the University of Colorado are housed together. Of our respondents, 85 percent report that that kind of living arrangement definitely enriched their participation in the life of their college community and that it brought them closer together. Bonds that are created in that eight-week summer experience go on for years and years.

Eighty-two percent of our student respondents indicated they were underprepared when they entered the TRIBES program and were elated to find later that they could excel in certain areas of study. Some of those areas mentioned were math and precalculus. They felt more confident of their academic capabilities when they then chose their college courses.

We received tremendous testimonials on TRIBES. I am sure all who administer programs feel immense pride when people tell you what a difference it all made. Often, I envy people like Rick Williams who are actually there with the students through the eight-week experience, while I do much of the other end. I am writing budgets and contracts, and I am raising the money and planning the board meetings.

In 1987, an annual reunion of TRIBES students was instituted in conjunction with AISES's national conference. They are delighted to come together to renew friendships and share college experiences. We hope to facilitate their coming together in a reunion atmosphere more often.

In closing, I would like to share with you one other thing CERT is involved in. Last October [1987], Harvard University sponsored a gathering of transition programs for minority students. Quite frankly, I was appalled to arrive at this prestigious meeting to discover that we were the only Indian transition program they knew of. Two things were quite apparent: (1) there was not a good directory or resource list of transition programs at any level for Indian students; and (2) there were not immediately available any hard data on the difference that Indian transition programs have made. I volunteered to at least make an initial effort to develop a directory of Indian transition programs. I asked my research assistant who had done such a great job with our student questionnaire to take on this task. Our preliminary list of transition programs is available for your review. If you know of additional programs that are not included, please contact us.

We need to be in touch with one another in our transition program efforts to get a better handle on available data to better plan for the future. We need data that can really show we make a difference, and we need to discover new financial resources to ensure continuation of these important programs. We also need to reach younger students.

It is a privilege to be a part of this important gathering and to share CERT's education efforts. I look forward to learning from each of you.

★

**APPENDIX A**

# *FACT SHEET*

## CERT EDUCATION FUND, INC.

The Council of Energy Resource Tribes (CERT) is a private, non-profit coalition of American Indian tribes that own substantial reserves of energy resources. Founded in 1975 by 25 Indian tribes, the coalition has grown to 43 tribes today. Collectively these tribes constitute approximately 50 percent of the on and near reservation Indian population of the United States.

CERT is governed by the elected membership of the member tribes and assists them in their efforts to attain self-government and self-sufficiency. To this end CERT provides a wide range of technical services to help the tribes develop stable economies, protect their natural and social environments, and manage their energy resources.

Recognizing that trained and experienced Indian people are essential to the achievement of CERT's goals and that American Indians are severely underrepresented in the engineering, science, business administration and related fields, the CERT Board of Directors has made education in these fields a very high priority. In 1986 the Board created a subsidiary corporation, the CERT Education Fund, Inc., to ensure that education would remain a very high priority.

To date, the CERT Education Fund, Inc., formerly CERT's Comprehensive Indian Education Program, has assisted more than 350 students in their education pursuits since the program's inception in 1979. The continuing goal of the program is to enhance the opportunities for academic success among Indian students in the fields of engineering, physical science, and business.

The program has two distinct activities. They are the sponsorship of an intensive summer academic college institute and the provision of financial aid and scholarships to college and university students in need.

### Tribal Resource Institute in Business, Engineering, and Science

The eight-week summer academic college institute, the Tribal Resource Institute in Business, Engineering, and Science (TRIBES), is specifically aimed at recent high school graduates of high academic promise for success who have chosen to continue their education in the engineering, physical sciences, or business disciplines. TRIBES '88 will be hosted by the University of Colorado in Boulder.

The program strengthens students' skills in English, physical sciences, and mathematics, and provides them a first-hand experience with college environment in advance of starting their critical freshman year. In addition to earning college credits, students also receive further guidance for careers in technical fields of study. Each year's program has exceeded the prior year's success in terms of students completing the institute. There has been a gradual and effective move toward intensification of the academic curriculum of the program. The curriculum is demanding and extremely worthwhile in preparing the students for their first year of college.

### CERT Academic Scholarship

During the academic year financial aid in the form of scholarships is available to promising Indian students who complete the TRIBES institute and are majoring in engineering, physical sciences, and business disciplines. CERT had developed a cooperative relationship with the American Indian Science

and Engineering Society (AISES) to maximize scholarship assistance opportunities. From the CERT scholarship fund, AISES awards amounts ranging from $500 to $1,000 per year, with priority given to students who have successfully completed TRIBES. AISES has student chapters on many college and university campuses where CERT students attend.

The CERT Foundation Fund, Inc. is funded each year by donor contributions. Thus, the level and extent to which CERT is able to support its education program activities is dependent upon the success of its fund raising activities. For additional information about CERT and the CERT Foundation Fund, Inc. please contact Lucille Echohawk, Associate Director at the following address and telephone number:

Council of Energy Resource Tribes
1999 Broadway
Suite 2600
Denver, Colorado 80202-5726
(303) 297-2378



# AMERICAN INDIANS: SCIENCE AND SELF-DETERMINATION

**Norbert S. Hill, Jr.**

**Executive Director**
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**1630 30th Street, Suite 30**
**Boulder, Colorado 80301**

*Norbert Hill is an Oneida Indian raised on a tribal reservation near Green Bay, Wisconsin. He has an M.S. in Guidance and Counseling from the University of Wisconsin at Oshkosh and is currently pursuing a doctoral degree in education. He has been active in the development and administration of educational programs for American Indian and other educationally disadvantaged students for more than 15 years. While at the University of Colorado at Boulder, Norbert Hill was instrumental in establishing the Annual Native American Career Conference, the American Indians in Science Project, the Science and Self-Determination American Indian Upward Bound National Demonstration Project, the American Indian Science and Engineering Fairs Project, and the All-Indian Long-Distance Runners' Training Camp.*

*As Executive Director of AISES since 1983, he has transformed the organization from a professional society to a major national resource in Indian education. In June 1988, Mr. Hill became the first American Indian to receive the prestigious Reginald H. Jones Distinguished Service Award presented by the National Action Council for Minorities in Engineering (NACME).*

I would like to share some of the things AISES does, because we are proud of some of the things we have done. However, we have a long way to go before we come even close to accomplishing our objectives for Indian people or tribes.

I have today a 50-minute tape, and then I shall add a few other things, and hear what the rest of you have to say. I would just like to introduce this presentation by saying that for Ellison Onizuki who was killed in the Challenger tragedy a couple of years ago, flying was his second mission. His first mission was to take an eagle feather into space. The eagle feather traveled 1.5 million miles in 72 hours and circled the globe 48 times, 24 times the speed of sound. The eagle feather probably traveled less physically than any other eagle feather in the history of humankind. When Onizuki brought it back, he said, of course, he wanted to take it on the next mission with him. I said, "You know, a non-Indian holding on to this eagle feather would probably get arrested - but with the amount of training the government has invested in you, you will not spend a minute in jail."

He said, "I want to ask my supervisor if I can take it on my next mission." And they can take stuff with them, as many of you know. When he brought it back the first time, he said, "This gift is too great for me to keep, and I would like to give it back to Indian people and to you as a sense of inspiration to help young people to become whoever they want to be, and perhaps astronauts, in the future." I think that was important. He wanted another eagle feather, which he was not able to take, for whatever reasons, on the second mission. I was just amazed to see a Brown astronaut and felt honored by that. He grew up on a "Pineapple Reservation." He was

a poor kid, and he became an Eagle Scout. Much was associated with the eagle in Onizuki's life. If you really look into a lot of the details of the patch he wore on his first mission - each patch is a different piece of artwork that the crew designs. I do not know how many there have been, but that is the only patch I am aware of that has an eagle on it.

Christopher Echohawk, Lucille Echohawk's nephew, works at the Goddard Space Center as an aerospace engineer on the Space Station. He has been working there for a couple of years and is interested in being an astronaut someday. So I think we are moving toward our objectives, and we are quite proud of him. And they are going to be doing a story on him, and we will carry it and share it with other young Indian people, so they know that they can do it, too. I think that is part of our mission with AISES.

This tape was made possible through the cooperation of CERT (Council of Energy Resource Tribes). The story is important to know.

## Transcript of videotape

Once great nations occupied this land. Nations bounded by rivers, forests, mountains, and distant mesas. The land belonged not to them. They belonged to the land. They lived in harmony with the land, the air, and the water. They built cities with paved streets, running water, and communications networks. They trained to be architects, physicians, artists, and scholars, as well as hunters and warriors. Each tribal nation knew itself by a name in its own tongue, meaning simply, "the People." And then one day, Europeans came. For the People, life was never the same again.

At first, the White man wanted gold and pearls. And when they found none, they settled for furs, and finally they took the land itself. The People, now called Indians, had little to match the weapons of the invaders. With each new wave of European settlers, new laws and treaties made solemn promises to the Indians; and, each time, another promise to the Indians was broken.

In 1830, the Indian Removal Act turned the Native Americans into refugees within their own land. This act allowed the President to move the eastern tribes to land west of the Mississippi River. It was deemed to be the most worthless land on the continent.

Then gold was discovered in the West, and the rush to settle the Indian lands began. The Indians fought back in a last, desperate effort to survive as an independent people. The Indian War raged for 40 years. By 1890, it was all over. The great nations no longer set their boundaries by the ancient landmarks. They were now confined by lines drawn on a piece of paper. On the reservations, they were left in poverty, without jobs and without hope.

The U.S. Government, which had taken away the land, now began to strip them of their culture. No longer did the young learn the old ways. Instead, they were taken away to Indian schools to learn civilized ways. The chiefs of the six nations saw the folly of it. "Several of our young people were formally brought up at the colleges of the northern provinces," they wrote. "They were instructed in all your sciences. But, when they came back to us, they were bad runners, ignorant of every means of living in the wood, unable to bear either cold or hunger, knew neither how to build a cabin, take a deer, nor kill an enemy. They spoke our language imperfectly, were therefore neither fit for warriors nor counselors. They were totally good for nothing."

Yet the Indians continued to journey to Washington to petition for their rights. They failed to win much from a U.S. government bent on fulfilling a policy of manifest destiny. They did, however, catch the attention of some of the great photographers of the time, who captured on film the dignity and power of a people refusing to admit defeat.

"We are fast vanishing," Geronimo said, "Yet I cannot think we are useless, or God would not have created us." During this time, a new and more valuable kind of gold, black gold, was discovered on Indian land, and a new invasion was set to begin. Over the next 50 years, leases worth hundreds of millions of dollars were signed between the western tribes and energy entrepreneurs whose names and fortunes became legends. But gradually, these First Americans were becoming the last Americans. Now they were visible only in popular myths - Buffalo Bill, cowboys and Indians, and that great long-running national morality play, the Western movie. The reality was grim. The Indians on their reservations were

forced to watch the American dream pass them by. Tribal leaders continued to journey to Washington even if their visits seemed mostly ceremonial. They saw the truth in Sitting Bull's admonition to the Sioux children: "In future, your business dealings with the Whites are going to be very hard," he said. "We older people need you to help us understand what the White men are up to. My grandchildren, be good. Learn all you can."

By 1974, nearly a century after the first discovery of oil in Oklahoma, the tribes began to take stock of their resources. Clearly, the formerly worthless land of the Indians contained uncounted wealth in energy, not only petroleum, but coal and uranium. They found that many past leases negotiated on their behalf by the Federal Government had left them only a small fraction of the market value of their oil or minerals. Agreements usually ignored the needs of the tribe or the prudent development of the land. We have to develop our resources so we can live without being dependent on others. Our goal is self-determination, the right to set our own tribal agenda and the ability to carry it out.

A hundred years ago, Chief Seattle said it so beautifully: "Every part of this earth is sacred to my people - every shining pine needle, every sandy shore, every mist in the dark woods, every clearing and humming insect is holy in the memory and experience of my people." And so it is today. If we are to sell our resources, then the only fair price is one which will ensure a legacy to bequeath to our children when those resources are gone.

By the early 1970s, the American Indian realized that the educational system had failed to meet our needs in the age of high technology. What we needed was our own organization. We needed our own top-quality technical experts to help develop and manage our resources. To help meet this challenge, a private nonprofit organization was established in 1977 that significantly increased the number of American Indians in science and engineering disciplines. The American Indian Science and Engineering Society, or AISES, as it is known across the country, is helping to develop leaders within the Indian community to integrate it with the modern technological world, yet are currently committed to tribal life.

Self-determination is our vision, but it will stay a hollow vision unless we get together a pool of trained technical Indian manpower upon which we can draw. AISES provides a broad spectrum of services to Indian students, including scholarships, leadership training, student chapters, teacher training, science fairs, publications, and national conferences. Since it was founded, AISES has grown to represent more than 40 collegiate chapters nationwide with more than 500 students and 275 professional, corporate, and individual members. With the help of AISES, students are able to bridge the bewildering gap between the small-world high school and the disciplines of college.

AISES has helped and encouraged students in their pursuit of a science and engineering career. It is also generating professionals who are greatly needed to help protect and develop the mineral, water, and land resources of our country.

[*Student speaking:*] You are going to learn how to manage your time, and you are going to be responsible and dependable and honest, and to work hard for yourself. You are going to grow up someday, and it is going start now.

I am studying mechanical engineering. I am hoping to go back and help my tribe. You fulfill something. You have a goal, and you accomplish it. I had one goal, and that for me was to make good grades in high school. This goal has carried me through to a much higher level. I feel it will be beneficial to me in the future.

I met a lot of people. Everyone is like a big family here. We did a lot of fun things together, and we invented a lot of companies - I never knew there were companies that were actually owned by Indians, but now I do.

The classes I took are going to help me now more than my high school.

I was first exposed to AISES in high school, and since that time, it has served many purposes in my life. It has helped me generate a great concern and awareness of issues facing my people. It has also helped me develop an understanding of some of the challenges facing our people. The AISES organization has proven to be an intensive support system for myself and almost every person involved with it. It has also been a key factor in my personal and academic development and, without a doubt, will continue to be.

[*Narrator*:] Through the American Indian Science and Engineering Society, young people have a chance to meet and work with role models such as Indian engineers, scientists, and business managers. They are discovering there are real opportunities for Indians. They are also discovering there is a tremendous need for them back home where they can use their education and experience to help their tribe determine its own destiny.

This program needs support from the outside, for there are years of educational neglect to be made up. AISES is helping develop a new generation of Indian people who believe they can make important contributions to America's needs by combining modern education with traditional wisdom and reverence for the land.

Almost 130 years ago, Chief Seattle told his people, "You must teach your children that the ground beneath their feet is the ashes of our grandfathers. So that they will respect the land, tell your children that the earth is rich with the lives of our kin. Teach your children what we have taught our children - that the earth befalls the sons of the earth. If men spit upon the ground, they spit upon themselves. This we know, the earth does not belong to man; man belongs to the earth. This we know: All things are connected."

[End of transcript]

Again, I would like to thank CERT and ARCO for helping us put this film together. One of the things we are trying to help kids do is regain ancient traditions that belong to them. Science and technology for Indian people are not anything new. It is just that we have to be able to share the old, the traditional ways, and the new way of learning science and technology. So they have a great opportunity before them.

***"My grandmother said going to school and getting an education are two different things; they do not always happen at the same time."***

I showed this presentation, and was talking to kids, about a year ago. A little kid came up to me after the speech, and I thought he was going to say something like, "This is in Wisconsin, my home state," and, "Mr. Hill, that was the most inspiring speech I have ever heard - I am going to go back to my reservation, and I am going to kick butt and do all these good things when I grow up." But instead he said, "Mr. Hill, I'm sorry I fell asleep during your presentation."

So sometimes I am not sure where we are. His mother made him tell me this, and I said, "Son, don't ever do that again to anybody."

We have kids in 121 different institutions across the country, and what I am really encouraged about, and the strength of our organization, is that the quantity and quality of young people improve each year. There are a lot of them out there. There are a great number we need to deal with yet because they are not getting very much. But the numbers are encouraging, and if we can get those kids to give something back to their own people and serve as role models and help the younger ones get to where they are, we are going to be in pretty decent shape in the next generation. And we can't let them forget that.

We have been fortunate enough to give about a quarter of a million dollars in scholarships to kids. We do not mess up scholarship money by giving it to the financial aid officers because then they somehow figure out how to take it away for other aid. So we just give it directly to the kids. That kid who is getting a 3.0 average in science or engineering or pre-medicine is a pretty responsible kid, and if he has to go home to visit his grandmother, that is a school-related expense. And they need to do that. So we do not make them rich, but we also acknowledge their accomplishments and achievements.

My grandmother said going to school and getting an education are two different things; they do not always happen at the same time. And she is absolutely right. My brother Charlie dropped out of the University of

Wisconsin because school was interfering with his education. I think that happens to many of us and many of our kids. As I said last night, the whole system is bankrupt. It is bankrupt for everybody. It is bankrupt for Indian kids. And I am not sure what we are going to do about that.

I think we have to create new systems and new ways of education, and I do not think summer programs that are supposed to enrich rather than supplant what they are supposed to be getting in the first place are going to carry the day. There are too many kids, if we have to turn down 80 percent of the kids who apply just to our summer programs in the seventh, eighth, and ninth grades. How many other kids did not get opportunities? I think there is a tremendous need out there, and parents are starting to recognize it. I was on one reservation where the kids did not even care whether they learned how to read and write. That is frightening, because I do not know what to do with that problem. I mean, we have some very bright kids. It is not ability, it is attitude.

I am a trained counselor and supposed to be able to ask open-ended questions, you know: "What did you do yesterday?"

"Nothing."

"What are you going to do tomorrow?"

"Nothing."

"What are you going to do when you grow up?"

"Nothing."

I mean, I could not get anything out of the kid. I say, "What are you going to do when you grow up?" and he says, "Nothing."

***"If we could kick kids out of school for an entire year and put parents in the school, or have some summer workshops for parents, I think we would get further faster."***

And I said, "How do you know when you are finished?" And he just looked at me and walked away. I just do not know what to do when stuff like that happens.

Education is the key to help our people to learn to think for themselves. And I am not sure what this country will do when we have a-million-and-a-half Indians walking around who are sober, who can read the treaties, who can understand them, who can make this government and agencies accountable to what their grandparents - what the People - have died for, and what the People in front of them deserve.

I think we have been doing it to ourselves, in a cultural kind of genocide, in dealing with alcohol. I did not want to mess with the alcohol business because that was too messy, but it transcends everything we do. It is a bigger problem than any one of our organizations can deal with, but I think collectively we need to make a statement. One of the statements we make in our organization is that we just banned alcohol from our meetings. If a student says, "If we can't drink, neither can you." And I say, "You are right. Neither can the corporate guys who are the White guys who come to our conferences." Hotels are not very happy with us about that, but I think it is an important statement in principle we make, saying that when we do Indian business, we do Indian business; and when we drink, we drink. When we eat, we eat.

I think if kids study all the math and science they can possibly get, and they become a lawyer or teacher or something else, it does not matter that that is not a scientific or technical career. We have not lost anything as long as that person feels connected through his own community, and if it means more than a job and a career and a house in White Plains - a new car and a house in the suburbs. It means, really, survival of a people. It means more than a career. And we have more at stake and more to lose than any of the other groups, and we are far more disadvantaged than many of them.

I talked to you last night about the math camps. We have had, just in New Mexico alone, 240 applications of seventh-, eighth-, and ninth-graders for 30 slots. Now, it is wrong to turn down that many kids who want to learn how to study mathematics because if they cannot do math, they cannot do science or engineering. If they do not get algebra in the ninth grade, they are not going to get geometry, trigonometry, and calculus as they go through and be able to be competitive at Cornell, Stanford, University of New Mexico, or Texas or SMU or any

other place. So they have to get the math sequence. The biggest problem we have had is - and I repeat it again and I do not know what to do - upgrading the teaching of math instruction, because you cannot have arithmetic teachers teaching trigonometry. You cannot have the coach who got a *C-* or a *D* in math or a minor in math teaching course material that he does not know. And that is not the kids' problem. Somehow, Indian parents, all of us, have to say, "Enough is enough," and, "We only want quality for our kids."

***"We have to get back into our traditional mentoring system throughout the community in schools that reflect our values rather than trying to send them into the Anglo world and forget ours, and become Indians at night."***

If you have not seen the movie *Stand and Deliver*, it is "required viewing," because what you have is good instruction and a teacher who cares. I think it is like *The Blackboard Jungle*, and it is like love and *Rocky* all wrapped into one. I rarely close down my offices, but I did one day and made my staff go see it, so they can understand what we are really dealing with and what we are talking about. Our kids deserve a lot more, and they deserve expectations that are real. We expect kids to do things beyond their dreams, but we have to help them dream and help them achieve those kinds of visions they have for themselves. I think we can do that.

Even good business schools demand calculus now, and this really separates the people from history majors. There is nothing wrong with history majors, but we do not need three million history majors. We need people who can go back and practice medicine. We need people who can help determine the resources on the reservation - somebody who can understand environmental law and somebody versed in the areas of science.

We are also trying to figure out the problem in terms of growing our own research, and maybe this group today can be helpful. We need to start tracking kids from the seventh grade through graduate school or job placement - where they fall in the pipeline and when they fall in that pipeline. I think it is our responsibility to make sure they drop out as Indian people. I mean, it would be a sin for that not to happen. And we have to figure out, What are the common things we want to measure? We know that many of the Indian people who are successful had a strong Indian woman role model in their family, either a grandmother, an aunt, or a mother. But we need to get our hands on some real numbers and drive our programs on data rather than anecdotes. I can tell you 15 wonderful stories about a kid who had brain surgery who is getting a 3.0 average in engineering. Those are all true stories, but we cannot live on those stories. We have to supplement our data with anecdotal materials, and we seem to do the reverse; at least, I do, because I just do not have the kind of data. Who is counting, and how many Indians are there? Why are Indian kids successful? We do not know. We really do not know. If anybody asked me,"Say, how many Indian engineers are there?" I do not know, and I am embarrassed to say that. We should know that.

It does not take 200 years to learn how to read and write. One of the interesting projects we are working on is with the College Board in New York. We are doing seven regional dialogues and talking to grass-roots people and saying, "What do you want for your kids in the next century? Where do you want them in the next generation?" We are talking to parents. We are talking to teachers. We are talking to Indian grass-roots leaders, trying to create some policy from the bottom up rather than from the top down. It is not going to come from BIA. It is not going to come from the State Department. It is going to come from a will of the people underneath to say, "This is what we want for our kids." And one of the Seneca chiefs said to me, "Look, we want our kids to share the best education opportunities possible, so they can go to Cornell and Stanford. We also want them to understand, to know, the best of what our traditions and culture have to offer - the best of both worlds." Somehow we cannot let kids forget who they are and where they come from.

I think parents are probably the most critical factor - they are the most critical teachers our kids have. The kids spend more time with their parents than with anybody else. They get a teacher for nine months, and then they change horses. You do not change your parents. If we could kick kids out of school for an entire year and

put parents in the school, or have some summer workshops for parents, I think we would get further faster. I do not think parents understand their role. They do not understand the power that they have. Japanese parents undergo prenatal care before the kid is born. Here we have kids who by the time they are 15 have watched 18,000 hours of TV and an equal amount of time on a radio and a squawk box, and the only other activity that comes close to using that much time is sleep. So we have a generation of young people who want to be entertained rather than to be educated. This is endemic to the society as a whole, but our kids are no different. Our kids transmit values. We have to have clear expectations and good ones.

Dr. Spock talks about abolishing all grade levels, because the kids are corrupted by learning how to memorize and that is just absolutely absurd. We have to have people understand what they learn, do some critical thinking, and understand the material. I think we should create Indian institutions that value kindness and helpfulness and cooperation and problem solving. That is what we ought to learn about. About 200 years ago, Indian kids knew their role in the community by the time they were 13 years old, and they had a whole community of mentors. They have to go back home. We have to get back into our traditional mentoring system throughout the community in schools that reflect our values rather than trying to send them into the Anglo world and forget ours, and become Indians at night.

***"All of you here know, of course, that Bob Crippen has been up in the Shuttle four times; you may not know that he is also of Cherokee heritage."***

It is just absolutely crazy what we are trying to do with kids, and it is almost understandable why the dropout rates are high, but certainly unacceptable and wrong. We can't have kids raising kids. We have too many young women having kids, and there is nothing more disadvantageous than for a young Indian woman with preschool kids to try to go to school. Regardless of the color, they are the most disadvantaged group I know about - White, Black, Brown, or Red. You get a preschool kid who has a single parent, the odds are dead set against him or her being successful by any stretch of the imagination. The drugs, the alcohol, the suicides - all that stuff is wrong, absolutely wrong, and we can't blame the victims. We have to facilitate education. My father says, "Indian people think in two ways" - and I think of our schools - "they think with their head, and they think with their hearts." Just look at anybody's grandmother, they think with their hearts. I think we need to get to that position so people understand that.

Our goal at AISES is to increase the number of Indian scientists and engineers. But the secondary goal, which I really push a lot harder, is to nurture effective leaders, because we are in a lot of trouble without them. They can become leaders in something besides science and technology; I do not care. If the last math course they get is checkbook math, we need more than that.

Mary Ross was on the film. Mary Ross was the first Indian woman engineer. She is still alive. She lives in California. She is the great-granddaughter of John Ross. She came to our conference and she was retired and she was the first Indian woman - the first Indian - Lockheed ever hired, and the first woman engineer. She had a math major - get this - an Indian woman having a math major in 1938! She went to a BIA school in New Mexico and she worked there, and they all cried when she left. I can understand it. She got a master's degree in engineering. She had a distinguished career through the Sputnik era with Lockheed.

So I said, "Look."

She said, "I'm retired, and I don't want to do all this stuff. I do not want to come to another meeting."

And, you know, certainly by that age you have paid your dues. But I said, "I want you to do something special. I want you to come to our conference in Los Angeles." (I was really trying to hook her to meet some of the kids because I knew she would enjoy them.) "But I want you to introduce Bob Crippen."

Bob Crippen - all of you here know, of course, that he has been up in the Shuttle four times; you may not know that he is also of Cherokee heritage. Not enough to trade on, and I know he does not trade on it, although it is something in his background that he feels to be very special. It was Bill Polk who referred me to Crippen. He said, "You don't want me to speak at your conference - you want Crippen. He'll come and do it because

of his background." I did not know Bill Polk was a retired astronaut and is Choctaw. We do not even know where our own role models are.

I said, "Mary, had it not been for your work, Crippen would not be in the shuttle."

"I don't know if that is true or not, but I'd like to believe that one."

And I said, "I want you to introduce him."

So she came. She drove from San Francisco to Los Angeles just to introduce him, and then she was taken with the kids. Of course, we were honored by an elderly lady 76 years old with those kinds of credentials, because it is our traditions and because it is certainly deserved. At the end of the conference, we were getting some student feedback and finding out where we failed and how we could make it better. Mary Ross pulled me to the back of the room, and said, "I want to tell you a secret."

I said, "All right."

***"I did not know Bill Polk was a retired astronaut and is Choctaw. We do not even know where our own role models are."***

She said it three times - she said, "I don't want you to tell anybody. You have drawn too much attention to me so far, and I don't want any more attention." And she handed me a little slip of paper - I have asked her since then if I could tell this story, so I am not violating any confidence - and she said, "I have been moved by this conference so much because, for 30 years, I have been trying to reconcile who I was as an engineer and who I was as a Cherokee woman, and I needed this organization 30 years ago." And I looked at the slip of paper, and it was a personal check for $1,000.

That was 1983. She has not missed a conference yet. The next week, she marched into Lockheed and got our first scholarship out of Lockheed for Indian kids. She has been honored by CERT; they have an honor in her name now. She said, "I have never won more awards." She is an interesting lady. *She* should be talking to you, not me. She said she needed a hip replacement, and she asked the doctor how long it would last - now, this woman is 77 years old. The doctor told her "10 years," and she said, "Find one for 20." I love it.

Unless something is a thousand years old in England, they do not consider it history. So they think whatever is here is not very old. We went to a place in Italy - it looked like a little pile of rocks - and there was a little sign there. During the bombings in World War II, they did not cover this pile of rocks. The pile was Roman ruins. I looked at the pile, and it dawned on me: *There is nobody around here speaking Latin*. If you go to Italy, there is nobody speaking Latin there.

If we go to an Indian community, you have people who have been living in the same places for 20,000 years, probably consecutively longer than any other community in the entire world, on the entire planet. And they are singing the same songs, they have the same chants, they have the same language, they have the same prayers. There is a richness in this country that is not celebrated. We celebrate this richness, but it is not celebrated by the entire country. Neither are the contributions that Indian people have made in science and technology, and just in being here and being alive. One of the things we have to look at for kids as we take the next step is to determine how to build bridges of opportunity around them so, when they finally get their degrees, they can go back to the communities where they came from and serve. I think community service is the key.

When we were in England, I had a chance to meet the man who founded the Peace Corps. This guy invented the Peace Corps, and when Kennedy was elected, he went and got the blueprint. Then Kennedy came here and created VISTA and the Peace Corps. He did overseas voluntary service. He took throwaway kids and had them working with autistic kids and blind people and old people, and they were giving and getting more back, and he was doing it around the world through his kitchen table. The guy is just fascinating.

Community service is something that is inherent in all our communities. We do not have to commit or convince our people to do it. We just have to set up a facility and a network for them to be able to do that. What better way than to try to link what they are learning in the theory with some practice! Let me just give you an example. Our chapter at NAU [Northern Arizona University], an outstanding chapter, got some solar

panels, and they went out to the Navajo community and installed them. Now, just picture this: As they hooked it up in one room, they screwed the light bulb in. The light went on. The old women said, "Now we can quilt at night." But somebody else said, "And we can read." They installed 11 solar panels in a community that had never had electricity in its entire history.

This is community service: applying the skills they are using, and feeling good about that and giving something back to their own people. We have a couple of kids on the St. Regis Mohawk Reservation who are doing water quality research so they can tell their people what they are drinking. What a better way to do something - learning applications. We don't do that. We do not do that. So we have to create a network big enough so people can. We need role models at IBM. They are going to offer them a lot of money, but we need role models in our own communities, and if we build a base big enough, we can do that. Our investment is in young people, and it is an investment in teachers. The biggest challenge is getting the kids to believe in themselves. And if they can believe in themselves, they can make it in spite of the system. That is the biggest challenge.

***"Determine how to build bridges of opportunity so that when they finally get their degrees, they can go back to the communities where they came from and serve."***

AISES has been in business for 10 years and again generates more questions than answers. We have trained over 800 teachers in elementary and secondary schools in the last four years in trying to develop some intercultural science-related materials, also dealing with the alcohol problem. I am convinced the alcohol problem is genetic. It is not social, it is not cultural; it is genetic. It is genetic, it is chemical, it is biological. So we are trying to develop curriculum materials that are science-related, talking about those issues. I think abstention is the only option for people who are genetically predisposed, and our people are at higher risk than anybody else. According to some of the research - and the problem is being looked at by some of the top geneticists in the country - 50 percent to 80 percent of our people are at risk; for Northern Europeans, 10 percent to 15 percent; Jewish, about 5 percent; and Irish, a little higher at 30 percent. But we "win." That is about the only thing we win, hands down, in terms of being an at-risk group. I think the lesson can be transmitted, and transcends communities, and we need to look at and address the issue.

It has affected all of us in some way. I know it has in my family, and we have to come to grips with it. I remember 10 years ago, if we had brought this up we would have been kicked out of the room. I was delighted to see NIEA take a vote to pass a resolution to ban alcohol. I do not know how successful that has been, and you can't manage and legislate 4,000 people in NIEA or NCAI or whatever. We have a smaller group, so it is a little easier to do. I sent a teacher home one time because he was drinking, and he was crying as he left. I could not - we just cannot - internally tolerate that kind of behavior.

We are preparing health material. It is legislated for the Bureau to get alcohol-related material, but it is old material, and people are not reading it. It does not work, so we have to get new materials, have the kids do research in the communities, to have them look at their own behaviors in their own families through a pair of science glasses. I think that is maybe one way we could help.

AISES publishes the *Winds of Change* magazine. If you are doing something good out there and you have an article you would like to see reprinted and you want other people to know it, send it to me. There are so many good things going on out there that we do not share. What are some positive things going on among the Choctaw, and in Alaska, and the State of Washington, and other places? You need to talk about that so we can enjoy each other. We need to connect people. The magazine is set up so the profits of the magazine go back into the nonprofit so we can help the kids help themselves. So it is set up to help people. And so I think it is time for us to set the agenda and determine what we want for Indian kids. Not the Bureau - I think we ought to drive the Bureau, not let the Bureau drive us. We ought to drive educational institutions.

It is so nice to see those kids at the International Fair just being recognized and bringing in the Indian flag and the eagle feathers and posting them with all the international flags and being recognized as a people. We

called one little girl and said, "You have been selected to represent your project in the international science fair, and we want you to represent your school and your family and your tribe and Indian people in this land." She - a tenth-grader - was very excited about that and was just yipping and dancing all over the living room. And the father, who had been involved in the tribal council seeing people drink themselves to death and shoot each other and be unemployed, started to talk and just started crying. It is a moving story about the dreams and the pride, the tears of pride that Indian parents have.

There is not an Indian parent I have met in this country who does not want the best for their kids, and they love their kids. They do not know what to do, and we are in a position to help them discover what it is that they want them to do. So I think that is what our programs are about. We need to involve people at the grass-roots level to help understand what their needs are and for us to help them understand what is happening out in that other world so we can become competitive in what we do.

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# COMPONENTS FOR AN EFFECTIVE SUMMER PROGRAM

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**ABSTRACT**

The University of Colorado at Boulder has operated summer programs for American Indian students interested in math and science for the past seven years. Fewer than 1 percent of these students have dropped out of high school, more than 77 percent have gone on to college, and 81 percent of those who went on to postsecondary institutions are still enrolled.

Several key components make this program effective. In recruitment and selection, we identify students who have the ability to matriculate successfully at a major university, based on factors indicating academic persistence and success: parental support, school support, and student motivation. An orientation process allows students to understand the concept, goals, and objectives of the program, and is an opportunity to clearly state student responsibilities and expectations for all participants. The foreign environment of a college campus offers an opportunity for producing positive changes in students, in a controlled, disciplined setting that is also challenging and inspiring. Finally, role models are an important part of the program.

I have been in the precollegiate business for eight years, and what I want to present is the philosophy and operation of summer programs for Indian students. As I look back on the seven years I have been involved with the summer programs, I see a lot of things that have changed, and a lot of things that have happened to make me believe in summer programs. I see a great need for additional summer programs and for opportunities for Indian students.

When I started working in the area back in the fall of 1980 at the University of Colorado, I found an empty desk and a proposal sitting on that desk. The person who was primarily responsible for developing the proposal had gone to Washington on a fellowship. And the person who was the acting director of the program was on vacation for two weeks. I sat down and read that proposal. I kept looking at this proposal, trying to figure in my mind how we could develop a program that would be useful to Indian people, especially in the confining atmosphere of a university. I have worked with the Bureau of Indian Affairs, the Law Enforcement's Assistance Administration, and the Indian Health Service, but I have never seen a bureaucracy that was as confining as the University structure. The university does things one way and only one way, and cannot do anything beyond that scope. So it was a very difficult task to try to develop a program that did not fit into the typical university structure.

*"Fewer than 1 percent of these students have dropped out of high school, more than 77 percent have gone on to college, and 81 percent of those who went on to postsecondary institutions are still enrolled."*

During our first summer, besides having to fight the bureaucracy, we had to fight the kids. It was a continuing struggle with the students. One of the things I saw was that a lot of our students had no idea what it was like to be involved in academics. They had no idea of discipline. They had no idea of responsibility, and they were very used to an unstructured life that was fun. To try to mold 75 kids into studious little robots was very difficult, and I almost went crazy the first summer.

You have to remember what my background was before I came to the University of Colorado. I had been working in the field of corrections, and had worked my way up to a position of warden of a small minimum-security prison. With a really strong background in discipline, I was very security-conscious. I did not manage very well with the structure of the program during the first summer. I had a feeling we could do a better job and that there were some things that needed to be changed. That belief laid the groundwork for the foundation of developing a sound program.

*"It is a shame we cannot provide opportunities for all the kids, because these programs make a difference."*

As we look to the future, we know we need more of these summer programs. We can provide a foundation. We can provide the blueprint for a plan for any future summer programs and help them be successful and help them provide good opportunities for our children. As I look back on the whole educational process of our children, what I see that has been missing -and it goes back to the beginning of our interaction with the dominant society - is good opportunities. Our grandparents and our mothers and fathers did not have a chance to participate in the educational process. It was not a question of ability. It was not a question of being intellectually capable of participating in those educational institutions. It was a question of opportunity. And given a sufficient opportunity, we have proven to be successful.

On the last day of our first summer program we had a banquet. We planned to have a nice banquet. We were going to have a dance for these kids. At about 11:30, it suddenly dawned on me that these kids were staggering around - they were drunk! I did not know where they were getting the liquor. I did not even anticipate that they were going to throw a big party. They did, with the help of some college students. They had a keg of beer in the next dorm. The following day, I identified 45 of the 75 kids that I knew had been drinking, and I expelled them from the program. The next year, I changed our recruiting guidelines.

I emphasized to the applicants, "If you come to our program, there is one thing I guarantee you: If you drink, if you get caught smoking - you are gone. No questions asked. No nonsense. You know that is the way it goes. You do not get a hearing. You do not have any rights. I am a prison warden; you do not have rights. You will be gone."

*"To try to mold 75 kids into studious little robots was very difficult..."*

The other thing I decided to do - and it proved to be very effective for me - was to stop spending my time with the kids who were giving us problems. Now I spend 90 percent of my time with the kids who are doing well. The very first summer, I spent 90 percent of my time dealing with students who had problems. The kids causing the problems loved it because they were getting all my attention. So they just caused more problems, so that I would spend more time with them. Well, that does not work any more. I only have to spend 10 percent of my time with the problem kids. They began to see that to get attention, they had to stay out of trouble.

Over the years I have modified the program to meet the needs of students preparing to go to college. The University of Colorado currently, in addition to the TRIBES program, operates the American Indian Upward Bound Program, which was originally funded as a National Demonstration Program called the American Indian Science and Self-Determination Upward Bound Program. We have one state program that works with kids from the Denver metropolitan area; I have about 10 Indian kids attending that during the summer. This past summer, we had 110 Indian students on our campus for periods ranging from five to eight weeks. We have our hands full.

We deny a large number of students an opportunity because we do not have the funds or resources available to accommodate them. In the TRIBES program alone, we turned away 65 students, and of these 65 students, probably 50 of them are going to be in college somewhere, and probably going into areas in the technical fields. So it is a shame we cannot provide opportunities for all the kids, because these programs make a difference.

*"...Of that 77 percent who went on to college, 78 percent of those have persisted. ...That is better than the national average."*

We have worked with 250 students in the Upward Bound Program since it was originally funded in 1980. Of those 250 kids who participated in the program, 99.5 percent of them have graduated from high school. Of those who graduated from high school, 77 percent went on to college. And the most amazing finding is that of that 77 percent who went on to college, 78 percent of those have persisted. That is better than any college can do with any students - Red, Black, White. That is better than the national average.

## KEY COMPONENTS OF AN EFFECTIVE SUMMER PROGRAM

We know summer programs can be effective, and we know they can have an impact. But how do they work? What makes a summer program work? How can a summer program be effective? There are some things that have to happen. There are components that allow you to create an environment that is good for learning.

Do not work with just the best kids. You try to get the best kids, but that does not happen all the time. We have taken kids in the program who were really high risks, so we had to deal with changing behaviors.

You have to deal with changing attitudes toward school. You have to deal with the social dynamics of operating live-in programs.

First, you get into the schools and initiate your recruitment process. You have to get the parents involved, and you have to get the school involved - sometimes that is the most difficult task. I remember one school, Tohatchi High School in New Mexico, that used to be like a prison. The very first year I went in to that school, some of the students said, "Will you come eat lunch with us?" And so I went to eat lunch with the students. While I was eating lunch, the principal, the vice-principal, and this massive bodyguard came and escorted me out of the lunchroom. I had permission from the counselor to go to lunch with the students, but they said, "You do not have permission to be in our school. We do not want you in our school." And so I went to the principal's office, and I sat down and talked for a long time and got the situation straightened out.

Since that time, the school has changed dramatically, and a lot of good things are happening for those kids. One of the reasons we have summer programs is that we know that the educational process, whether it involves reservation schools or public schools, is not providing good opportunities for our children. The resources are lacking. Because of the inadequate resources in a lot of our schools, we do not provide opportunities for our children. Even though they try to do their best, they do not have the money to do what needs to be done to prepare our kids to go to the universities.

One of the key things, as people have said many times before, is parental involvement. Are the parents involved in the educational process? It is a major factor in the success of students. Parental involvement is very important, but for Indian people, it is very difficult because a lot of times they have not been a part of that educational system and so they have a tendency to stay away from that system. But I encourage parents to be involved in our program. I ask parents to come to an orientation process so they know what we are doing, and I explain to them a little bit about what we try to do with the kids.

Once these kids leave their homes we have an excellent opportunity to change behavior. If you want to provide a change in somebody's life, one of the ways to do it is to provide a significant emotional experience. People can change with a significant emotional experience. Death is an emotional experience for change. You have seen people who have been alcoholics all their lives, who lose a spouse or lose a child, and then, all of a sudden, they change. It was a significant emotional experience that provided that change. We can do that in our environment - we can use homesickness as a tool for change. Just coming to a big city is a tool for change. We have an opportunity to provide that significant emotional experience, and if it can be a positive emotional experience, it can motivate kids to change - to change behaviors, to change in a very positive way.

A lot of times the change may not occur until the program has ended. One of the most emotional parts of our program is the end, when everybody has to go separate ways. It is a very emotional experience for these kids because they know they are not going to see their friends again. It provides a good opportunity for change because we know, if they go back to school and they do not do well in school, they are not coming back the next year. So they have a reason to change. If they want to come back, they have to do well in school. They have to follow the guidelines of the program, do the homework we send them, and follow a few rules we set up for them. All this provides a good opportunity for change.

One of the most important factors in a program, and it has been mentioned before, is role models. Role models - men, women, and college students - are important. They have to be an integral part of the program. If you have dorm counselors who are working with these kids, they have to be Native American. They *have* to be in college. They *have* to provide a lifestyle for these kids to model. In addition, it is important to bring in Indian professional people. And a lot of times, Indian professional people come in and ask, "Well, what should I say?" I tell them, "Just tell them how you made it, the things that you had to do to be able to make it through the educational system." Community people are important role models; students can identify with people in the community who are successful. It is also necessary to provide leaders for students to model, to give them a clear direction of what is expected, and what the responsibilities are. If we do not model the right message, they are going to get a different message. So we model our leadership for the students.

When we bring those kids in, one of the first things we do is put them through an orientation program. That is another key ingredient to molding kids and helping provide an opportunity for change. Once you get them in a mode to change, then you have to say, "What do you want with this change?" We take them

away from the campus environment to this beautiful place in the mountains - spectacular views, and a wonderful place to be. We tell them what we are going to do with them during the summer. And it will be about the third time they have heard that. I talk to them about our expectations. What are the expectations that we have of the students? What do we expect them to do in this summer program? We try to inspire them and encourage them. It is important to inspire them. And as Jerry Elliott said yesterday, we challenge them. You have to provide a challenge.

***"One of the reasons we have summer programs is that we know that the educational process, whether it involves reservation schools or public schools, is not providing good opportunities for our children."***

If you provide these opportunities, then the students become motivated. They motivate themselves. They are self-motivating if you create an environment that allows for motivation. They are self-starting. You do not have to sit on them and say, "You have to do this, you have to do that." Most of the time, if you expect them to do it, they are going to do it. You cannot just assume they know that they are expected to do it. You have to tell them. And believe me, they moan and they groan and they complain. When I tell them they have a curfew of 10:00 p.m. every night during school nights, they say, "Whaaaat! I never did. I get to stay up all night if I want to. I never have to go to bed until 2:00." We know if we are going to provide a good academic experience for kids, they have to go to bed at 10:00 because if you just let them go to sleep when they want to go to sleep, they will stay up all night. And they will do that for four or five days before they finally conk out. They will just keep going. I mean they have unlimited energy. They will wear anybody out. So we make them go to bed at 10:00 because they have to be awake in class the next day. If you are going to learn anything, you have to be awake and you have to be alert. We feed them well; we make sure they get three meals a day. We make them go to the meals. They have to go, whether they eat or not (we do not force feed them), but we make them go to the meals to have an opportunity to eat. Because the nutritionists say that if you want to have a healthy mind, you have to eat, we make them go to the meals. There is somebody sitting there waiting for them to check their name off. If somebody does not show up, he or she is in trouble.

We also expect them to be on time. We do give them a little flexibility: they are allowed to be late three times in six weeks - but the third time they come to see me. They do not want to come see me, so generally they are not late after the second time. They are not allowed to skip classes. It does not happen. You tell them, "You are not allowed to miss class, under any circumstances," and you uphold those expectations. You say, "You are expected to be there." They will be there. In our TRIBES program last year, we had one unexcused absence - 29 students for eight weeks and only one unexcused absence in classes. Their schedule was very demanding. They started at 8:00 in the morning and were in class until 5:00 in the afternoon. They had an hour off for dinner. On Monday and Thursday nights, they had to go to computer classes from 6:00 until 9:00. And every student who was not maintaining at least a 2.0 grade point average in all of his or her classes had to go to mandatory study hall from 9:00 to 11:00. From 11:00 to 12:00, they had free time. The college students had curfew at 12:00. It was a very demanding schedule; we kept them busy on weekends. And they loved it. We worked them hard, and they just went right to it. We are a little bit easier on the younger students. We do not push them as hard. We put a good work load on them; if you keep them busy, you keep them out of trouble. If you keep them involved in something, you keep them out of trouble.

One of the other things that is important is that we encourage these kids to be responsible for themselves - and even more importantly, to be respectful. So when we talk about the academics and the three *R*s, I always say there are two other *R*s that are just as important: respect and responsibility.

They have to be respectful to each other. In the seven years I have been involved with the summer programs, I have never had a fight in my program. I have never had students fight each other. And that is one of the things parents used to ask me. They do not ask anymore. I guess it is no longer a question:

"Is my child going to be safe? Are there going to be kids picking on my child?" We intervene before those kinds of things happen. If there are problems, we intervene, and we do not allow disrespect. You cannot be disrespectful to each other. You cannot be disrespectful to the staff. You cannot be disrespectful to the teachers. It is not permitted. And that is part of our tradition, and that is part of our heritage; and generally, it is not a problem for Indian kids. It has not been and is not a really big problem for them to understand what it is to be respectful.

***"So when we talk about the academics and the three Rs, I always say there are two other Rs that are just as important: respect and responsibility."***

One of the bigger problems is responsibility. How do you make students understand that they have to be responsible? A lot of times, we baby our kids, our own children. We do a lot for them. We do too much for them. We do their laundry, we get them up in the morning, we fix their breakfast, we make sure they get to school. If they are late, we jump in the car and we take them to school. We go pick them up if it is raining. We go take their coats to them. We take their homework they forgot. We do all these things for our children. We spoil them. It is terrible. And we do not teach them any responsibility. We do not say, "If you want some clothes to wear tomorrow, you go down and do the laundry."

In the Upward Bound Program and the TRIBES program, we do that. If you want to get up in the morning, it is your responsibility. I am not going to get you up. Who is going to get you up when you go to college? Are your parents going to call you: "You have to go to class now!"? No, it is not going to work that way. So we start developing that responsibility in the students, making them responsible for themselves. And, believe me, sometimes it is a disaster. We notice these kids come in nicely dressed the first week (new jeans and pretty shirts). The next week you see them, the new white shirt is blue because they washed it with their jeans. They are all wrinkled because they were never ironed. And the boys have a tendency to never wash their socks. They think you can wear socks forever. So sometimes we have to help them become responsible.

## INTERVENING AT DIFFERENT GRADE LEVELS

### Ninth Grade

We are intervening after the freshman year in high school in the Upward Bound Program. We work with them after their freshman year, and we try to work with them for three consecutive summers until their senior year. The TRIBES program picks up a few of these kids after their senior year and provides an opportunity then.

### Fourth Grade

It is my belief that if we are truly going to be successful in further developing our kids, we need to intervene at an earlier age. I honestly believe we need to start our intervention programs at the fourth grade. I believe that because I have read all the educational material that says you have to intervene at the fourth grade. But more importantly, I look back at my own experience, and I look back to the fourth grade. Prior to the fourth grade, I did not realize I was different; I thought everybody was the same. Everything was good. In your life, there were no real problems. But when you reach the fourth grade, all of a sudden you realize little things: I did not take the same kind of lunch to school that everybody else did - Kabobo bread sandwiches were different from what everybody else was taking. You know, they had white bread.

Those kinds of things make you understand all of a sudden that there is a difference. You see yourself differently, and you begin to see and understand stereotypes. So, for a lot of our children, it is important for their self-esteem to begin working with them intensively at the fourth grade.

***"It is my belief that if we are truly going to be successful in further developing our kids, we need to intervene at an earlier age."***

Seventh and Eighth Grades

Another critical stage is the seventh grade. Seventh grade is difficult, probably one of the most difficult times. Although fourth grade is tough, seventh grade is even more difficult because those young people's bodies are changing. They are physically changing. They are going through all kinds of emotional stress - changing schools, changing the things that have been constant for them in their environments for a long time - and they need a lot of help during that time. And, again, when I look back on my seventh grade experience, it was terrible. It was *terrible*. Seventh- and eighth-graders are the meanest people in the whole world - they treat everybody terribly. They hate themselves, they hate everybody else. It is hard to get kids through that stage of life. We need to provide as much support as we can to our children during that time.

If a student is going to drop out of high school, he or she makes that decision in the seventh grade. So it is important to intervene and maintain that intervention from the fourth grade to the seventh grade. Again, it is difficult to do this because it takes a lot of resources to operate these programs. For example, in the Upward Bound Program, we spend almost as much for a summer program as the school districts do in a full year. If you want to have quality, if you want to provide these kinds of good opportunities, they are expensive. I spend $2,500 per student per year in the Upward Bound Program. It is very expensive.

## CONCLUSION

I will leave you with a true story. About two years ago, I received a call late at night from a young lady from Ramuh Navajo, which is south of Gallup, New Mexico. She was going to school at Santa Fe College.

She was crying, and she said, "Rick, I am really sad. I've got some bad news to tell you. I am dropping out of school." She was in her second year. And she said, "I'm pregnant. I am getting married. I am going to have a baby. So I have to leave school, and I feel really bad. I don't want you to be mad at me because I really tried to do good and get a college degree and everything. You know that I know that after I'm married and after I have this baby, I'm not going to have an opportunity to continue my education."

And I said, "That's all right. The important thing is that you went to school and that you took a chance and left the reservation and went off to college. You know that's the important thing."

And she said, "No, the important thing for me is that now I know what is expected. Now that I know what college is like, I know that my child is going to have that opportunity. I am going to prepare my children from the time they are born. I'm going to prepare them all through their life to go to college. And even though I didn't make it, I know that my children will be successful in college."

So I know from that story, and from experience, that our future is not with the kids we are working with now. It is with generations to come. And I know that we are not going to have an impact on all the students. Maybe we are not going to make the changes in every one of the students, but the change will come in their children and the children after them. We have to keep providing opportunities because that is the secret: Provide the opportunity.

## QUESTION AND ANSWER SESSION

Question from the floor:

What are your selection criteria for the program?

For the Upward Bound Program, we ask for three recommendations from people within the school. We ask the students to write an essay, and we look at their transcripts. Five people evaluate each of those criteria, and then we do a ranking of whoever scores the highest. We take the top 30 or 40 kids. We make modifications for boys. Sometimes we will drop a girl to take a boy. The reason is that our programs typically average two-thirds girls and one-third boys. And so a lot of times we have to take inferior boys to maintain our quota. Sometimes we have to make modifications for the schools. For example, I cannot take every student Shiprock sends me - they always send us 15 excellent applications. We can only take five of those kids. So, we only take five, and for each of our target schools we try to maintain a similar number. We do not have a specific grade point average that we look at. And we look at family situations. We do not take kids whose parents have graduated from college because: (1) it is a federal regulation, and (2) they will have other opportunities. In the Upward Bound Program, those financially needy kids will get a good experience and have some kind of opportunity that otherwise they might not have. Kids who are not financially needy have additional opportunities in our program through AISES. AISES has been providing 10 scholarships for kids to participate in our program. The TRIBES program is different in that we look at a number of different things: what career choices they have made, whether they have been accepted to college, how they did with their essay, and whether or not they are acceptable for admittance to the University of Colorado.

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# SCIENCE, ENGINEERING, AND TECHNOLOGY (SET) FOR THE ELEMENTARY AND JUNIOR HIGH SCHOOL GRADES

**Wallace Coffey**
**Chairman, Comanche Tribe**

**Executive Director, 1985-1991**
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*Wallace Coffey is a member of the Comanche Tribe and was the Executive Director of the Denver Indian Center, and a former director of the Nebraska Indian Commission and Dean of Students at Nebraska Indian Community College. His Live In Space curriculum, a preschool aerospace curricular module, came out in December, 1987.*

My presentation takes a different perspective. First, often we think education is the cure-all for all of our Indian problems, and this is not so. I will give you an example. I am very proud that I have a lot of individuals in my family who have an education. My master's degree is from Harvard University. My undergraduate degree is in psychology. I have a sister who graduated from Dartmouth College for her undergraduate degree and got her master's degree from the University of Oklahoma. I have a brother who graduated with a degree in journalism from Trinity University in San Antonio. I have a nephew who graduated with an economics degree from Princeton and a law degree, summa cum laude, from the University of New Mexico. I have a cousin who graduated from University of Oklahoma with a bachelor's degree in civil engineering and from University of New Mexico with a master's degree in civil engineering. I have a cousin who graduated from Radcliffe College and received a law degree from Stanford, and another cousin who graduated from Stanford Law School. But, of the highly educated individuals in my family, only two of us are involved in tribal practices and traditions. Many times, education takes us away from the important task of developing character. Although we have a high level of education, there are some members of my family who do not know what it is to be a Comanche. I do, and I am very pleased to come here today and reclaim Texas - which at one time included all of Oklahoma.

It is quite pleasing to know that you know today we are doing a lot of work toward the advancement of science, engineering, and technology. However, much of it is reactionary. Sometimes we respond after the fact. So, what I am going to present to you is more directional. Hopefully, all of you here will provide information to the Center for the Advancement of Science, Engineering, and Technology (CASET) that will give them an opportunity to serve more of a leadership role and assume some of the responsibilities for American Indian people in the fields of science, engineering, and technology. There are some programs that are doing many wonders, but we need to know how to develop character as well.

I have a son who is 17 years of age, and he is going into sports education. He will be enrolling in a year and a half at the University of Oklahoma. I also have a daughter, 11 years old. Occasionally she says, "I want to be a teacher." And I say, "Why do you want to be a teacher? Why don't you be an administrator?" Occasionally she says, "I'd like to be a nurse." I say, "Why do you want to be a nurse? Be a doctor." So I have had a lot of thoughts on these subjects in the past year. I have been trying to develop a planning

chart for a career in science, engineering, and technology. I am also developing a planning chart to establish character, concerning Indian issues and concerns for a young girl of 11. I am focusing on the seventh grade. I am allowing her to learn the basics (reading, mathematics) and to be a good kid in the elementary grades. But by the time you get into the seventh grade, you learn social concerns - those differences that separate you from him, her, and them. Sometimes our Indian children have many difficulties in that, and we lose them in the process. So it is very important to look at the materials that are available.

*"For a SET career, basic subjects include computer science, mechanical drawing, and testing (PSAT, SAT, ACT)."*

I called on a friend of mine, an engineer who graduated from Cornell University, and I said, "Waldo, I need your help. I would like you to prepare for me a chart for a career in science, engineering, and technology. I want to look at this chart in order to ensure that I know what I need to do to prepare my daughter for a career in science, engineering, or technology, beginning at the seventh grade." So Waldo and I sat down, and we looked at each other. (Many times we visited with each other for just an hour, and we would just sit and look at each other. We do not have to make conversation, but we enjoy each other's company.) I said, "Upon graduation with a degree in engineering, how many of these engineers have good character?" And he said, "Wallace, 80 percent of our engineers have the academic backgrounds but not a solid well-rounded character." And he asked me the same question about American Indians: "How many Indian people have a very good academic background?" I said, "Well, just like you stated - 80 percent of our Indian people may not have academic credentials, but we all have a solid well-rounded character." So naturally he had to smile. We immediately became friends, and in the process we prepared two charts.

Table 1 is the chart we made to help plan for a career in science, engineering or technology. In the middle school grades certain required subjects are very important. In English, these are the required subjects that Waldo recommends. Writing comes at the seventh grade. It is recommended to have some writing modules and literature reading from the seventh grade all the way through the four years of college. Speech is very important in an academic career. Composition begins at the ninth grade and continues all the way through the four years of college. For senior English, the chart suggests an essay of 250 words minimum, critical for entrance to college and scholarship programs, entitled "The Importance of Science and Engineering."

Mathematics is another area that is recommended to a student pursuing a career in engineering. In the eleventh and twelfth grades, mechanical drawing should be required. In the math areas, arithmetic begins in the seventh and eighth grades; algebra in the ninth, tenth, and eleventh grades; trigonometry in the tenth grade; plane geometry in the eleventh grade; solid geometry in the eleventh and twelfth grades; and calculus in the senior year of high school and the freshman year in college. In the sciences, biology is recommended in the ninth grade and in the freshman year of college. Chemistry begins at the tenth and the eleventh grades and physics in the twelfth grade. For a SET career, basic subjects include computer science, mechanical drawing, and testing (PSAT, SAT, ACT). Civics is very important in the eighth and ninth grades. History can be repeated in the freshman year.

**TABLE 1**

PLANNING CHART FOR SCIENCE ENGINEERING AND TECHNOLOGY CAREER

| BASIC SUBJECTS | MIDDLE SCHOOL | | JUNIOR & SENIOR HIGH SCHOOL | | | | COLLEGE OR UNIVERSITY YEAR | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1. ENGLISH | R | R | R | R | R | $R_2$ | R | R | R | R |
| 2. MATHEMATICS | R | R | R | R | R | R | R | R | R | R |
| 3. SCIENCES | | | | R | R | R | R | R | R | R |
| 4. SOCIAL SCIENCES | R | R | R | R | R | R | R | R | R | R |
| 5. COMPUTER SCIENCE | | | | | R | R | R | R | R | R |
| 6. MECHANICAL DRAWING | | | | | R | R | | | | |
| 7. TESTING | | | | | PSAT ACT | SAT ACT | G | | | |

END OF INTRODUCTION TO ENGINEERING

GRADUATION FROM HIGH SCHOOL

END OF BASIC SUBJECTS

| 8. SUPPLEMENTAL EXTRA-CURRICULAR ACTIVITY | A | A | C | C | C | C,D | | E | E,F | E,F |
|---|---|---|---|---|---|---|---|---|---|---|
| | B | B | | | | | | | | |

EXPLANATION OF LETTERS AND SPECIFIC RECOMMENDATIONS ON OTHER SIDE

BACHELOR OF SCIENCE (ENGINEERING)

OTHER PREPARATION

SEE VARIOUS COLLEGE CATALOGS FOR SPECIFIC REQUIREMENTS REGARDING TRANSFER FROM JUNIOR COLLEGES OR COOPERATIVE WORK-STUDY PROGRAMS WITHIN A COLLEGE.

G. MANDATORY FUNDAMENTALS EXAMINATION PREPARED BY NATIONAL COUNCIL OF ENGINEERING EXAMINERS (NCEE) ADMINISTERED BY THE VARIOUS STATE BOARDS OF REGISTRATION.

BEGINNING OF THE ENGINEERING CAREER

P.E.

P.E. = PROFESSIONAL ENGINEER REGISTERED BY STATE BOARDS OF REG. FOR REGISTRATION PROFESSIONAL ENGINEERS AND LAND SURVEYORS UPON PASSING NCEE PRINCIPLES AND PRACTICE OF ENGINEERING EXAMINATION NO LESS THAN 4 YEARS AFTER OBTAINING B.S. DEGREE OR MORE THAN 6 YEARS AFTER DEGREE.

NOTES: -$R_2$- SUGGEST AN ESSAY OF 250 WORDS MINIMUM CRITICAL FOR ENTRANCE TO COLLEGE AND SCHOLARSHIP PROGRAMS ENTITLED "IMPORTANCE OF SCIENCE ENGINEERING".

Supplemental extracurricular activity is also necessary from middle school through college. For example, you should have, or require, visits by the Speakers' Bureau from the National Society of Professional Engineers, engineering professors and industry representatives, in cooperation with secondary schools and administrators. Other examples:

- Presentations by Indian educators, lawyers, travel resource persons, artists, agency directors, etc.
- Participation in conference seminars, legislative sessions, spiritual gatherings, cultural activities, travel meetings, etc.
- Sharing cooperative undertaking, fundraising ventures, tribal colloquia, summer work programs, resource identification, higher education grants and scholarships, college preparatory sessions, higher education alternatives and strategies.
- Participation in Indian youth clubs, cultural and recreational activities, tribal tournaments, physical activities, academic and honor programs, internships at tribal governments, national and local Indian organizations, urban Indian centers, etc.
- Character development assessment and the optional modules and practicums.

Right here (see Table 1) you will see a *G*, which refers to completion of a college degree and subsequent preparation for becoming registered by the state boards as a professional engineer or land surveyor. This is an opportunity for an individual, once he or she completes all the required subjects, to pursue a career in science or engineering.

A lot of times we overlook Indian character development, in the process of pursuing career opportunities. By the tenth grade, an individual will have the physical sciences and all the coursework necessary for a career in science or engineering. But the social sciences have been omitted in the engineer's background. A lot of times social development is not implemented, or is not a high priority, for engineers. But if you do not have social science involvement, you are not going to have a well-rounded engineer. The next chart is a plan for American Indian character development beginning at the middle school level. I have three subject areas that I thought were very critically important: humanities, beginning at the seventh grade; education, beginning at the seventh grade; and cultural activities and involvement in ceremonies, throughout life. English is recommended from the seventh grade all the way to completion of college. The fifth subject area is participation in advocacy groups, such as the National Indian Education Association, the National Indian Health Board, and the Council of Energy Resource Tribes. A young person needs to be aware of all of these organizations in addition to the American Indian Movement. It is very critical to see how Indian people have evolved and how we are adapting to today's modern society. I also include advocacy groups, beginning at the twelfth year, as an optional elective, optional modules or practicums, and/or papers specifically related to a particular tribe or economic evolution of a tribe. You have to have a knowledge of the background of not only your tribe, but also Indian development on a nationwide basis. The Center for the Advancement of Science, Engineering, and Technology may make engineers out of us, but what does it know about American Indian development? And the sad part about it is that CASET itself must understand Indian people. If it does not, it will perpetuate making something out of us. Sometimes we become brown White people, and a lot of times we do not become American Indians. So I think it is very important for us to realize that, and that, sometimes, rather than your reactionary roles, *we* need to take the leadership roles.

Upon graduation from college, utilizing this planning chart for character and development, our Indian youth will be knowledgeable of federal laws and policy. They will have an understanding of cultural values and practices on a nationwide scale. They will have resource linkages with national groups, regional groups, and urban Indian groups. And they will have a positive self-image as a motivating factor. If we do not have a positive self-image, we will self-destruct. A lot of our youth will turn to alcoholism and substance abuse, and we will never get them back. A lot of you realize that. I mentioned earlier that I have a brother who has a journalism degree from Trinity University. My brother is highly educated and probably one of the

most talented of all of our family members, but he lives on Skid Row in Oklahoma City. We lost him along the way, somewhere along the line, and I doubt we will ever get him back. It is very sad, because a lot of talent has gone to waste. Somewhere along the line we did not pay a whole lot of attention to his character development.

This chart is specifically geared toward giving an individual a well-rounded character. At the beginning of a science, engineering, or technology career, an individual will be registered by state boards upon completion of professional certification. Thus, you will have a well-rounded individual knowledgeable in areas of Indian issues, and competent in a professional field.

This is the planning chart I plan to use in my daughter's education. First of all, I have had a tremendous background. I started television work in 1970 in Tulsa, Oklahoma, with KTAW-TV in the production department, and I transferred in 1973 to the Oklahoma Educational Television Authority as a producer/director and had my own Indians' program for three years called *Indians for Indians*. I was given an opportunity in 1976 to produce a children's *Indian Sesame Street* program in New York. We used puppet characters. I had Toothbrush and Toothpaste on a reservation - they were marionettes. I had dancing moccasins, and their mouths opened from the tongue part of the moccasin. You could see the tongues, and they had little eyes. They would dance, but they would talk to each other - Left Foot and Right Foot - and everything was geared toward obedience, sharing, and character development in Head Start in the early child education program. In 1979 and 1980, I produced a teenage program, a docudrama, called *I Am Different from My Brother*. I used an 11-year-old girl to read the script. A lot of times people think we Indians are all alike. That is not so - there are 300 different tribes and 300 different languages. We are not like our Hispanic brothers who come from one common language. We are not like our Black brothers who come from one common culture. We are 300 different cultures and 300 different languages. Please do not treat us the same. And if CASET does not realize this, then I think you will be remiss as well. We are dealing with 18,000 Indian people in Denver, Colorado - 50 different tribes. Ninety percent of the total population is at risk, and 78 percent of our Indian people live in poverty. That does not mean we are poor. Sometimes I have a really negative feeling toward condescending attitudes from educators, from anybody - but particularly from Indian people.

So, in the process, I still have a strong desire to see the children develop. Recently, the Denver Indian Center completed an early childhood education curriculum. Denver is an urban environment, but we take into consideration the Northwest coast region and the tribes of that region. We have taken into consideration the tribes of the southwest, the northern plains, the southern plains, the Great Lakes region, the northeast, and the southeast. Our tribes come predominantly from the Sioux Indian reservations (29 percent), and 19 percent of our tribes come from the southwest - the Navajo, Hopi, and Pueblo tribes. But we want our children to learn more about other tribes as well as their own.

We begin our program each Monday with a Cedar Ceremony, by which our children understand spirituality. Many times, spirituality is absent in a lot of our Indian people. And we talk about religion, but religion is different from spirituality. Worship is very important to Indian people. It is just like food - we have to have it every day. A lot of times, a non-Indian will go to church on Sunday morning for one hour and get spiritual fulfillment, but Indians have to have it everyday. So we want to ensure that our children start out with proper spirituality and good character development. At the end of each day, we used to require our children to give each other a hug and a pat on the back and say, "We'll see you tomorrow." And when that happened, our little children were quite pleased. We do not do that any more because it has become automatic, repetitive. Last week, we graduated 19 Indian children, all from different tribes. We have a waiting list - 40 Indian children whose parents want them to be in our program.

**TABLE 2**

**PLANNING CHART FOR AMERICAN INDIAN CHARACTER DEVELOPMENT**

| | MIDDLE SCHOOL | | JUNIOR & SENIOR HIGH SCHOOL | | | | COLLEGE OR UNIVERSITY YEAR | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 7 | 8 | 9 | 10 | 11 | 12 | 1 | 2 | 3 | 4 |
| 1. HUMANITIES | R | R | R | R | R | E' | R | R | R | R |
| 2. FEDERAL POLICY | | | | R | R | E' | R | R | R | R |
| 3. EDUCATION | R | R | R | R | R | R | R | R | R | R |
| 4. ECONOMICS | | | | R | R | R | R | R | R | R |
| 5. ADVOCACY GROUPS | | | | | | E' | | | E' | E' |
| 6. CULTURE ACTIVITIES | R | R | R | R | R | R | R | R | R | R |
| 7. ASSESSMENT | | | | | NDN I.Q. | NDN I.Q. | | | | C A |
| 8. SUPPLEMENTAL EXTRA-CURRICULAR ACTIVITY | A B | A B | AB C | AB C | AB CD | AB CD | AB CE' | AB CE | AB CE F | AB CE F |

NOTES: E' - OPTIONAL MODULES OR PRACTICUMS AND/OR PAPERS SPECIFICALLY RELATED TO PARTICULAR TRIBE OR ECONOMIC EVOLUTION OF TRIBE.

CHARACTER ASSESSMENT

OTHER PREPARATION

1. KNOWLEDGE OF FEDERAL LAWS AND POLICY.
2. UNDERSTANDING OF CULTURAL VALUES AND PRACTICES.
3. RESOURCE LINKAGES WITH NATIONAL GROUPS.
4. POSITIVE SELF-IMAGE AS A MOTIVATING FACTOR.

BEGINNING OF SCIENCE ENGINEERING AND TECHNOLOGY CAREER

CAREER

P.E. - REGISTERED BY STATE BOARDS AND COMPLETION OF PROFESSIONAL CERTIFICATION.

* WELL ROUNDED INDIVIDUAL KNOWLEDGEABLE IN AREAS OF INDIAN ISSUES AND COMPETENT IN PROFESSIONAL FIELD.

Question from the floor:

Are you advocating that these charts should be in the school curriculum and that they should be specific to Indians, or is this a program you are designing for your daughter?

It is primarily extracurricular at this time, but I firmly believe that, as one of our noted Presidents said, "The buck stops here." Now, who is going to educate our children, but us? And I do not think CASET is capable of educating Indian children as I am capable of educating my children, so I have to do some planning for my daughter. Maybe this planning can be applied to other disciplines, not just to science, engineering, and technology. You could utilize it for psychology, or education.

Question from the floor:

What do you mean by education?

Well, this is what I am going to tell you now. Remember those first four headings we talked about? First is cultural values, and I am talking about humanities, cultural values, religion, ethics, art, and media, all the information about Indian people that is of worth. I always say to Denver public schools, take everything about Indians written before 1970 and scrap it - take it off the shelves. It is worthless. It ain't no good. It is junk. Replace it with new and modern material about us that we Indian people feel is good. At the same time, we have to have a concept of religion and methods of worship instilled in our lives. We are inviting the Native American Church of North America to have its June conference in Denver, Colorado. This is a religion that is sweeping America. Ethical values are very important. As we said earlier, humanities, federal policy, education, and economics is knowledge critical for our youth. So these are the subject matters as far as education is concerned.

Let me talk about federal policy first - the history of our Indian people, the process of federal policy, tribal governments and how Indian tribal governments operate today, trust responsibilities in the Bureau of Indian Affairs as well as Indian Health Service - federal enactments and all the laws and resolutions and legislative orders and executive orders that have an impact on our lives. We need to know about it, and then about the Indian Reorganization Act, and where we currently stand as far as tribal government development today. On education, everybody needs to know how we have been affected by the Bureau of Indian Affairs and BIA schools in our educational process. We also need to know about parochial as well as mission schools development, and how parochial and mission schools are still operating on current reservations.

When I was in Nebraska, the Catholic Church was operating on a Winnebago reservation. I was the Director of the Nebraska Indian Commission, and there were no Indian people in administrative roles. They all had blue-collar positions, and it really upset me but I did not say anything. But, at one time, a young child was beaten and punished by a social worker, so as the director of the Indian Commission, I asked all the parents to remove their kids from that boarding school. I asked the Catholic archdiocese to rescind its funding for this Catholic boarding school, and I even asked the Father to go into an alcoholism treatment program, and they got upset with me. And I said, "I will use whatever means necessary - the press, the legislature, and the courts - to impact change." So they asked me as the Director of the Indian Commission to come visit with them, and they had people lined up around the seats just like vultures waiting for prey. I said, "You know, we've got one problem here, and it is a sore. And if you don't put a cure to it, it is going to fester and get worse, and then you are going to have to apply a stronger remedy. But if you apply the proper remedy right off the bat, we are going to cure it. I invite you to the Capitol, and when you come, I will give you a tour of the legislative chambers. I will let you meet the governor, if he is available." So, a month later, I got a call from this Catholic institution. They brought their students down there to the capitol and had a chance to meet the lieutenant governor and an opportunity to go to the legislative chambers. That was good for character development, but, at the same time, that administration learned a few things. They wanted to keep their school. They knew if that school was

closed, the land and all the trust areas would go back to the tribe. So the tribe was in a very critical and pivotal position. I recommended that they learn something.

These are only a few subjects (Table 2). You all could add a lot of areas to these, too. So, education is important today - we are talking about education reform. We are talking about what Indian people are doing. I was the dean of students at the Nebraska Indian Community College, and it was very sad to realize that some of our Indian students will never make it in this society. And I was responsible for preparing plans for career opportunities for Indian students, but we were talking about low academic skills, low employable skills. So, now, I am finding myself doing the very same thing in an urban environment, with more people from different tribes. But in the process, I was teaching courses such as The Indian Child Welfare Act and the Best Interest of the Child. I was teaching courses in television and socialization. I was teaching courses in human development and how we think and how we grow, the transitions from one phase to the next. All of you realize, according to Skinner and Erikson, there are seven phases of development, but in the Indian world, there are four: young age, teenage, middle age, and old age. Indian men are often recognized to be responsible at the age of 25. But in the dominant or Anglo male society, when you are 18 you are out of the house. A lot of times in Indian families, you find two or three generations living in one household, and we do not push our kids out. They are welcome to stay. Many times we have to learn from our cultural traits, because it is important how we develop as well.

I also recommend the area of economics: What is taking place on Indian reservations today with the Claims Commission, natural resource development, Indian Finance Act, and water rights? I am recommending that these come in the college years, but here I put down the Indian-controlled schools. They are working, you know. Plus, at the same time, they have a high concept of pride among Indian people, among Indian youth. So I have recommended Indian Finance Act in the third and fourth year. Indian Studies is not going to be available at every college or institution, let's face it. And I doubt if Ethnic Studies has a very long history in some of our major institutions. When I was in Nebraska, I advocated that the legislature ensure that the University of Nebraska required its teachers to have nine hours of multi-ethnic study prior to certification for teaching in Nebraska's public schools. Boy, did they get mad at me! I said, "Look here. Look in the classroom. You look in any classroom, and you find poor Anglo children, poor Black children, poor Hispanic children, poor Laotian children, poor Indian children, but the teacher is still middle-class Anglo." And a lot of times, the teacher will relate better to the child who is most like them. In other words, if a child wears designer jeans and the teacher wears designer jeans, they are going to have a good relationship. And I firmly believe that if you remove economics from the classroom, we will all survive. We will all do well. But, let's face it: that is not the situation in a lot of our public schools.

In Denver, Colorado, we petitioned the Denver Board of Education to create an American Indian Education Advisory Council. Now we have an American Indian Education Advisory Council. Last week, we had a sit-down dinner with the Board of Education. We want more Indian educators in Denver Public Schools. We want more opportunities for the Indian student that come from Denver Public Schools' resources, not from Title IV or from Indian parents. We want Denver Public Schools to put their own money into the process of educating Indian children. They look at us. "Boy, you guys are really asking for everything, aren't you?" I said, "Well, don't expect me to quit next year, because I am coming back, you know." So, I firmly believe in character development.

So, this is what I prepared for my daughter. I am superficially starting it in her fifth-grade year, but my daughter just turned 11 and will begin her puberty rites training this fall. Some people think Indian tribes no longer have puberty rites, and that is not so. This will take four years, after which, by the time she is 14 years of age, she will be fully knowledgeable about Comanche ways and customs and value systems. She is going to be a powerful lady, I guarantee it, at 14 years of age - and can you imagine what she is going to be like upon graduation from college! At a young age now, she is currently Junior Miss Indian Colorado, and she has learned how to trill her tongue. She is good, and she understands the concept of pride at an early age. She is probably the only "darkie" in the whole school. But that school understands that she is proud of her tradition, and they are not trying to break down her pride and self-concept. In fact, they encourage the rest of the kids to gain some knowledge from her training. So, because of that, I feel she is going to be a very well-rounded character. We have been establishing that in her lifetime since she was a young baby. Paid for her ways in Indian ceremonies since she was the age of three, and we still have a

long way to go. She talks about going to Radcliffe or Harvard or Oklahoma University, but I know she is going to college somewhere. Of course, you have to keep your fingers crossed at all times.

> ***"I am here to say I am firmly interested in ensuring that we do have a living Indian presence in the areas of science, engineering, and technology."***

So, that is what I have developed. My friend Waldo and I, we have always had a good, cooperative relationship, and I am not suggesting this is something everyone should incorporate. But it is something I feel I am going to use for the character development of my children, and it is something we have in the Denver Indian Center curriculum for preschool. I am working with adult education students at the end of the hall. I do not want the preschool kids to be in the same circumstances as my adult education students, and I am hoping there is a big gap and a big disparity between early childhood to adulthood. So if I prepare something for a parent to look at in his or her own character development, as well as a career opportunity, then I can narrow that gap or that disparity between early childhood to adulthood.

The first chart curriculum is middle-class and non-Indian-oriented. The burden of professional development lies on the educator, whereby it is assumed that the educator will learn about the heritage of the people he or she is teaching, but that is not always so. Plus there is a lack of Indian values in the education process. Plus American belief that education can transform Indian people into "good citizens." Plus academically-oriented choices are considered beyond the scope and ability of Indian people, and I do not think that is so. If you look at the Indian chart, you will find there is opportunity to develop thinking skills in the middle school curriculum. You will have an opportunity to promote inquiry on the part of the student, and you can maintain cultural relationships, recognize barriers to accomplish character and organizational development, and maintain group identity.

We have to start somewhere, and because of that, I appreciate this opportunity. I am not here to say to the Center for the Advancement of Science, Engineering, and Technology they do not know what they are doing. But I am here to say I am firmly interested in ensuring that we do have a living Indian presence in the areas of science, engineering, and technology. And I firmly believe in the process, whereby I am going to have a living Comanche Indian president by the year 2088. If we do not start now, we are just going to be brown White people.

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# NIZHONI CAMP SUMMER COLLEGE ORIENTATION PROGRAM

**Tanya Gorman**

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*A Navajo, Tanya Gorman has spent much of her professional life with agencies and organizations providing services to the Navajo Tribe, in which her bilingual ability in English and Navajo has been an asset. Funding of her proposals and projects has allowed her to expand the horizons of members of the tribe and others - culturally, socially, and educationally. She is currently Assistant Director for the Office of Admissions at Northern Arizona University.*

My presentation is on Nizhoni Camp, a precollege summer program at Northern Arizona University (NAU) in Flagstaff. NAU has a full-time enrollment of about 9,600 students. The "headcount" is around 12,500. NAU is the smallest of the three universities in Arizona. The other two are Arizona State in Tempe, and the University of Arizona in Tucson. One board of regents governs all three universities. NAU is primarily dedicated to undergraduate education. Its emphasis is on liberal arts and undergraduate degree programs.

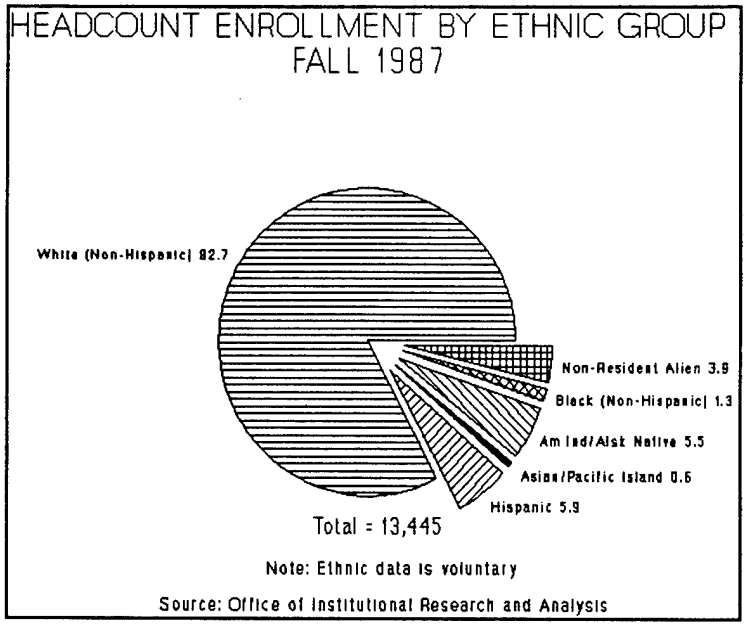
I do not know how familiar you are with Arizona, but I want to share with you where we are located. As you probably know, Arizona does have a large Native American population. We are located in the northern part of the state, in Flagstaff. The university is situated close to the Navajo Reservation, home of the largest Indian tribe. NAU is also near the Hopi and the White Mountain Apache tribes. NAU has a strong commitment to serve Native American tribes and the students pursuing postsecondary education.

Organizationally, Nizhoni Camp is located in the Educational Support Programs (ESP). ESP is not located in the academic unit but rather in the Student Services division. ESP works with the vice president and the assistant vice president of the university.

Administration of outreach and campus-based programs and educational support are ESP's primary responsibilities. The director is Ray Rodriguez, a Hispanic, and I am the assistant director. My responsibility is to oversee three programs: Upward Bound, Educational Talent Search, and Nizhoni Camp. During the summer, I coordinate the Nizhoni Camp and Upward Bound for more than 150 high school students. These programs are outreach programs. On campus, we have the Learning Assistance Center and the Student Support Services that serve the NAU students.

A little bit more about NAU. As I said earlier, our enrollment is about 9,600 full-time students. The Native American population this past academic year was 798, with the majority Navajo. In comparison, Arizona State has a little more than 200 Native American students, although ASU is about four times larger than NAU. The University of Arizona has about 100 Native American students. NAU's Native American population in 1987 was about 5 percent (see Figure 1).

**FIGURE 1**




Nizhoni Camp was initially proposed and developed by Lawrence Gishey, a former director of the Department of Higher Education with the Navajo Tribe in 1983. I have been personally involved with the program for two years. Since 1985, the staff has been making some changes and modifications in the program design.

Nizhoni Camp is jointly sponsored by NAU, the Navajo Department of Higher Education, and a number of secondary schools located in Arizona, Utah, and New Mexico. Secondary schools have used Johnson O'Malley (JOM) Act and Title IV funds to sponsor additional students.

People usually ask what *Nizhoni* means. Figure 2 briefly describes what the word means, and how it is used in the final verse of the Navajo Beautyway Prayer.

**FIGURE 2**

The Word *Nizhoni*

*Nizhoni* - it, she or he is pretty; it is beautiful, clean, good, nice, fine or neat.

*With beauty before me, I walk.*
*With beauty behind me, I walk.*
*With beauty above me, I walk.*
*With beauty under me, I walk.*
*Everlasting and peaceful*
*Everlasting and peaceful*
*Everlasting and peaceful*
*Everlasting and peaceful*

*- Final verse in the Navajo Beautyway prayer*

The objective of the camp is to introduce the participants to the rigors of university life, while improving their academic skills in preparation for postsecondary education. Nizhoni Camp is an intensive five-week college preparatory program for Native American high school students who plan to pursue a college degree.

There is still a large number of Indian students graduating with promising grade point averages and ACT scores who experience academic hardship in college, due to inadequate preparation in the basic skills. Many lack the fundamental skills of mathematical calculation and analysis, English grammar and composition, and the curiosity to explore new phenomena. It is essential that they learn these skills early, before they leave high school, to allow them to enjoy a rewarding and successful college experience.

In 1984, the Arizona Universities' Study Groups reported in *Minority Student Recruitment and Retention*:

1. Minorities are underrepresented in the student populations of the state's three universities.

2. Within the universities, minority students are frequently found in areas of study which do not emphasize the acquisition of skills in higher mathematics and experimental sciences.

3. Economic difficulties are pervasive, arising either from shortage of financial planning, or lack of experiences in personal budget planning in a university setting.

4. Minorities, with the exception of the Asian American/Pacific Islanders, have higher rates of attrition than Anglos.

The Navajo Nation also expressed its concerns about high attrition among its college students in the *Navajo Post-Secondary Education Initiatives for the Fiscal Year 1988 Budget*. It estimates the dropout rate among incoming freshmen is as high as 60 percent. This is alarming, and the Department has pointed to several factors, among which are "poor academic preparation, insufficient planning, insufficient orientation toward college work, problems with disciplinary use of time, etc. The outcome... is a loss of the student, and for the Navajo Tribe."

Nizhoni Camp is built on our academic component by providing a precollege curriculum, and by developing the foundations skills in composition and mathematics. These students need to refine their reading skills, study skills, and other basics.

Nizhoni Camp is designed for Native American high school students in good academic standing whose high school curricula reflect a college-bound program. It is suggested only students who are in the top third of their class be recommended for participation. Applicants who are selected must be committed to completing the full program as designed.

The morning foundation classes include mathematics and composition. Two years ago, the participants of Nizhoni Camp enrolled in the regular university courses. The participants did not have a very good success rate. So we evaluated the curriculum to determine what problems there were in our mathematics course. Consequently, the staff designed a whole new curriculum for the mathematics class.

Most of the students attending Nizhoni Camp are sophomores and juniors, and these students are college bound. By their sophomore year, the students have taken Algebra I and, hopefully, Geometry. Some of the juniors may have taken Algebra II. One of the major underlying problems discovered in the mathematics area has been in reading word problems. The pretest showed a large number of students were having difficulties with word problems. Therefore the five-week summer program in the mathematics area focuses on mastering word problems. According to the post-test, every student in the mathematics class last year improved his or her skills in word problems. In the English programs, the teachers used to cover a conglomerate of different types of compositions, plus research and other activities. Last year, the class was redesigned and limited to essay writing. The students developed the skills to write a 250-word essay. This validated the content of the class. These students have to learn the different types of essays and to develop the particular writing skill.

In the afternoons, the students are enrolled in integrated studies: Career Development, Study Skills, Reading, and Computer Literacy. The students develop study skills and explore career, educational, and personal goals. In Study Skills, the students learn memory techniques, test-taking methods, note taking, time management - basic study skills. In Career Development, the emphasis is on career awareness and opportunities. The students participate in career exploration and complete the Self-Directed Search to identify their strengths and interests. The students alternate Career Development with a class in computer literacy, an orientation in word processing.

The academic program emphasizes Mathematics and English as the foundation courses. The students have an opportunity to refine their skills and to identify career opportunities in the long range through integrated studies. In addition, the Camp has a well-developed residential program. Aside from academic preparation, becoming a member of a university is a challenge to the students.

The Camp helps the students adapt to the university setting. A lot of students who come to the university leave, even after their first year, not because of their academic capability or lack of academic potential, but because of their lack of social skills. A majority of students attend schools with primarily Native American enrollment. The high schools may have a majority of Native American students with perhaps one or two Anglo students. When the students come to the university campus where there are only 700 Native Americans out of 9,000 students, what do they do? In the residential component, these students learn how to make friends with students from other tribes, and develop living skills in a dormitory setting. Living in the urban area presents new problems, since the students may never have been away from home. The residential component strives to help the students make the adjustment.

The Camp also offers recreational activities. On the weekends we have field trips to different locations. When you think of Arizona, you think of the Grand Canyon, but many of our Native American students -

even those from areas of Arizona or Northern Arizona - have never been to the Grand Canyon. The Camp schedules field trips there. In addition, the students have access to the facilities on campus. On the Navajo reservation, there is probably only one swimming pool, and it is not located in a school. Many of these students see an Olympic-sized swimming pool for the first time at NAU; most of the students do not know how to swim. Nizhoni Camp provides these students with the opportunity to participate in a wide range of activities.

Students like to use the Dome because of the weight room and a running track. The staff encourages the students to use the facilities if they enroll at NAU or attend another university. The students are more apt to use university facilities if they know that the facilities are open to them and that they can take advantage of those services.

Another recreational activity is the talent show, which the staff uses as a group bonding activity. Each student is assigned to a counselor (there are usually about 15 students to a counselor). The groups develop an act, whether it is a skit, lip-sync to music, or a special show. The talent show is held during the second week.

The Camp provides interaction with minority professionals who serve as role models. Guest speakers are invited to speak in the Career Development class or in the evening. Through this interaction between our participants and the guest speakers, we hope the students will learn how these professionals accomplished their educational and career goals, the commitment that they had to make, and about the experience that they had in college.

In 1985, we had a major drinking problem with our students because a lot of these students are away from home for the first time. Unfortunately, the residential staff were really lax with the students. The counselors condoned the drinking, and consequently, the Camp had a major epidemic. Students were drinking during the week and on the weekends. The following year, 1986, a partnership agreement was developed with the students and the parents. Four items that are cause for immediate dismissal were agreed to by the students and the parents. Students can be immediately dismissed for four specific infractions: possession of any type of weapon (a handgun or a knife); drinking; disrespect to staff, other students, or instructors; and sexual misconduct. Of these four dismissal grounds, students are most often dismissed for drinking. Last year, we only lost two students from the Nizhoni Camp for drinking. The parents are involved and have an exit interview with me.

ESP also has a partnership agreement with the counselors because these counselors act as role models. The majority of the counselors are Native Americans, and we want them to represent themselves and the university in a positive fashion. The counselors are not allowed to drink on campus during camp sessions. If they do drink, they have to stay off campus, and not be seen on campus in that condition.

Seniors have participated in the Nizhoni Camp program in the past, but our primary funding source, the Navajo Tribe, felt strongly that these high school seniors should participate in university-sponsored orientation programs. NAU has a college orientation program for incoming freshmen - STAR. NAU freshmen students are encouraged to attend that orientation. The University of Arizona has its own orientation program - New Start.

Nizhoni Camp focuses on the high school sophomores and juniors. The students are college bound and taking appropriate classes. Their high school transcripts are reviewed to evaluate the classes they have been taking. These students should have taken at least Algebra I, and possibly Geometry and Biology, and should be planning to take either Chemistry or Physics.

The students should also take a composition class each year and meet the social science requirements. These prerequisites are geared toward admission requirements for the three state universities in Arizona. These requirements include four years of composition, three years of mathematics, two years of science with a laboratory, and two years of social sciences courses.

There are three factors in the selection of participants for Nizhoni Camp. The initial criteria in the review of academic progress is the student's cumulative grade point average, followed by the grade point average in each of the subject areas. The students also submit three short essays, on their high school preparation for college, their career goals, and how they feel Nizhoni Camp will contribute to their future success or future postsecondary plans. Other counselors are involved with me in the selection process, but, as one counselor puts it, I "play God." I select who goes and who does not go to Nizhoni Camp. It is a hard decision to make. Very few high-risk students are selected because there is so much competition for

the limited number of positions sponsored each year. For example, this year the Navajo Tribe only funded 25 slots for Navajo students, but there were 110 applicants. The cut-off for most of the cumulative grade point averages has been around 2.9 and 3.0; few students with averages between 2.5 and 2.9 are selected.

Nizhoni Camp receives funding from White Mountain Apache, Gila River, Navajo Tribe, and Title IV and JOM programs through the high schools. One sponsorship for a single student is $850. For a five-week college preparatory program, this is not as expensive as some other summer programs, but it is still expensive. In total, more than 40 high schools from Arizona, Utah, and New Mexico send students to Nizhoni Camp (Table 1).

Over the past two years, the staff has worked diligently on accreditation. The curriculum design and certification of teachers for secondary education allow the program to meet the requirements. The students receive one high school credit - a big plus for Nizhoni Camp. Certified high school instructors teach each of the subject areas. The credit is accepted by the high schools as an elective. Nizhoni Camp does not attempt to replace the curricula or basic requirements at the high schools.

The Bridge component has been deleted from Nizhoni Camp this year. It is being continued under the Upward Bound program.

Over the years, Nizhoni Camp has grown. The program started back in 1984 with 14 participants. To date, 186 students have participated. As of the end of last year, 54 students were still in high school. The students who had graduated from high school were surveyed to see whether they have pursued postsecondary education. A total of 26 students responded to the survey; this represents half of the surveys sent out. Out of this group, 16 were in their first year of postsecondary education, eight had continued to their second year, and two were in their third year. The two in the third year are the students who were ready to graduate from high school when they attended Nizhoni Camp. We collect data continually. Each year, the graduating seniors are contacted just to obtain their educational plans, admission status, major at the college, and their career goal.

Since 1984, 186 high school students have attended the five-week precollege program (see Table 2). Most participants were juniors. Academically, the students performed above average. Over the four-year period, 80 to 85 percent of the students received grades above *C* (see Table 3). The Integrated Studies course reflects that 93 percent did average or above. The problem with the students with the poor grades was attitude. The students with *C*s, *D*s, *Incompletes*, or *F*s had a lack of commitment to their education. The students who were getting low grade point averages have been the students who were not self-disciplined. If they do not have the self-discipline and the commitment from themselves, they will not do well. The counselors and instructors do counsel the students, but it may not help. A case in point: One student had major problems and received straight *D*s. He had good test scores and did well during the academic year. This student was the youngest student at Nizhoni Camp. The young gentleman "discovered" girls. He left the Camp with straight *D*s. This year, his counselor and his mother want him to come back to bring up those grades. The only problem is that funding sources and limitations do not allow students to repeat the Camp to demonstrate their academic capability. This student lost his opportunity. Maybe, in the long run, it will have been a lesson for him. He has learned he cannot just saunter through a summer program, not do well, and erase the mistake. He owns those grades. Maybe when he goes to college, he will have a different approach and a different attitude toward grades, and do what he must do to get good grades.

The course descriptions are included in the handout on Nizhoni Camp (see Appendix).[1]

Over 26 different schools have been represented at Nizhoni Camp over the years. There have been at least seven funding agencies.

NAU is proud of what Nizhoni Camp has become. The university is located close to numerous Indian reservations. The university has a major commitment toward the education of Native Americans. Nizhoni Camp is just one program designed for Indian students. In the next couple of years, the university may be able to share more of the expense in administering the camp. For the past four years, the program has been a pilot program, and data have been collected to determine its impact. The goal is to increase the number of students coming to Nizhoni Camp by reducing the amount of tuition that has to be paid by the sponsors. The university may be able to double the number of students attending the Camp.

[1] For a copy of the current Nizhoni Camp brochure, contact Adrian Tanakeyowna, Coordinator, Nizhoni Program, Educational Support Programs, Northern Arizona University, P.O. Box 6035, Flagstaff, Arizona, 86011-6035; 602-523-9011.

**TABLE 1**

Nizhoni Camp High School Representation

| High School | 84 | 85 | 86 | 87 | Total |
|---|---|---|---|---|---|
| Alchesay | | 1 | 1 | | 2 |
| Aztec | | | 1 | | 1 |
| Baboquivarie | | | 1 | 1 | 2 |
| Camp Verde | | | | 1 | 1 |
| Casa Grande Union | | | | 1 | 1 |
| Chandler | | 1 | | | 1 |
| Chinle | | | 1 | 1 | 2 |
| Coconino | | 1 | 1 | | 2 |
| Crownpoint | 1 | | 1 | 1 | 3 |
| Flagstaff | | 1 | 1 | | 2 |
| Gallup | 1 | 1 | 1 | 1 | 4 |
| Ganado | | 1 | 1 | 1 | 3 |
| Holbrook | | 1 | 1 | 1 | 3 |
| Kingman | | 1 | | | 1 |
| Kirtland | | | 1 | 1 | 2 |
| Many Farms | | 1 | 1 | 1 | 3 |
| Monument Valley K | | 1 | 1 | 1 | 3 |
| U | | | 1 | 1 | 2 |
| Navajo Mission | | | 1 | | 1 |
| Navajo Pine | | | | 1 | 1 |
| Newcomb | | | 1 | 1 | 2 |
| Parker | | | 1 | | 1 |
| Phoenix Indian | | | 1 | | 1 |
| Ramah | | 1 | | 1 | 2 |
| Red Mesa | | 1 | | 1 | 2 |
| Rehoboth | | | 1 | | 1 |
| Richfield | | | 1 | | 1 |
| Rock Point | | | 1 | 1 | 2 |
| Rough Rock | | 1 | 1 | 1 | 3 |
| Sells | | 1 | | | 1 |
| St. Michaels | | 1 | 1 | 1 | 3 |
| Shiprock | | 1 | 1 | | 2 |
| Snowflake | | | 1 | | 1 |
| Southwest Indian | | | | 1 | 1 |
| Thoreau | 1 | 1 | 1 | 1 | 4 |
| Tohatchi | 1 | 1 | | 1 | 3 |
| Tuba City | | | | 1 | 1 |
| Whitehorse | | 1 | 1 | 1 | 3 |
| Window Rock | | 1 | 1 | | 2 |
| Winslow | | | 1 | 1 | 2 |
| Unknown | 3 | | | | 3 |
| Total | 7 | 20 | 29 | 25 | 81 |

**TABLE 2**

**NIZHONI CAMP PARTICIPATION BY GRADE LEVEL**

| Grade Level | 84 | 85 | 86 | 87 | Total |
|---|---|---|---|---|---|
| Freshmen | | 9 | 1 | 2 | 12 |
| Sophomores | | 8 | 17 | 9 | 34 |
| Juniors | | 39 | 29 | 26 | 94 |
| Seniors | | 13 | 9 | 11 | 33 |
| Unknown | 14 | 0 | 0 | 0 | 14 |
| Total | 14 | 69 | 56 | 48 | 187 |

* Final Reports, 1985 and 1986; Registration, 1984 and 1987.

**TABLE 3**

**NIZHONI CAMP GRADES***

| SUBJECT | Course Grade | 1985 | 1986 | 1987 | Total | Percent |
|---|---|---|---|---|---|---|
| ENGLISH | A | 16 | 8 | 7 | 31 | 21% |
| | B | 23 | 18 | 10 | 51 | 34% |
| | C | 16 | 11 | 11 | 38 | 26% |
| | D | 4 | 7 | 8 | 19 | 13% |
| | F | 3 | 2 | 0 | 5 | 3% |
| | I | 0 | 0 | 4 | 4 | 3% |
| | Total | 62 | 46 | 40 | 148 | |
| MATHEMATICS | A | 18 | 11 | 6 | 35 | 23% |
| | B | 24 | 13 | 12 | 49 | 32% |
| | C | 16 | 20 | 8 | 44 | 29% |
| | D | 1 | 3 | 3 | 7 | 5% |
| | F | 0 | 1 | 4 | 5 | 3% |
| | I | 4 | 0 | 7 | 11 | 7% |
| | Total | 63 | 48 | 40 | 151 | |
| INTEGRATED STUDIES** | A | 72 | 62 | 20 | 154 | 45% |
| | B | 40 | 60 | 14 | 114 | 33% |
| | C | 13 | 36 | 1 | 50 | 15% |
| | D | 0 | 9 | 2 | 11 | 3% |
| | F | 0 | 8 | 0 | 8 | 2% |
| | I | 0 | 0 | 4 | 4 | 1% |
| | Total | 125 | 175 | 41 | 341 | |

* 1984 Grades not available.

** Integrated Studies includes grades from two courses, Career Development and Study Skills, for 1985 and 1986; 1987 includes grades from four courses: Career Development, Study Skills, Reading, and Computer Literacy.

Source: Final Grade Reports, 1985, 1986, and 1987.

The staff will continue to follow up with past participants to see whether they have gone to college and obtained a degree. Students do come back to visit the staff. They tell you, "I'm still in school, and so-and-so is still down there with me." Immediately, I write down the information in the file. At the end of the school year, we send out graduation cards with a little questionnaire to the seniors. The students provide information about their educational plans. We record those plans in the student file. In addition, at the end of their senior year, we request final transcripts. An evaluation of the students' grades before they came to Nizhoni Camp and their grades afterward is conducted.

## QUESTION AND ANSWER SESSION

Question from the floor:

What is the cost per student?

$850.

Question from the floor:

Is that for room and board?

It includes books and supplies, instruction, everything.

Question from the floor:

And transportation?

And transportation, too.

Question from the floor:

What is the philosophy behind it?

Nizhoni Camp started out with students who were academically successful, in the top 10 percent of the class with high grade point averages. A majority of those students, after a review of their transcripts, were not college-bound students because they would not meet admissions requirements. Nizhoni Camp is a college preparatory program; therefore, the eligibility criteria changed. The students do have to be college bound, they must have taken certain subjects to meet university admission standards, and they have to identify a career area. The Navajo Tribe's educational priorities are the sciences, engineering, health, and business administration.

The philosophy of Nizhoni Camp is to approach education from a holistic perspective. These students must develop academically, refine their composition and reading skills, or begin to develop study skills necessary to be successful in a university setting, and at the same time, we expose them to a college environment. The students must learn how to survive on a campus, how to adapt to being a Native American in a dormitory and classroom where they are a minority, and how to use university services. It is a college orientation program that emphasizes the development of skills. Without the mathematics, without the reading, the students probably will not succeed.

A lot of our Native American students may have taken Algebra I and II and even Trigonometry, and will place into precollege-level mathematics when they take the placement tests. This may occur because of their test anxiety or lack of experience with testing, not because of a lack of knowledge. Nizhoni Camp gives them the experience during the summer program. The students take their college placement tests for English. The tests are graded and the students placed accordingly. They are given post-tests at the end, and their grades do go up.

Nizhoni Camp has been designed for lower grade levels simply because intervention at the senior year is too late. The students are graduating, and they are either admissible or not admissible to the university. At the junior level, you can intervene by saying, "Well, you're short Algebra II. Go back and take your Chemistry. If you have a 3.0 this year, your grade point average will come up to a 2.5, and you'll be admissible." Working with sophomores is better because they are just now beginning their high school

curriculum. If they have no plans to take mathematics but they really want to go to college, or maybe they only want to take Algebra I, you can advise them about admission requirements. In the sophomore year they still have their junior and senior year to take college-bound classes.

Through our program, we have an Educational Talent Search, which focuses on our junior high students. We do a lot of workshops and group presentations for our sixth- and seventh-graders, and even eighth-graders, and talk about high school curricula. A lot of it is informing students how to prepare for college, and the steps in going from high school to college. This is necessary, because a lot of these students do not get that orientation anywhere else. For example, some of the students on the Navajo reservation attend boarding school. They have one counselor for 400 high school students - how could they do every student justice? So we do classroom presentations. We work with a younger population.

*"If they want to go to an orientation but they are going to a college that does not have it, the students should reconsider where they are going. Institutions with orientation programs are interested in student success."*

Question from the floor:

How do you deal with the homesick students?

The students do call home, the parents visit, or the students go home for the weekend. There are so many activities that they may not have time to be too homesick. The high school graduates are encouraged to enroll in the Bridge component orientation. If they want to go to an orientation but they are going to a college that does not have it, the students should reconsider where they are going. Institutions with orientation programs are interested in student success.

Question from the floor:

Do any of those seniors, after you have pointed them in the right direction when they were sophomores, go astray from their original objective, so that you then have to bring them back to it?

A lot of them have decided by the seventh grade what they are going to do. When they get to be seniors, they have already made up their minds. This may not be going astray, but rather a commitment to family. They may not be dropouts, but rather stop-outs. It is reported that, in university systems, 80 percent of Native Americans drop out after their first year, in comparison to about 60 percent for the total population. Thus, for Native Americans, the dropout rate is about 20 percent higher. Some of those Native American students return to school and say, "I was not a dropout, I was stop-out." The research still classifies them as dropouts.

If students leave and come back, it may be because of other commitments that have priority. These include family, finances (they have to go to work), or death in the family. I believe that the students who do decide to come back will stay. I personally know a girl who finished with a nursing degree, and it took her 12 years. She finally did the last two years at NAU. These are factors that have to be recognized.

ESP is a visible program because most of our staff members are Native Americans. Most are Native American women. The program has a receptionist and an administrative assistant who smile a lot. We have a lot of students just coming into our office to visit and get help or information. As an outreach program, we are supposed to be out recruiting at the elementary schools and the junior high and high schools. I believe that these students are coming in asking for help because the staff looks friendly. I think this relationship is really good for us, and those students may stay in school because of the staff's interest

and assistance. Students with financial aid problems see us. The financial aid application is probably the worst procedure to complete, because of its red tape and documentation requirements. The staff can usually work through the problem with the students. These relationships are an asset to the program and the university.

Question from the floor:

Do you ever have an exit interview with the students who either stop out or drop out? And, if so, do you ask them whether they intend to come back or not?

The only ones who get an exit interview are the students who withdraw during a semester. The students start the withdrawal process with the Dean of Student Life. There is no way to contact a student in the fall to find out why he or she left at the end of the spring or summer semester, unless you want to do a study. This would have to be done using a questionnaire, but you cannot intervene in between semesters. What we find out from students who are trying to find alternatives, is that they are looking for things they can do besides dropping out completely, such as part-time enrollment, and other long-range planning. There are a lot of dropouts. This is evident from the older student population returning to the campus. The older students may have gone to school a year, 10, or 15 years ago, and have come back - they are the stop-outs. Very few of the older students are new students who have never gone to college.



**APPENDIX I**

## NORTHERN ARIZONA UNIVERSITY

Educational Support Programs
1988 NIZHONI CAMP
Integrated Studies: Reading and Study Skills

**GOALS & OBJECTIVES: Study Skills Component**

**The student will acquire and improve skills in notetaking.**

- The student will demonstrate knowledge of at least one viable notetaking strategy and record it in his/her journal

**The student will gain awareness of how he or she learns and how this knowledge can be used to make personal learning effective and efficient.**

- The student will report his/her understanding of the principles of learning and how they can be used to make learning effective and efficient
- The student will report his/her own definition of meta-cognitive learning
- The student will describe two or more mnemonic devices

**The student will acquire and improve skills for effective and efficient textbook reading.**

- The student will demonstrate abilities for comprehension monitoring
- The student will demonstrate abilities for extracting main ideas from information reading

**The student will acquire and improve skills related to preparing for and taking tests.**

- The student will describe strategies for preparing for both objective and essay tests
- The student will describe strategies for taking tests

**The student will be able to analyze, evaluate, and personal study strategies.**

- The student will make a personal study skills handbook

**GOALS & OBJECTIVES: Reading Improvement Component**

**The student will be able to make critical analyses of reading material.**

- The student will be able to make evaluative judgements of reading material
- The student will read at least one novel during the program
- The student will increase his personal enjoyment of reading

**COURSE SCHEDULE**

| | |
|---|---|
| Week 1 | |
| Reading: | Book selection, journal writing, discussion |
| Study Skills: | Note taking: Cornell Notetaking System and variations, Graphic Organizers |
| Week 2 | |
| Reading: | Silent reading, critical reading |
| Study Skills: | Memory and Learnin; Library skills and Library tour; Long & Short term memory; Meta-cognitive; Mnemonics |
| Week 3: | |
| Reading: | Silent reading, analytical reading |
| Study Skills: | Effective & Efficient Textbook reading; Comprehension monitoring; Getting out the main ideas; Speed reading |
| Week 4: | |
| Reading: | Silent reading, evaluative reading, final report |
| Study Skills: | Test: Preparing for test, Objective vs. essay tests, test-taking tips |
| Week 5: | |
| Study Skills: | Synthesis: Planning the personal handbook; Making the handbook |

## APPENDIX II

### NORTHERN ARIZONA UNIVERSITY

Educational Support Programs
NIZHONI CAMP 1988
Integrated Studies: Career Development

**COURSE OBJECTIVES**

- Increase understanding about yourself, your needs, values, skills and interests
- Develop and enhance personal communication skills, and problem solving; experience working in groups
- Explore a variety of post-secondary occupations, careers, and educational opportunities
- Increase knowledge of independent living, survival skills (stress management, budgeting money, renting, writing letters of introduction and personal resumes)
- Practice goal setting, life planning and applying your skills, interests, and values to the work world

**COURSE SCHEDULE**

Week 1

Day 1 Introductions, ice breakers, getting acquainted; course goals and assignments; Explanation of grading.
Day 2 Hierarchy of Needs; Values Clarification (Values Auction and Survey); Focus on control; Introduction to career project and handbook.

Week 2

Day 1 Explore interests; "The Party"; Student Interest Survey; Exercises in Active Listening; Communication role plays.
Day 2 Problem-solving, detective games; Non-verbal communication; Assertiveness training.

Week 3

Day 1 Harrinton-O'Shea Career Decision Making; GIS (Guidance Information Systems).
Day 2 SPEAKERS ON A VARIETY OF CAREERS (Handbook notes).

Week 4

Day 1 Letter and Resume Writing for Employment; Career Presentation - interview - videotape - my bag.
Day 2 When You're Out on Your Own: Survival Skills, Coping with stress, time management, renting a house or apartment, budgeting your money.

Week 5

Day 1 HANDBOOKS DUE, Introductory letters and resume
Day 2 Complete Life Planning Workshop

**GRADING**

| | |
|---|---|
| Career Handbook (Journal) | 50 points |
| Attendance | 30 points |
| Class Participation | 10 points |
| Career Project (Resume and letter of Introduction) | 10 points |

The Career Handbook is the student's personal account of the five-week course. Each student will write at least a few lines in the handbook for each day that the class meets. It will also include any personal feelings you may be experiencing on any day. So, this journal or handbook will serve, as well, as a kind of diary of the NAU summer experience. The cover of the handbook will be something of the student's own design.

**APPENDIX III**

## NORTHERN ARIZONA UNIVERSITY

Educational Support Programs
1988 NIZHONI CAMP
Mathematics: Foundations of Algebra

**COURSE DESCRIPTION**

The mathematics component of NIZHONI CAMP will focus on problem solving and reasoning skills necessary for mathematical thinking and understanding. The approach will proceed from an overall relationship perspective to computation skills. Instruction will also be provided in critical thinking, study skills, test item analysis, and the reading of mathematics.

**OBJECTIVE**

The student will develop:

- procedures for solving algebraic equations.
- the ability to identify similarities and differences in mathematical concepts and problems, with particular emphasis on word problems and graphing relationships.
- study skills for algebra, including note taking, organizational and test taking skills, through the use of test item analysis.
- the ability to read algebraic explanations through a process of translating material into personal language and demonstrating application.

**COURSE SCHEDULE**

Week 1: Study Skills, Math Terms, Number Sense
- Day 1 - Pre-Test
- Day 2 - Review of math terms; Note taking skills; Test taking skills
- Day 3 - Fractions; Percents; Decimals; Relationships between fractions, decimals, and percents
- Day 4 - More mathematic relationships; Estimation of answers; Reading calibrated scales correctly; including whole numbers, fractions, and decimals
- Day 5 - Estimation of numbers not on the scale; Graphs; Quiz

Week 2: Understanding and using numbers to quantify thinking
- Day 1 - Introduction to basic word problems
- Day 2 - Word problems involving fractions, decimals, percents, and consecutive numbers
- Day 3 - Word problems involving discounts and saving money
- Day 4 - Scientific notation; Algebraic substitution
- Day 5 - Review substitution; Quiz

Week 3: Measurement
- Day 1 - Units of measure; Quantification; Appropriateness of units of measure; Conversion between units of measure
- Day 2 - Concepts of geometry; Linear, Area and volume measurement; Review algebraic substitution
- Day 3 - Relationships for the measures of common two and three dimensional geometric figures
- Day 4 - Geometric and spatial relationships
- Day 5 - Review; Quiz

Week 4: Mathematic Relationships
- Day 1 - Distinguishing mathematical relationships, direct, inverse, etc.; measure
- Day 2 - Symbolizing a relationship appropriately; Interpretation of a relationship expressed in symbols; Understanding the use of a formula as a way to solve a similar class of problems
- Day 3 - Making generalizations and supporting them; Identification of counter examples and inappropriate generalizations
- Day 4 - Truth tables; Summary and review; Quiz

**GRADING**

Traditional grading procedures will be used. These will be based on demonstrated performance on assignments, tests and quizzes. The emphasis in grading will be on appropriate logic and procedures when applicable.

**CREDIT**

Thirty hours of instruction will be provided in the mathematics course. This will be equivalent to .25 Carnegie Units of credit.

**APPENDIX IV**

## NORTHERN ARIZONA UNIVERSITY

Educational Support Programs
1988 NIZHONI CAMP
English Composition

**GOALS:**

This course will acquaint the students with academic writing standards common to the NAU freshman composition courses. The course uses a process approach to teach writing skills, and stresses critical reading and thinking abilities in writing. The fundamental perspective on writing in the course is audience awareness by the writer.

**COURSE OBJECTIVES**

During this course, the students will demonstrate knowledge of writing process skills in designing and completing a writing project. The process skills consist of methods of generating ideas, methods of focusing on and selecting useful ideas in writing, organizational flexibility, and final editing skills.

**TEXT:** Selections from Writing With Power by Peter Elbow and selections from the St. Martin's Guide to Writing.

**COURSE SCHEDULE**

Each class session will be divided into two 45 minute sections; one section will focus on the general writing concerns outlined above, and the other section of the class will focus on the students' ongoing work on their particular projects.

Week 1

Writing: Audience awareness; The basic writing process; Emphasis on idea generation methods; Journal assignments; Freewriting (Elbow)
Projects: Examine samples of persuasive, audience-oriented writing (brochures, letters, etc.); Break into dyads; Discuss projects; Library tour
Reading: Chapter 2, Elbow.

Week 2

Writing: Examine sample NAU freshman essays from Significance/audience awareness perspective; review basic writing process; Discuss focus/selection in the writing process; Defining a topic; Introduce peer editing; Journal assignments
Projects: Focus and selection used in decision on what the project will be; Peer editing workshop; Library session (class to be held in library)
Reading: Student essays; Chapter 14, "Defining" (St. Martins)

Week 3

Writing: Review basic writing process; Discuss organization in the writing process; Classifications within a topic; Examine sample NAU freshman essays from organization/audience awareness/peer editing perspectives; Journal assignments
Projects: Dyad presentations of work in progress; Discuss organization of projects, including possible formats; Peer editing workshop in organization; Library session
Reading: Student essays; Chapter 15, "Classifying" (St. Martins)

Week 4

Writing: Review basic writing process
Projects: Discuss editing concerns within the writing process; content vs. form; Examine sample NAU freshman essays from various perspectives, including overall grading; Illustrating; Journal assignments
Reading: Student essays; Chapter 16, "Illustrating" (St. Martins)

Week 5

Writing: Review basic writing process; comparing and contrasting; Journal assignments
Projects: Presentations of selected projects by dyads; Written critiques of projects
Reading: All projects; Chapter 17, "Comparing and Contrasting" (St. Martins)

# GIFTED AND TALENTED EDUCATION FOR AMERICAN INDIAN STUDENTS

**Stuart A. Tonemah, Ph.D.**

**President**
**American Indian Research and Development, Inc.**
**2424 Springer Drive, Suite 200**
**Norman, Oklahoma 73069**

*Stuart Tonemah, a Kiowa/Comanche, began his life in Lawton, Oklahoma. He received his Bachelor's Degree in Education from Oklahoma University and, at the time of this American Indian symposium, was a doctoral candidate at Pennsylvania State University. Tonemah has extensive experience in American Indian education and has held various professional positions including Director of Native American Programs at Dartmouth College, Executive Director to the National Advisory Council on Indian Education, and several positions with American Indian Research & Development, Inc. including his current position. His other professional activities include membership in the National Indian Education Association, consultant for several tribes and education agencies, and various publications and presentations in his area of expertise. Tonemah was also honored to receive the Indian Educator of the Year award in 1980-81 from the National Indian Education Association. He is Director of the American Indian Teacher Training Program of the Master's Degree Program in Gifted Education at Oklahoma City University, and was recently elected to the Board of Directors of the National Association for Gifted Children.*

There are so many pressures on our kids today that they do not know who they are. They are struggling with growing up, struggling with adolescence. They are struggling with their identity - who they are as an adolescent, an individual, an Indian person, a tribal person. Many of the kids we deal with in our gifted program are struggling with trying to accept or understand who they are as gifted kids. To address this concern, we have adopted in our programs for gifted kids through AIRD [American Indian Research and Development], an environment in which it is okay to seek excellence. We want to create an environment in which the kids can feel good about being Indian, and we want to surround them with other Indian kids like them, so that excellence is the norm. The challenge is to exceed that norm, and to be accepted and accepting for who they are as tribal persons and as individuals.

I am a bit of a philosopher, and I am rather cynical about the bankrupt public school system Norbert [Hill] was talking about. We Indian educators have not been successful in adapting that system for Indian students, not at all. If we were able to make some changes in that system, we would not have the extremely high dropout rates we have among Indian students today. Sixty to seventy-five percent of our kids drop out. Then we say, "Well, the BIA [Bureau of Indian Affairs] does not do any better." Well, a lot of times the BIA schools still in existence are all that is left for some of these kids. Sure, some of the kids may be court referrals and hard cases, but if we eliminate the BIA schools, these children would not have anything.

Greg Cajete and I were talking about that last night: What if we did away with the BIA right now? What would result? I believe it would cause total chaos for a lot of our people - total chaos. A large number of us have become dependent upon the BIA, and its elimination would create a devastating void in human services. As someone has said, "The BIA is an 's.o.b.', but it is our s.o.b., you know." It is still ours, and is based on the treaty relationship between the Federal Government and tribes, a legal agreement not based on poverty or race or ethnic minority. It is a legal relationship, and we should hold the feet of the federal government to the fire - that is, get the Department of Interior and the BIA to upgrade the standards of education in the BIA schools. It is a legal right we have, not something given to us because we are poor or disadvantaged or a cultural entity.

***"...we have adopted in our programs for gifted kids through AIRD [American Indian Research and Development], an environment in which it is okay to seek excellence."***

A lot of people do not understand this legal relationship Indian people enjoy with the Federal Government. It is based on treaties. When tribes dealt with this fledgling government, the United States, the U.S. Government came to us and said, "We would like to have a peace treaty. We do not want to fight with you." They did this because they knew they could not whip all the tribes. It was too costly. They did not have the money, they did not have the ammunition, they did not have the men, so the easiest way to deal with the tribes was to make a treaty. And in those treaties, tribes said they would allow them to cross their land or to settle, build forts, hunt, fish, etc. And the federal government said, "Okay, we will do this for you: We, on the other hand, will provide you [in essence] health, education, and welfare in perpetuity... as long as the grass grows and water flows." Today some people think those treaties are no longer valid. There has not been one instance - not one instance - where the Congress or the President has abrogated any of the treaties with tribes. Those treaties are still in effect today - "in perpetuity" means forever. I have viewed some of those treaties in the National Archives, in the same building the Constitution and the Bill of Rights are stored.

As a result of treaty-making, Indians have a special relationship with the Federal Government, more so than Black people or Hispanics or Asian Americans or any other ethnic people. We have a very special relationship with the Federal Government - a legal relationship. I think we need to educate our own people about this legal relationship. A lot of tribal people do not understand the concept of the treaty status. A lot of people do not understand what sovereignty or tribal sovereignty entails. *Sovereignty* is a people's own right to govern what they do as a nation. It is our right to provide an education to our people in the way we feel it should be provided, not adhering to what the state or federal government says, but rather what our tribal people say is appropriate for our Indian students. At times we get involved in education with the day-to-day, nitty-gritty of classwork, funding and managing projects, and we lose sight of what our sovereign rights are and what sovereignty can mean for our people. Sovereignty is a difficult concept.

There are a number of basic tenets to sovereignty. One of those basic tenets is to allow a large government to provide some services for us. That does not mean we lose any of our sovereignty, but some people, some of the states, and even the Feds, think that because we allow them to supply this education we do not have the right to give direction to it. Well, we allow them to have a monetary system. We could establish our own monetary system if we wanted, as a sovereign nation; some tribes have done that in the past and that is another of the basic tenets of sovereignty. For example, another basic tenet of sovereignty is to declare war. The Comanches declared war on Japan in 1941. They only just signed a peace treaty about two years ago. Those who declared war forgot that they declared war, and it was brought to the attention of the Comanche business commanding officer that they did not declare peace so they had to have a peace-signing ceremony. The Comanche Tribe wanted to establish trade relationships with Japan, which is another basic tenet of sovereignty: establishing trade and intercourse with foreign nations.

We, as Native people, American Indian people, tribal people, need to study sovereignty to understand and to learn more about treaty relationships, about the sovereign status we have, that special relationship we have with the federal government. It is a legal status. The legal status provides for Johnson O'Malley programs, for the Bureau of Indian Affairs education programs, the Indian Education Act and the Tribal Control Community College Act. All these laws are aimed at American Indians because of the special status of American Indians.

***"In no way am I satisfied with the educational system our kids have to go through."***

We, as tribal persons, do not teach much of this to our students, to our kids. My kids know it, but I do not know how many other children really get an understanding of tribal sovereignty, the treaty relationship, the trust status. In working with school districts in the State of Oklahoma or the six states we work with (Kansas, Oklahoma, Texas, Arkansas, Louisiana, and Missouri), I have found that many of the school personnel do not understand that relationship. They say, "Well, we want to teach our kids, including those Indian kids, just like everyone else. They do not have a special status, they are just Americans." That is not true. That is incorrect, and we tell them that line of information is incorrect, and they do not like it. They do not understand. They ask "Well, how come them Indians are getting services other kids don't get?" It is because of the treaties they have signed with the Federal Government. In the Treaty of Medicine Lodge of 1863, the government said they would give the tribes in Oklahoma - the Kiowa, Comanche and Apache tribes - an education, give us some farm implements, and do a whole lot of other kinds of things to help us live on our reservations, in exchange for land - the eastern slopes of Colorado, part of Kansas, and the Texas-Oklahoma panhandles down into New Mexico. Later, the Congress passed the Dawes Act (1889) and the Indian Reorganization Act of 1934, which broke up the reservations in Oklahoma. We did not have enough Indians to allot all of Oklahoma, and a surplus of lands existed, so they were not allotted. So what did they do? The State of Oklahoma, in 1889, opened the unallotted lands up for western expansion. Oklahoma celebrates 89'er Day in Oklahoma annually, one of the big celebrations there, and what they are celebrating is the taking away of Indian land. That is one of only two times Indians are talked about in the public schools in the State of Oklahoma: 89'er Day, and Thanksgiving. We really do not have anything as a people to celebrate during either one of those days. Strange, strange. And our Indian students are taught to be proud of these days! It is drilled into them, grilled into them.

So how do we turn around these attitudes, change the attitudes of people who think we are satisfied - that we, being Indians, are satisfied with the norm? In no way am I satisfied with the educational system our kids have to go through. I tried to change it. I am still trying to change it, but I have found there are not enough hours in my day, and probably not enough years in my life, to make substantive changes in the public schools' educational system in the United States to accommodate Indian students in a real way.

What are the alternatives? We are talking about them right here - developing programs that Indian people can direct that will make some changes for a number of Indian kids. You are talking about 240 applications for 30 program slots. We had over 700 nominations for 100 slots in our gifted and talented program for Indian kids from all across the country. We can only take 100 - that is our capacity - but the gifted and talented kids are out there. For a long time, people did not realize we (Indians) had gifted kids. The public school systems have stereotyped Indian kids. For example, they put my daughter in a Chapter I reading program in the second grade, and I went up there to see her test scores. I wanted to see how she qualified, how they qualified her for a Chapter I reading program, when she had been reading since before the second grade. I taught her to read. There is money in Chapter I for disadvantaged minorities and for Indian students who are designated as super *A*s - you get twice the money. That is one of the reasons, but they did not want to admit it. The school personnel reassessed her or tested her again in

reading, and she passed with flying colors. That is what we, as Indian parents, need to do - we need to become more aware of the educational system. I do not say we can change it, but at least we should become aware of how the system works, and use it to our advantage.

Some of the things you were talking about last night, things happening in Minnesota, is excellent stuff - laws passed for cultural education. Ten Indian students in a school district have to have a parent committee - right on! We have to hold the policymakers' feet to the fire, and make them respond - or at least try to get them to respond - to our needs in Indian education.

***"I do not say we can change it, but at least we should become aware of how the educational system works, and use it to our advantage."***

What does all this have to do with gifted and talented education? A lot. I worked in Washington for a number of years, from 1976 to 1979. I was Executive Director of the National Advisory Council on Indian Education (NACIE). NACIE is a 15-member council, presidentially appointed. It could be and should be one of the most influential Indian education groups in the United States, because it has access to and reports to the Administration, the White House, and the Congress. It was during this time in Washington that I worked with Dr. Dorothy Sisk, who is now at the University of Florida. She was the head of the Gifted and Talented section in the Education Department at that time. Ten million dollars was allocated - this was 1978 - for gifted education in the United States. Only 10 million dollars. That is not a whole lot of money in comparison to other Federal monies for education. We tried to direct some monies toward Indian education. One of the things that happened was a symposium like this one, to talk about gifted and talented Indian education. Then, the next year, 1977-1978, the Gifted and Talented section was dissolved. There was no money. And, so, for a long time there has been a void in the federal effort for gifted and talented education. Just this year [1988], a new bill was introduced and passed, that directs money for gifted and talented education. There was an 11-year hiatus.

Let me digress for a moment, to tell you how I became aware of gifted and talented education and how I wanted to eventually be involved in this. I have worked in a number of schools. I started out at Fort Sill Indian School, then at Chilocco Indian School, and then six years at Haskell Indian Junior College. I accepted a job at Dartmouth College, a college chartered in 1769 to educate "the natives of this land and others" (and over the 200-plus years the others have taken over). In 1971 they had a new president - his name was John Kemmeny. He is of Hungarian descent. He is the gentleman who wrote the computer language Basic. He is an outstanding, very smart individual, a very humane person. He wanted - it was their bicentennial year - to recommit the college to its original intent, "educating natives of this land." He recruited an Indian counselor, John Olguin. John was the first Native American counselor at Dartmouth, and he lasted less than a year. I was hired, and worked up there for two years.

While at Dartmouth College, I became acquainted with a program called the ABC Program. It is called "A Better Chance" Program. What this program does is identify gifted or potential gifted students from Appalachia, the ghettos, the barrios, reservations, Alaska, Oklahoma, and bring them into some of the prep schools and high schools in Vermont and New Hampshire. The students are housed in homes with live-in house parents, and they undergo intensive tutoring, counseling, etc. Upon finishing their course of study at these high schools or prep schools, they apply to elite institutions - some of the higher-ranked institutions and Ivy League colleges such as Dartmouth, Princeton, Cornell, Yale, Harvard, Michigan, Stanford, etc. And the ABC students were being accepted. It was there that I had this thought: Why do we have to bring these kids from Oklahoma 1,400 miles to this "foreign land" called Northern New England and place them in an environment where, at best, they are a curiosity in those communities? I felt self-conscious as an adult (I was 28) working at Dartmouth College. I would walk across the green, and I could almost feel the eyes watching me walk across when I put on my boots and wore my hat and my ribbon shirt. It was like a parade. Or, shopping at a grocery store, I was like a curiosity. And I was thinking, "You

know, these kids are going through this - in addition to adapting to the rigors of college life." A lot of students were dropping out or drugging out. I asked myself, "Why couldn't we do this back in Oklahoma, back in Indian Country?" So I talked to the people in the Tucker Foundation - the people who funded the ABC Program - and they said, "Yes, that is a good idea." They said all kinds of good words, but what it finally came down to was control of the money. So the idea to start an Oklahoma-based ABC Program fell by the wayside.

***"We have to hold the policymakers' feet to the fire, and make them respond - or at least try to get them to respond - to our needs in Indian education."***

I went, from there, to do my doctoral work at Penn State, and eventually to Washington to work with Dorothy Sisk for a while, then back to Oklahoma. It was a forced career change (I was out of a job) that prompted me to choose to go into gifted and talented Indian education. I considered a lot of options - there were a lot of things I could do. But what did I **want** to do? I have always done what I needed to expand my horizons and to contribute to Indian education. I thought about the ABC Program, and I decided to research the concept further. I went to the library at Oklahoma University to see what they have on Indian gifted and talented education. I went over to the card file, and it took me about three minutes to find out what they had on Indian gifted and talented education - nothing! Nothing had ever been written on Indian gifted and talented education. There were a number of citations on gifted education. There is a lot written on culturally diverse populations and disadvantaged populations - that is how they classify Indians, you know.

I started reading up on gifted education, about characteristics, standardized tests, assessment, achievement tests, IQ tests, creativity, leadership. All these concepts started intermingling in my mind - enrichment, acceleration, in-class programs, pull-out programs, mentorships, parent committees. Finally, things started to come into focus, and I started to integrate these things - acceleration, exclusive grouping versus classroom, in-class or individual education plans. I was trying to determine appropriate methods to teach our kids. It is important that our kids know who they are, and that we know who they are and how they learn - learning styles, right brain-left brain. All these things were emerging in the research. I started talking to other people who operated gifted and talented programs. I called Washington, and I corresponded with others to find where the Indian Gifted projects were located. They said, "Well, there was one up in Minnesota, the Northwind Warriors Program. There was one up at North Kipsap, Washington. There was one in Bismarck, North Dakota. There was one at the Cherokee Nation."

"Wow, can I go visit them?"

"Oh, they are not funded anymore."

"Well, can I get copies of their proposals or the evaluations?"

"Well, we've got their proposals, but they are stored in a salt mine over here in Virginia, and we will have to go get them out of storage."

But there was absolutely nothing readily available to give me some guidelines on Indian gifted and talented education. So, tongue in cheek, I started writing on Indian gifted education and suggesting that maybe this is the way it should be. I talked to educators, and they were saying, "Well, I don't know what that study says about this," but I continued to listen to what they said and thought, "Well, maybe this will work for Indian people." What would happen if we got Indian students who were motivated, who were gifted and talented, brought them together for a period of time, either all year long - ideally - or for a shorter period, and provided them the best we have in education, the best Indian teachers, role models, courses, and other bright Indian students with them? Include boys and girls, field trips, speakers, tribal cultural people interacting with them, with a tribal cultural orientation to the curriculum. All the courses should be Indian-oriented, including mathematics - there is such a thing as Indian math. There is such a

thing as Indian science, music, dance, art, literature. We thought about maybe just focusing on mathematics and science - on the things we are talking about at this meeting. We got to thinking, too: We want to provide these students with the best we can, but for what purpose? Someone mentioned that purpose last night and today - effective leadership. We look at our tribes, today; we are suffering from a lack of effective leadership. Tribes are still suffering from the extremes of the social ills: poverty, high dropout rates, high suicide rates, high incidences of alcohol and drug abuse, high percentages of teenage pregnancy. How do we address those issues so our tribes can survive into the year 2000 and beyond?

***"...there is such a thing as Indian math. There is such a thing as Indian science, music, dance, art, literature."***

Tribes have the P.L. 93-638, The Indian Self-Determination and Educational Systems Act, which provides tribes the opportunity to contract from the Bureau of Indian Affairs. A shortcoming of that act is that it does not provide enough money for training and technical assistance for the tribes to take over those projects and those programs. So we are still in trouble.

I thought about this dilemma, and concluded the solutions must come from the younger people - it has to come from the kids. We have to identify these youngsters and assess their abilities appropriately - not just with standardized achievement or IQ tests. We need to consider other measures. We must consider their leadership qualities, consider their creativity, consider their problem-solving ability, consider their understanding of themselves as tribal persons. We need to build tribal cultural understanding into any program or curriculum for Indian gifted education.

I wrote a proposal and turned it in, proposing to develop an American Indian Gifted and Talented Assessment Model (AIGTAM). We proposed to field-test and validate it in one year. The assessment model was funded in 1984. So we had a full year to develop the AIGTAM. One of the things that scared me was that we were going to develop a number of recommendations and procedures to assess kids appropriately using a multicriteria approach. One of those criteria was going to be their tribal cultural understanding. We were going to develop a checklist to assess that.

When the AIGTAM was funded, I was apprehensive, because I had little idea how we were going to develop the Tribal Cultural Checklist. When we were notified of the award, we were happy we got it, but apprehensive of the size of the tasks ahead. How were we going to do this Tribal Cultural Checklist? We thought, and we talked to people back and forth - psychometrists and test developers - but we still did not come up with a viable plan. So we decided to ask Tribal their tribes' perspectives of gifted and talented.

We thought this would work. We got some feedback at the NIA Conference in Phoenix at our workshop on gifted and talented education. We asked our workshop participants the question, "What is your tribe's perspective of the gifted and talented?" They wrote their comments and returned them to us. We found the responses really interesting. We went to Albuquerque to the special workshop of the Council for Exceptional Children and we asked a larger group to respond to the question. We went to Oklahoma City to the combined Western and Eastern Johnson O'Malley (JOM) Act Title IV meeting. Two hundred people were there, and we asked them the question and they responded. Eventually we wound up with over 635 responses, and then the question arose, "What are we going to do now?" We used a research methodology called content analysis. I was familiar with this research methodology, but not an expert in it. So we went to the University of Oklahoma and invited a professor who is an evaluator and who had administered a gifted academy in California for many years. We asked him to do a content analysis of those responses. He found 13 categories and a number of subcategories; he had grouped them, and it looked good. We wondered if an Indian research person would have a different perspective, and if the results would be a little bit different?

We invited an American Indian doctoral candidate whose research methodology was content analysis to conduct a content analysis on our data. Sure enough, the categories were different - some were similar,

but some of them had changed completely and some of the subcategories were different. Four major areas emerged in terms of how to assess tribal cultural understanding. One was tribal cultural awareness, with the following subcategories: respect of tribal elders, respect of others, understanding of tribal history, understanding of tribal culture, ability to produce tribal art, storytelling ability, and tribal language competence. Another major category was acquired skills: problem-solving ability, mathematics ability, task and scientific productivity, etc. The third major category, personal human qualities, included inquisitiveness, individualism, intelligence, intuition or insight, self-discipline, etc. The fourth major category was aesthetic qualities: artistic ability, dance ability, instrumental music ability, vocal music ability, and drama ability. We sent the checklist to 200 people to get their responses for appropriateness or inappropriateness of the items, and then we weighted and ranked the items. We developed a study and made recommendations on creativity, leadership, tribal cultural understanding, and assessment of the visual and the performing arts.

***"We need to build tribal cultural understanding into any program or curriculum for Indian gifted education."***

We also developed the Indian Student Biographical Data Questionnaire (ISBDQ), a four-part data collection instrument for students who apply to our programs. Part A is for the parents to fill out. Here we ask them to rate some abilities of their child and answer some questions about the student. Part B is for the students to fill out. On this we ask for some demographic data, plus we ask them to do some rating of themselves in their abilities, and list some of the awards they have won. The list of awards is an indication of traits of leadership. If kids are involved in activities, they will win things. They will do things to win recognition, and the judging for those awards and recognition or participation is subjective. Form C is for the school personnel to fill out, and we ask a lot of questions: "Is the student in a gifted program?" "Do you have any achievement test scores?" - any IQ scores, and results of any other assessments they may have had. "Are there any other recommendations the teachers or counselors or Title IV-A people would have on that student?" The Form Ds are recommendations from community persons. Here we use the Leadership, Creativity, and Tribal Cultural Checklists for someone to rate this student. When we receive the forms, we compare this data with minimum criteria we have established.

***"And that is what we are about - appropriate assessment of any student's gifts and talents using a multicriteria approach."***

One of the things we recommend on the achievement tests and IQ scores is that we should not reject them totally. Even though they are biased toward the larger society, they can still be used as at least a guide. For achievement tests, most states have some kind of guidelines they use to determine which students are gifted and talented. In Oklahoma, anyone who has scores in the 97th percentile on achievement tests or has a 130 IQ must be provided an accelerated or differentiated education. For our purposes, if the Indian students score at the 80th percentile or above, they have met our achievement test score minimum criterion. We take Indian students who have an IQ of 115 or above. Some would say this score is barely above average; that may be so. But - if the tests are biased - this score may be way above average for Indian kids if they were inappropriately assessed. On the Tribal Cultural Checklist, the Leadership Checklist, and the Creativity Checklist, we say that they have met our criteria if they score in the 80th percentile. If they have had a 3.0 minimum grade point average over the last three semesters, they have met our grades criterion.

We have eight criteria. After we review their ISBDQ, those students who have met eight, seven, six, or five of the criteria are accepted automatically into our Explorations in Creativity [EIC] program. Students need to show evidence of high ability in the visual, performing, or literary arts, which they can do through videotapes, audio recordings, or pictures of their work. This additional data is all subjective and helps support their application. With students who meet four, three, two, or one of the criteria, we scrutinize the ISBDQ information to discover qualities such as leadership or creativity, or other reasons why the student was nominated. Let me tell you a story about an EIC student who met only one criterion.

We had a kid [Cory Deere] who met only one criterion. We reviewed his application thoroughly to determine why he was nominated. His folks did not write very much on his Form A, and some of the questions were left blank. The school personnel (Form C) did not write very much on him. He was nominated for Art. Someone had mentioned he was a good artist, but we did not have any evidence of this. So we called him, and wrote him, and finally we received a Polaroid print of a black-and-white drawing the student had done. We had already selected all our EIC students, and he was an alternate. We sent him an acceptance and he responded positively. He came in to register, and he was wearing these black gloves with studs on them, short-sleeve T-shirt, he had tattoos, a ghetto blaster, he was wearing a bandanna - and I wondered, "What are we getting into?" To make a long story short, our art teacher, Sharon Harjo, introduced him to watercolors, colored pencils, and acrylics, and Cory's talents really came alive. His work emerged as a mature artist's work. By the time he finished EIC, he was outstanding. He won the Outstanding Student award in EIC. We had a multicriteria approach, and an inclusive philosophy, so we accepted him. I do not know how many other gifted programs this kid would have gotten into based on meeting one criterion out of eight, but we gave him a chance, and he proved himself. He went last summer to serve on the Smithsonian Program in Washington as an intern. We gave him just a little bit of opportunity or impetus, and the guy is excelling now. He showed us he could do it. That is what we are about -appropriate assessment of any student's gifts and talents using a multicriteria approach.

***"These are the teachers who affect kids. Teachers who are into their disciplines is what makes our program work."***

We design an individual education plan (IEP) for each of the kids who come to EIC. They talk with their instructor and negotiate what they want to learn - what <u>they</u> want to learn! How many times in our educational experience or in your educational experience have you negotiated with your instructor and said, "I want to learn this in this course"? Our educational system is not set up to do that, but that is what we do at EIC, and it works. Greg Cajete was one of our instructors. He can tell you the variety of ideas these students had in terms of their products. Each one of these students has an IEP. The instructors review them daily or as needed, and even that is product-oriented. They have to agree on what they are going to have as products, because a lot of what we do in education is for enrichment, and not product-oriented. But we have a product for each one of these IEPs, and as a result the student knows what is expected as well as do the instructors.

We offer a number of courses: mathematics, science, computers, dance, art, creative writing, video production, athletics. We offer 12 areas of instruction. The kids have a major, on which they spend four hours a day; a minor, for two hours a day; and then a choice of 10 electives, during the time they are there. The kids the first year did video production. They did the news once a week, and we were there three and a half weeks. Riverside Indian School has video production or live television capabilities, and so they did the news this past summer at 9:30 every morning - live. That put some heat on these guys, but they were equal to the task. This year they are going to do morning and evening news because they can "cut it." And this video was done by the video production crew here. It is about six minutes long.

We also had leadership activities designed to provide the kids an opportunity to exercise their leadership skills through a model tribal government. The student was the tribe, the EIC represented many clans, and

the Riverside Indian School grounds were our reservation. We assigned each one of these clans a tribal issue to research, discuss, and present to the EIC tribe, for example, "Should non-Indians be allowed to adopt Indian children?" This is a very, very difficult question and we are facing such issues every day in our tribe. "Should we allow the Oklahoma Gas and Power Company to erect a power line across our land?" "Should we establish a tribal operation?" "Should we establish trade relationships with Japan?" Those are questions of jurisdiction, morals, and sovereignty, different kinds of issues these kids discussed in their clans. We had faculty and staff advisors assigned to the clans, to work with these students to answer questions and to assist in some research. We allowed them to bring people in to help talk about these things. The EIC Tribe elected leaders, and clan leaders who presented the results of these discussions, and then they voted on these issues. And, like most tribal governments, how many issues do you think, out of 10, passed last year? Take a guess. Think about your own tribe and the issues you vote on. Three! That is all. Three out of 10 passed, and the year before it was three out of 10. Very similar to the way tribes vote - regardless of the rightness or the wrongness or whatever, they still do not pass very many issues - and our kids reacted the same way.

We have role models: Jerry Elliott, Greg Cajete, Dennis White, Billy Mills, Kate Casherra. How many Indians with Ph.D.'s in mathematics do you know? We sought these people out, and they sought us out. Our intent is to find the best qualified people, those who have a love for their discipline. The teachers may not have the credentials, but if they can show me their enthusiasm or their love for what they are doing, I probably will select them. Their enthusiasm and love for what they are doing is contagious to kids. I like someone who talks about mathematics and just gets engrossed in it. These are the teachers who affect kids. Teachers who are into their disciplines is what makes our program work.

EIC was nominated as one of ten outstanding projects funded by the Indian Education Act. When we describe what makes EIC work and why it works, it is the people involved - the instructors, the students, the environment, the atmosphere. It is a high intensity program. In three sessions of EIC we have had close to 300 students. We have only had to expel one student because he went home on a pass and brought back some pot and liquor. We dealt with him immediately. There is no room in our operation for that kind of activity - no second chances. The students know it. They deed their parents a copy of the EIC rules, to acknowledge the rules. Their parents sign a statement saying their child will abide by the rules. There are others there who are motivated, who want to be there for particular reasons. We do not want one or more students spoiling the program by boozing or drugging it.

> ***"The answer this time is, 'I believe I can do anything if I work hard enough. I have the ability to be what I want to be.'"***

On the last two days of EIC, because the IEPs are product-oriented, we want to provide students with a sense of pride. How do we get them to feel that sense of pride? We do it by recognizing what they have done, in front of others. We provide the opportunity for demonstrations, exhibits, exhibitions, and performances for all areas - dance, creative writing, drama, music, instrumental music, singing. We have a whole schedule for the performing arts, tours around the different classrooms, and an art reception. We do the same with the computer, mathematics, and science areas. We give students the opportunity to show their skills to parents, to Indian educators, to non-Indian educators, to tribal representatives. We do this for two reasons: to recognize the students' accomplishments, and to show the world what these kids can do if given the opportunity. Indian students are always at the tail end for social ills: dropouts, suicide, drug abuse, etc. But, here, we give these students a chance to show positive things to the public, and it is amazing. Some of these kids - who would never even speak or even look up in public - are up there performing, singing a song, playing their violin or piano. And they can do it, because an environment has been created in which it is acceptable for them to try. We get very emotionally involved at the end of EIC

when we give out the Certificates of Achievement. We have become very close. We have been through a lot, and the kids have made friends they will have for the rest of their lives.

That is only the tip of the iceberg, and it is so much fun. You really have a lot of fun. It is tiring, it makes you bone-weary, but these kids are super. When you realize that they are going to be our leaders, tomorrow, it makes the effort worthwhile. They are our future leaders. When they come in, we do a survey, and we ask the question about gifted and talented education. Most respond, "I'm like everybody else - I'm not gifted." The Friday before they leave, we ask them the same question. The answer this time is, "I believe I can do anything if I work hard enough. I have the ability to be what I want to be." Fantastic! Positive change in attitude, self-concept, and self-esteem has occurred. They believe they can do it all. And that makes it all worthwhile, folks - it really does.

I want to talk a little about creativity. We looked at a number of other measures of ability, to try to influence public schools in Oklahoma, or schools these kids attend, to consider creativity as a measure for accepting them into gifted programs. We focus on creativity, and we administer the Torrence Test of Creative Thinking, Figural form. Last year, in the senior high group, we had 67 kids taking the Torrence test. Of the 67, 58 scored at the norm or better - 58 out of 67 scored 100 or more. We had 25 kids scoring one standard deviation above the norm. We had four kids - three in the senior high camp and one in the junior high camp - who scored two standard deviations above the norm. Those four students were qualified as Torrence Scholars; they are now in a mentorship program. A mentor has been provided for each one of these students. My daughter was one of them. She is working with a writer out of New York City, and he has written her a proposal to get her a computer so she can do word processing and write stories on her own at home.

That is why we are pushing this creativity testing so much. We decided to attend the Verbal Form this next year, because we felt it was the most non-culturally-biased test we could find for assessing creativity. We felt that our kids read well enough that they would score as well, or better, on the verbal form. We will test that this summer. So we are doing some validation of this process, even though for non-Indians these criteria may be at the average or a little above the average. But we are finding Indian students who are gifted and talented.

I believe in giving the students the choices to make. The only influence I want to put on them is to consider, somewhere down the pike, when they are the movers and the shakers of this world, to consider coming back and working with our tribes. Because we need people who are critical thinkers, who are futuristic, who are effective leaders, who are creative problem solvers, in our employ with the tribes, to help us survive as tribal entities - not only next year but also 50 and 100 years from now. And these kids can do it, I know.

Thank you.

## QUESTION AND ANSWER SESSION

Question from the floor:

So, in other words, you concentrate on the role model?

Absolutely. There are a lot of computer camps. Computers are just electronic slide rules. So we are leading with mathematics. This will make them better students, whether they like it or not. One thing I did not mention is that we have been involved in Indian education for six years now. The AIGTAM was the first project, EIC was the second, the expanded summer program where we had junior high and senior high kids in two separate camps was our third, and a weekend program called Project WISE (Weekends for Indian Scholar Enrichment) was our fourth. The latter is described in the handout.

This year we have two more projects. One is Project IMAGE (In-service Mentorship Accessing Gifted Education), which is developing and providing workshops for parents and Title IV Johnston Valley tribal educators about gifted education, and then establishing a mentorship model based in the State of Oklahoma. That model will be finished in August; you can write us for information on it. If

your school district, your state, or your tribe wants to start a mentorship model, we have procedures on how to do that. Another project we have this year is Project COYOTE (Centering Optimum Youth Opportunities Toward Excellence) - you proposal writers know you have to have catchy names. In essence, the project is to develop an American Indian gifted and talented resource center, and teaching aids and materials in those 12 areas of instruction I mentioned. We will be developing curriculum guides for that. We have just finished the videotape for developing a planning committee for gifted and talented education, and we have one project funded for next year. It is called the Elementary American Indian Gifted and Talented Assessment Model, and that is where it is, folks. We started with the AIGTAM, which was for the secondary level, and everybody kept asking, "Well, what about our kids?" We could not answer because we did not have an elementary level model. Now we have one funded and there will be a product available in August 1989.

Question from the floor:

Do the kids go through your program only once?

No, we have students who repeat the program.

Question from the floor:

How long is the program?

It lasts two weeks, June 12-25, at Riverside Indian School. We stay in the dorm with the kids ourselves.

Question from the floor:

Do you do any follow-up to try to mainstream some of these kids in gifted and talented programs in their schools?

That is in progress right now. We do not have anything like that funded, but we are doing it on our own initiative.

Question from the floor:

Do you have mechanisms set up to track them in any computerized way? This is one thing CASET is interested in doing.

We have all the information, and a lot of kids last year who were EIC One and EIC Two also became a part of WISE, and so we have had some contact with them. Those computer files are about six months old.



# IMPACT OF MINORITY BIOMEDICAL RESEARCH AND SUPPORT (MBRS) PROGRAM

**James Tutt**

**Vice President, Administrative Services, 1988**
**Navajo Community College**
**Shiprock, New Mexico 87420**

*James Tutt is a representative of the Navajo Nation and former Vice President of Administrative Services at Navajo Community College. He is now the Vice-President of Crown Point Institute of Technology, Crown Point, New Mexico. He holds a Master's Degree in Education.*

It is a pleasure for me to be here to talk to you about the program I have been involved in for the last ten years. This program is the Impact of the Minority Biomedical Research and Support (MBRS) Program at Navajo Community College at the Shiprock campus.

Before I start, I would like to give you a little information about the college I am with currently, Navajo Community College. Probably within the next 30 days I will be leaving to go to my new assignment - or new challenge - as President of the Crown Point Institute of Technology. As they all say, a lot of what is going to happen will stop with me now, so I cannot lean on other people to carry out the responsibilities, the mission, or the goals and objectives of the institution.

I have been with the Navajo Community College for 14 years. I started as a faculty member, then became Center Director or branch campus director. For the last four years I have been the Vice President for Administrative Services, a position which consists of maintaining the facilities, working in the Student Services support area, auxiliary service, finances, and lobbying in Washington; so I have all that experience.

The Navajo tribe established or chartered the Navajo Community College 20 years ago; this is its twentieth anniversary. It was the first institution chartered by an Indian tribe, and we are very proud of it. I believe there are 20 to 21 other institutions chartered by various tribes now, throughout the United States and Canada. Our main campus is centrally located on the Navajo reservation on 1200 acres at Tsaile, Arizona.

This first slide shows the main campus at Tsaile. That is the first phase of the campus construction. The construction is occurring in three phases. A lot of this construction was funded under Housing and Urban Development, the Department of Education, various Federal funds, and also part of the tribe's funds, to establish the college there.

In 1973, the tribe opened the branch campus at Shiprock, New Mexico, to train Navajos for technical positions in agriculture and various industries in the Four Corners area. Mainly, the largest projects on any reservation are Indian irrigation projects. It was one of the main reasons for establishing the branch college at Shiprock. Besides Shiprock, there are seven other small community campuses throughout the Navajo Nation, which is the size of West Virginia. As you can see, the vast area of the reservation is across the

three states, into Utah, and well into Arizona and New Mexico, and we have centers located throughout this area.

The MBRS Program was initiated under my direction in coordination with Dr. S. Gonzalez at MBRS at the national level. The overall objectives of the program have been to provide students with a sound basic education in biomedical science and other science-related areas, in the context of research on health problems of concern to the community. Basically, we wanted to get students involved in research activities relating to some of the problems we identified within the community, and have them try to write a proposal.

***"The Navajo tribe established or chartered the Navajo Community College 20 years ago; this is its twentieth anniversary. It was the first institution chartered by an Indian tribe, and we are very proud of it."***

This morning, I would like to tell you about the origins of the program, some of the results of the major research that has taken place, and how this MBRS Program has contributed to the students' development. The program relates to the instructional mission of the college and its improvements and physical facilities as well as the academic performance at the college, at the Shiprock campus in particular. We try to take these programs to other campuses. The MBRS program, as I said, originated in consultation with the college and also with the Indian Health Service, to identify the needs we can address and the students involved in that particular area in Shiprock. During the 10-year period 1978-1988, MBRS has supported two to three student investigations at the Shiprock campus.

Initially, three projects were funded. The first was the Navajo Drinking Behavior Study. Its chief investigator was Dr. James K. McNeley, then Dean of Instruction and now the Administrator, a faculty member in the social science area. We did a survey and identified this particular area as one we wanted to address. At the outset, in 1978 I believe, alcoholism was one of the major problems in that community. In the drinking behavior study, a survey of 326 persons, 15 to 75 years of age, was conducted to establish: (1) the sequence of activities involved in drinking behavior, (2) the conditions preceding these activities, and (3) the outcome. A lot of this was done by ethnographic types of interviews and consultations with the people we surveyed. Observation from this study provided a base for constructive intervention with those adults and kids who have drinking behavior problems.

The second study was Gastroenteritis Among the Navajo. The chief investigator of that particular study was Glosser. Gastroenteritis [inflammation of the lining of the stomach and intestines] is common in Navajo infants who suffer from diarrhea. The research question was; "What is the basic cause of death before the age of one year?" since the mortality rate was very, very high below age one. The disease may be transmitted by lambs, and Navajo children are very attached to their lambs. The gastroenteritis project found that the organisms causing diarrhea in infants and in lambs were not the same [suggesting that contact with lambs was not the cause of the infants' gastroenteritis].

The other study was Laboratory Diagnosis and Epidemiology of Streptococcus Disease Among the Navajos, by Dr. Lora M. Shields. In 1978, three streptococcal diseases accounted for 62 percent of the five most common diagnoses for admissions to reservation outpatient clinics. The first of these streptococcal diseases is otitis media, infection of the inner ear, with 25,549 cases reported. This [slide] is basically the cause of it, and a lot of the drinking of milk pulling into the inner ear of the infant. The second is strep throat, of which 15,326 cases were recorded. Of untreated strep throat cases, 1 to 3 percent develop into rheumatic fever. You can see the inflammation buildup, here, around the walls of the heart. Rheumatic fever in 1978 was 17 times more prevalent among the Navajos than it was nationwide, so it was very high among the Navajo outpatients. And the third streptococcal disease that was very high among the Navajo was impetigo, with 5,149 cases - you can see the sores around these kids' faces. The streptococcal study determined the incidence of group *A* ß-hemolytic streptococcus, which you see in this slide. Strep cultures from swabbing the throats of systematically selected patients at the Shiprock and Fort Defiance Indian

Hospital showed no group *A*-ß. These figures were higher than group *A* positive cultures from elementary school teachers and children aged 5 to 15, carried out by the Gold Tooth Tribal Strep Control Program. (We coordinated a lot of our study with the tribal group that does the laboratory swabbing of the throat of each child in school in that area.) The throat cultures ranged from 4 percent to 15 percent positive for the ß-hemolytic group, as compared to 20 percent to 25 percent positive for the group *A* in hospital patients. So, basically, there was less strep in the children, more in the hospital.

With all of these kinds of activities and research going on, we got the students involved in going out and helping with the people from the tribal programs and the Public Health Service (PHS). We assigned the students to work with these people on a one-to-one basis.

The MBRS program currently has three studies in progress. The Public Health Impact of Navajo Area Energy Projects, headed by Dr. Bauer, assesses the health effects of relocations, lifestyle changes caused by mining or other displacement, and economic development. As you are probably aware, we have relocation problems, energy development, mining activities, these kinds of things, and we wanted to know the human side of them. We wanted to know what is really happening, so we have students going out into the field and doing a lot of assessments and interviews using the ethnographic type of interview to determine and to aid in our policy development with the Navajo tribe at the national level.

The second project is Lead-210 in Navajo Teeth and Sheep Teeth and Bones, also by Dr. Shields, estimating the radiation hazard from environmental contamination. You can see [slide] some of the open shafts of uranium mines in the Four Corners areas. You see a lot of them in the northeastern quarter of the Navajo Nation. Some of the rocks taken out of the shafts of these mines have been used in the construction of homes, and there are probably still some open mine pits, open mine shafts, and so forth out there. This project very much involves the local dental clinics. When a Navajo person loses a tooth, he or she brings it in, we compensate them, and then do some analysis on it. The students take the sheep heads, remove the teeth and ground them, then send this all to the national laboratories in California for highly accurate readings, and we do some experiments right there as well. The quantity of lead-210 in tooth dentine represents lead-210 intake and, hopefully, radiation exposure, over the lifetime of the tooth. As you can see [slide], the dentine, inside the tooth, is yellow. The tooth retains all the lead-210 in that area. We are correlating these lead-210 levels in Navajo teeth with those of sheep teeth and bone to evaluate the use of the sheep tissue to estimate the radiation hazard from environmental contamination. We try to control for where the individuals worked and lived; all of that information is taken. We have gotten teeth from Navajos aged 2 to 80 years old, and found from 0 to 0.26 curies of radioactivity per gram. This was not consistently higher in people in uranium-mining areas versus the control area. However, in the teeth and bones of the sheep - a grazing animal that forages from the ground - lead-210 was seven times higher than in the Navajo teeth from the same area.

The MBRS Program shared funding with the March of Dimes Defects Foundation for the study on the role of this radiation in causing birth defects and stillbirths among the Navajos. That was another project, because we identified the need for dealing with radiation-related problems. We got some funding to get students involved and to find out what is happening in the local area. Basically, we wanted to address uranium mining, by determining the birth outcomes of the 13,000 Navajos born in the Shiprock uranium mine area between 1964 and 1981. This is another project headed by Dr. Shields. This study involves the abstraction of the medical record for each birth at the Shiprock Indian Health Service Hospital for that 18-year period, followed by a family interview of selected cases. Defects occurred at a rate two to eight times higher in these births than in those of the United States in general or other Indian tribes during that period. Our findings on birth defects showed a decisive shift toward normal rates as uranium mining declined in 1975. Starting in 1975, you can see [slide] the decline in the rates of stillbirth and some of the birth defects. As you can see, here are some pictures of the more severe anomalies. This is Down's Syndrome. This is a palic disease, orthogenesis imperfecto. Here is a graph for the actual study, between 1967 and 1979. As you can see, the black line indicates the stillbirth rate, which, as you can see, was beginning to decline, and in 1974, it really went down, to here. Infant deaths per year also declined. A lot of the activities ceased at the end of 1974. Why that particular year? That was the time uranium-tailings-processing in Shiprock ceased. At that particular time, too, a lot of the uranium processing and mining were declining.

Students who are trained in the MBRS have helped us in a lot of ways to work with the community because of our charter as a community college. A lot of our institutions of higher learning are also involved in the research. We are really not doing the research, but we are putting together a lot of information that exists there and that nobody has had a chance to really look at. The students are so fascinated by this - we get their interest up really high. We get them to present papers. We get them to do a lot of their own experimental designs even though it is related to biomedical or into the biology area and social science area. Students are recruited in such a way that they have an interest in it. And the student must be admitted to the college. Our mission is very open-ended. A person interested in the science area or biomedical area is encouraged to participate. Students do a lot of demonstrations in the local science career activities, and are role models. Even when they get into the biomedical programs with the AISES organization, students participate in the local high school or even in the elementary school. They do a lot of judging in the elementary science programs. We have students who are doing a lot of tutoring in the high school in their area. The number of Navajo students participating each year ranges from 4 to 11 in a program, depending on the amount of funds we get. But a lot of times we try to get other funds as a supplement so we can take one more student.

Of the initial 53 students who have trained with MBRS, 24 have continued beyond the two-year programs and are enrolled in a four-year school. So about 45 percent of the students have continued to four-year schools. Other students who train under MBRS have completed two years of study. They completed two years of study but they are now employed in the public health, social service, or other industries in the area. A lot of those students who have continued have received advanced degrees. And because Navajo Community College is a two-year school, our emphasis is primarily on ensuring that our students get admissions to and success in the four-year institutions. We try to go back and use this as a measure to improve a lot of our programs. One of our trainees, Wilfred Denetclaw, is in his last year of the Ph.D. in the biomedical program at UC-Berkeley. We have another student who has been through our program at the graduate school at the University of New Mexico with a teaching assistantship in chemistry. We have two other graduates applying for graduate study at this time. We really work on an individual basis with the faculty and with the students to ensure interest, responsibility, and dedication.

Part of the MBRS program emphasizes student participation and a presentation at the national symposium. Our students have presented two or more reports at the last six regional Native Americans research symposia. The most recent one I remember was at the Washington level. A total of 36 presentations were made by the students who were in the program, and five manuscripts are in the final stage for publication.

Part of the MBRS deals with the financial support of the projects. Two current ongoing projects are funded by the MBRS, the March of Dimes Foundation and the Minority Institution Science Improvement Program (MISIP). We have an average annual funding of $71,000, with approximately $12,000 for administrative support. As you can see, a lot of it goes directly into the students, into the actual research activities. Over 10 years we have received a million dollars from the MBRS National Institute of Health. A lot of this MBRS funding we receive goes into furnishing equipment that is needed within the college, because we really do not get any state funding. We get operational money to support just the basic operation instruction from the Navajo tribes. From federal appropriations, we get about 46 percent of our funding. So for the rest of it, we have to raise our own operating funds. Then 20 percent of the funding comes from the Navajo tribe. So the national support project has been very helpful in acquiring a lot of the capitalization, equipment purchases, computer acquisitions, and so forth. You have to have these things to do research. We are working with the Navajo tribes to coordinate receipt of the equipment that we get under the MBRS, mainly the computer acquisitions tying in with the Navajo tribes as networking.

We have to rely on other government agencies such as the National Science Foundation, MISIP, and MBRS because we do not have the capital outlays or the funding to support a lot of this development. A number of courses were added to satisfy the needs of the community and to carry out the student research. We basically develop a lot of our own auditorial programs - our own microbiology auditorial programs, and statistics using the computer.

We also have a very close working relationship with other national laboratories. For example, Lawrence Livermore National Laboratory has been very helpful in helping us, as have the Sandia and Los Alamos

Laboratories. They have sent technicians and scientists to our campus to talk about certain areas of their research. They helped us to repair some of the equipment that has been idle for 10 years. Auditorial video instructions were developed, because of the language barrier for the Navajo students. They read and use the visuals, and they retain a lot. We learned that the students were not really well-prepared in reading, so we developed the materials, which will published by next year. That will be one of our contributions. Hopefully, we will be able to use some of those audiovisual materials we develop to get the intervention at the high school level as well as the elementary level.

***"The students need to identify themselves with local needs and have contacts at the national levels."***

We also have other resources shared with other organizations like AISES, other colleges involved with various programs, and various career opportunities. The major effort has been on the quality of students. You have to get student involvement. The one-to-one relationship is very, very important if you are going to get someone who is going to be motivated. It is very surprising even at the main campus that we do not get that top 10 percent of the high school graduates off the Navajo reservation; the other 10 percent of the high school graduates go to other universities. So we are dealing with about 90 percent of our students who come to the college at Shiprock, Tsaile, or other community campus throughout the Navajo reservations. About 90 percent of these students are deficient in basic reading and math, but we have intervention programs at that time. I know a lot of it might be too late, but we find out that after one or two semesters in the programs, we have a very high percentage of students completing after one year of that remediation. About 70 percent of those students who go through one-year remediation complete the two-year program. We really do not know how many have gone on to four-year programs overall, but in this particular program, we are 40 to 50 percent successful in the federal projects we have been carrying out.

The research students have to be very much interested in a graduate program. We do a lot of screening - there is a need in getting student involvement in the research. And, it has to be in a familiar environment. This really helps us, too, because if they were involved in other parts of the country, they would not be familiar with the surrounding and the needs of that community. The students need to identify themselves with local needs and have contacts at the national levels.

Students are involved at the national levels. It gives them a positive image of the opportunities out there. Every year we take 10 to 12 students to Lawrence-Livermore to expose them to technical research that is ongoing there. At the same time, we have visiting lecturers who come to our campus for one to two weeks at a time and work with students at the high school level. Again, it is very important to get some sort of support from other agencies that are well-supported. A lot of these students will continue into the research area. This particular program that has been ongoing for the last 10 years has had a tremendous impact on the selected students, but there is a need to have such a program supported by federal agencies or private foundations. It has also had an impact on the instructional delivery system - developing new, innovative curricula to meet the instructional mission of the college. It also helps us to improve our physical facilities and to acquire additional equipment necessary to carry out the academics and activities related to instruction at the Navajo Community College.

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# GUSH-KUS-ZIN, MESABI (WAKING UP, SLEEPING GIANT)

**Ruth Myers**

**Assistant Director**
**Center of American Indian and Minority Health**
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**University of Minnesota**
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*Ruth Myers, an enrolled member of the Grand Portage band of Chippewa Indians, is Assistant Director of the Center of American Indian and Minority Health at the School of Medicine of the University of Minnesota at Duluth. She has been the recipient of several grants, the most recent of which was the Shea Grant Program in Duluth, to write Medicine Woman in collaboration with B. Charnley. She has received many awards and honors, including Marvelous Minnesota Woman in 1988 and the Service Award as President of the State Board of Education in 1986. Her involvement in civic and professional activities is extensive, and ranges from her appointment by the Governor to the Martin Luther King, Jr., Holiday Council, to her membership on the Duluth Pow-Wow Committee to develop and promote the Ojibway National Pow-Wow.*

I would like to read you some letters I brought with me, to Dr. Nina Kay. This is one from the American Indian Advisory Board that has existed on the University of Minnesota campus since 1977. It says:

*The University of Minnesota-Duluth [UMD] American Indian Advisory Board is happy to send greetings for your efforts in sponsoring the first American Indian SET Symposium.*

*The UMD American Indian Advisory Board supports projects which advance the American Indian learners' education, especially in the science, engineering, technology, medicine and health fields. The American Indian is severely underrepresented in these professions. Your goal to improve the number of participating and graduating American Indian students in the science, engineering and technology fields is shared by the UMD American Indian Advisory Board....*

*The UMD American Indian Advisory Board would like to invite your organization to hold the Second SET American Indian Symposium in the City of Duluth. The Duluth community is located at the head of Lake Superior and offers a cool breeze for our spring and summer visitors. The Fond du Lac American Indian Reservation is located 20 miles from the Duluth community. Many activities could be located on the Fond du Lac Reservation. The City of Duluth is centralized in the heart of the Ojibway Nation which includes the states of Michigan, Wisconsin, Iowa, North and South Dakota,*

*along with Minnesota and the Country of Canada. If your organization is interested in the City of Duluth or UMD as a site, call my office anytime.*

*[signed] Don Wiesen, Chair.*

***"...we are becoming more expert at the subtle utilization of guilt in order to achieve some results."***

I have another letter from Dr. James G. Boulger, Interim Dean of the School of Medicine, to Drs. John Q. Taylor King and Kay:

*Greetings from the University of Minnesota, Duluth School of Medicine. I would like to take this opportunity to wish you well in your continuing efforts to increase the opportunities for American Indians in science, engineering and technology...*

*We offer you, through her, an open invitation to come to Duluth and explore the programs that Ruth and others have begun and continued on behalf of our Indian students. All of us would be the beneficiaries of such a visit. May your conference be successful and productive!*

One more letter to Drs. King and Kay, this one from Lawrence A. Ianni, Chancellor of the University of Minnesota:

*...Permit me to say how commendable I find your efforts to increase the representation of American Indian people in the scientific and technological areas to be. The cause of self-determination will greatly be abetted by the success of your efforts. We not only applaud your efforts but are willing to be of assistance in any way that we can. If you feel that a visit to UMD would in any way be facilitative to those efforts, I hope that you will visit us and discuss the possibilities.*

*Good luck with your important task.*

Those are three very sincere invitations to hold your second conference in Minnesota.

One of the handouts I gave you is a copy of what I call the Treaty Map of Minnesota. I like to remind my people and your people, and everybody else in the State of Minnesota, about the land base for the area they call Minnesota. There are about 10 treaties that enabled the immigrants to develop the state, and we are becoming more expert at the subtle utilization of guilt in order to achieve some results. When you talk to a certain senator, you say to him, "Your home is in the 1847 area," and you constantly remind him of that.

Minnesota's population, as of 1986, was 4,214,013 people. It is probably a few more - probably about the same size as Houston, almost. The American Indian population is about 40,000. There is a Black population of about 55,000. The Hispanic population is about 32,000. The Asian population is growing every year. One-half of the American Indian population resides in the three cities of the first class. There are eleven reservations in the State of Minnesota, four Sioux and seven Chippewa. There are approximately 11,500 school-age children. The Indian population in Minnesota is very young, and getting younger. There are 434 public school districts; about 105 are eligible for Title IV, and only about 65 apply. There are, I think, four tribal contract schools and no Bureau schools. The last Bureau school that operated in Minnesota was closed in 1950. We have five university campuses; the main campus is in Minneapolis. We

have seven state university campuses, 19 community college campuses, 33 vocational/technical schools, and 18 private colleges.

> ***"The Board of Teaching grants eminence credentials, for Indian people to teach history and culture and at the same time work toward achieving their teaching degree."***

I want to tell you a little bit about the history of Minnesota. I think it is important for Indian people, if you are going to work for change, that you understand what occurred. That is probably important for all of us - that we not only know what happened nationally, but also what happened in our particular area. Minnesota was established as a state in 1858. The University was established in 1851. It was a land-grant college. President Grant divided the country up between various religious groups: the Congregationalists, who were supposed to have the area of Duluth; the Methodists; the Episcopal group; and the Catholics. They all had this mindset that they were going "civilize" us. In 1909, the Bureau of Indian Affairs operated an agricultural school on 240 acres in south-central Minnesota. That was the time they were going to make farmers out of all of us.

In 1909, the Federal Government in its wisdom, without consulting the tribes, gave the 240 acres and its buildings to the State of Minnesota with the provision that all Indians could go to Morris College tuition-free. It is my contention that the only way that Indian students happen to enroll at Morris is if they stumble on it on the highway. There is not an affirmative effort to recruit Indian students at the campus. That campus has a reputation of having a very good liberal arts education; it would be a good place to establish a good American Indian pre-engineering program, and "guilt-trip" the state into contributing some resources.

In 1936, the Bureau, in its wisdom, entered into a contract with the State of Minnesota and said it would provide for the education of all Indian students in this state - again without tribal consultation. And now, 52 years later, that contract has never been fully implemented or its' agreements fulfilled.

In 1950, the Pipestone Indian School was closed. Interestingly enough, although the Johnston-O'Malley Act stated that any public education building no longer utilized as a school for education should revert to the tribe, the gym was given to the local vocational school. I hope sometime that the Sioux will get together and take the gym back. Even if they do not have a use for it, but it would be a nice place to have pow-wows or whatever.

In 1955, the State of Minnesota established a state Indian scholarship, with the advice and consultation and encouragement of a private group of people who had previously operated a scholarship program. The first state appropriation was $5,000, and it has continued since 1955. When the governor of Minnesota reviewed the Morris Campus Act, he was appalled at the nonfulfillment of responsibilities. In his budget, he favored funding so that all Indians in Minnesota could obtain a postsecondary education free, not just at Morris, but throughout the state. He was not able to bring about that funding, but he doubled the amount of scholarship dollars per year. The State of Minnesota now gives $1.6 million per year for postsecondary education for American Indian students, and currently funds about 1,600 students, but we have 450 who still have an unmet need. Minnesota does allow for graduate education, and will give medical school scholarships and pay for it part-time even if you are working, because of the importance of education.

In 1963, the Indian Affairs Council was established. It is still in existence. Minnesota also has a Council on Black Minnesotans, a Spanish-Speaking Council, and a Council on East Asians, so it is an interesting state to live in.

In 1968, the first American Indian was hired by the State Department of Education to serve as the Director of Indian Education, and he wrote the first grants such as Adult Basic Education in 1969. In 1970, the state passed a human relations law requiring in-service human relations training for all teachers.

Problems still exist in Minnesota 18 years later, though. We need to do something about that, and I am not quite sure how.

Additional legislation that has been passed in Minnesota provides chemical-dependency problem money for Indian reservations and organizations; the money is managed by the Indian Chemical Dependency Committee. The state gives money for Indian mental health issues. We have the Minnesota Indian Child Welfare Act. We have Health Resources for the Urban Areas. We have state Indian housing. There is legislation called Indian Family Act. Education bills are for cultural and bilingual programs. The state funds a program called Postsecondary Prep. The Board of Teaching grants eminence credentials, for Indian people to teach history and culture and work toward achieving their teaching degree at the same time.

***"I realize education is not the absolute way out of all our dilemmas, but I also believe that until we change what education teaches to us and about us, we are going to stay pretty much the same way we are."***

In 1964, the Indian community in Duluth found out that, for the first time, Indian scholarship money was available for off-reservation schools.

In 1965, the first urban Indian organization in Duluth was organized, and it still exists: the American Indian Fellowship Association. I was involved in education, and I realize education is not the absolute way out of all our dilemmas, but I also believe that until we change what education teaches to us and about us, we are going to stay pretty much the same way we are.

In 1970, the first American Indian counselor was hired at the University of Minnesota at Duluth. That came as a result of community pressure. In 1972, the grant was written to establish an American Indian Studies Program at the UMD. It is now a department, and is funded by state money. In 1972, the charter class to the established new School of Medicine came on board, and of those, two were American Indians. (The population of the University is 7,600 students; of these, about a hundred are Indians.) The medical school is dedicated to family practice in a rural area. The overall mission of the UMD School of Medicine is to "educate large numbers of family practitioners for rural Minnesota." The medical school has accepted its first Black student. It had a discriminatory sense that Blacks could never practice in any rural Minnesota community.

In 1975, I called the governor and said I was interested in being on the State Board of Education. After a lot of political negotiating, he appointed me in July, 1975, and I have served the past 13 years. In 1977, based on Indian student requests and demands at the University of Minnesota, the Advisory Board was established. In 1988, we have eight American Indian faculty members. We are looking for one for Indian Studies. We have eight civil service positions. We are looking for two - one in financial aid, one in counseling.

These are the programs we operate: American Indians Into Research Careers, which is a Minority Access to Research Careers (MARC) program; Native Americans Into Medicine (NAM), a Ni Shou Gabawag program; Minority Biomedical Research, Minority Biomedical Research Support (MBRS) program; and the Howard University-Rockefeller Foundation program, which is Rockefeller money coming through Howard University. Another one not listed is our American Indians in the Marine Sciences, a Sea Grant Program. We have the only one in the country.

In the 14-year history of American Indian programs, we have not established a good tracking system. We unfortunately do it the Indian way - when we go to pow-wows, we will say, "Have you seen so-and-so?" But we pretty well know where they are. Of the four practicing American Indian physicians in the State of Minnesota, all have been through our program in the Medical School.

We have a satellite agreement with the Bemidji State University (BSU), which has a large Indian population because it is right in the center of three reservations. We have a working arrangement with Arrowhead Community College. We originally had a relationship with College of Saint Scholastica. If they

have a student over there, we will pay the student. The philosophy of our program is that, many times, our students are place-bound by family, and by home, and for many reasons cannot move from Minneapolis to Duluth or from Bemidji to Duluth. So we are trying to "satellite-out" our programs, so the students do not have to disrupt their home life.

*"One young woman graduated from the Red Lake Indian High School; the counselor told her she would make a fine secretary."*

Our dream is to expand to Alaska, Colorado, and California. Some of the students of our very first class of 1979 include one with an M.P.H. in nutrition who works on the Fond du Lac reservation. From the American Indians in Marine Science Program, we have a graduate who is a water-quality specialist on the Leech Lake Reservation. One of our students who took an urban studies degree is working in the city of St. Paul. One of the students from Minneapolis who received a degree on the Minneapolis campus now is someplace in Colorado. Because our institution is not a minority institution, we utilize the criteria that allow a tribe to apply for the MBRS program. This worked with the Fond du Lac Reservation. They were funded, and now they subcontract the School of Medicine program. They currently have 11 full-time, 12-month students, and they have 10 high school slots. The research part does not involve Indian health issues because all the faculty members in the medical school are Anglo. The faculty members write the research grants, and the students work with them.

Part of our job is to support the Indian students. One young woman graduated from the Red Lake Indian High School; the counselor told her she would make a fine secretary. Luckily, Dr. Pozos visited Red Lake and somehow sensed her potential, so he encouraged her to come to NAM. When NAM was first funded, it operated programs on the UMD, BSU, and Morris campuses. Cathy was one of the first NAM students. She finished high school and went to a private college for one year. She felt so alone and alienated, because she was the only Indian student there, that she transferred to UMD, and she got her chemistry degree. She applied to the medical school and came to the medical school for a year, and then her father died. Many of our Indian students respond to the needs of family - you can't say, "Keep a stiff upper lip, and you will make it." So her mother was having some difficulty, so she decided to go home and spend some time with her. The belief among the medical school faculty was that she would never come back. But she came back, and she was in school a couple more years. Something else happened, and she took a year off and went back to the reservation and worked. Again, the voice of doom throughout the faculty was saying, "She'll never complete. She'll never complete." She received her M.D. degree, however, and she did her three years of residency. She is clearly an example that the educational pathway is not straight. It has little diversions once in awhile. But she made it. She got her M.D. degree.

*"Whenever we see students who are either at the bachelor's or master's level, we always say "When are you going back to school?" Sometimes I think they don't want to see us coming, but that is also our role."*

One student just barely made a 2.0 to get a Chemistry degree. He is now a researcher around the Minneapolis campus. Whenever we see students who are either at the bachelor's or master's level, we always say, "When are you going back to school?" Sometimes I think they don't want to see us coming, but that is also our role.

One of the enrollees is from White Earth. He is one of the four practicing physicians in Minnesota, and he is practicing around the Metro area. His name is Leonard Warren, descendant of William Warren.

Marla Golke is a Red Cliff Indian enrollee. Her father was in the Air Force, so she did not need our program. She had the drive and the grades and the commitment to do what she wanted to do, but she felt she needed the cultural support. She was doing a residency in surgery in Cleveland but has decided she does not want surgery. She is going to go on to psychiatry. So, we are waiting for her to finish, because we have very few clinical psychiatrists - I do not think we have any.

> ***"...we are dealing with a country that I believe practices educational apartheid."***

We are going to operate a satellite program with the Minority Community College of Science and Education and the Medical School so they can encourage more student participation in engineering, computer science, and other technical fields. Our premedicine students go there, our Sea Grant students go there, but we also need to encourage our students in the other technology fields.

Dr. Kathleen Annette, the first female physician in obstetrics and gynecology, decided she would go back to the Catholic Indian hospital. She has been there a number of years, and she will probably spend a little more time there. She serves as a fantastic role model. She exemplifies all we struggle for, and she knows what it is to struggle.

We are trying to build some networks with Alaska. But as we prepare for the 21st century, we have to get our tribal selves together before we can get ourselves together nationally - before we can get ourselves together internationally.

When the report called *Nation at Risk* was released, they still were not considering the fact that the Indian Nation has always been at risk, since the first boat people arrived, that we are dealing with a country I believe practices educational apartheid, and that they are not free in providing for education the way that they wanted to. Intellectually, we have to make sure that the lights of learning stay on and that we do not sleep until we do all we can.

Minnesota had some interesting new legislation. For example, according to the Higher Education Act, any public postsecondary institution that has 10 or more full-time American Indian students must, at the request of the students, establish an advisory committee. The advisory committee shall recommend instructional programs and student services to meet the unique needs of American Indian people. That is the first time in the history of Minnesota that all postsecondary institutions must establish an advisory committee. It is important for us to make sure that the students in postsecondary institutions understand that. Minnesota, in its K-12 education, has a law that any school district that has 10 Indian students shall establish a parent committee. It also appropriated $100,000 to study the feasibility of having a tribal school district within the city of Minneapolis. For the first time in my life, I heard Minnesota legislators say to their colleagues in the Senate, "The American Indian under the ritual of tribal authority is a political entity, not a racial group." And I think that is the point we need to make.

> ***"Intellectually, we have to make sure that the lights of learning stay on and that we do not sleep until we do all we can."***

I would like to remind you we are still celebrating the bicentennial of the U.S. Constitution, and I hope wherever you are going you are reminding the people that you read that. The Great White Fathers did not create that document, as they would like us to believe; they borrowed a lot, and took a lot, and met a lot with the Iroquois Confederacy. I serve on the Governor's Bicentennial, and that is my sole role. And in preparation, in 1992, there will be the quincentury celebration of Columbus' "discovery" of America. We

have to work hard to change the word from *discovery* to *arrival*. You do not discover something that is not lost. So take up that cause.

I would like to close with a quote. It is just the bottom few lines from a saying that the elders were telling the members of the Iroquois Confederacy:

Nephews and nieces, should they chide you for any error or wrong you may do, but return to the way of the great law which is just and right. Look and listen for the welfare of the whole people and have always in view not only the present but the coming generation, even those whose faces are yet beneath the surface of the ground, the unborn of future nations.

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# AMERICAN INDIANS AND SCIENCE AND ENGINEERING TECHNOLOGICAL EDUCATION

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One of the first American Indian support programs designed to assist American Indians through an engineering curriculum was founded by George Thomas at the University of Oklahoma in the mid-1970s. Because engineering is one of the most difficult majors at the undergraduate level, Thomas, who was himself a master's level engineering student, recognized that without an intervention strategy the number of American Indian engineers was never going to increase. Oklahoma seemed to be a logical starting point because of its large American Indian population. The original funding for the program came from small grants from the U.S. Department of Energy and the National Aeronautics and Space Administration. The basic program provided tutoring and good, old-fashioned one-on-one encouragement. The Council of Energy Resource Tribes (CERT) and various companies like Conoco, Arco, and Amoco also joined in with support. Eventually, a two-week in-house precollege program was developed to get high school students on campus and encourage them to find out what engineering is all about. This hands-on minority engineering program was competitive and extremely successful. It emphasizes an important aspect of Indian education - where there is support for their success, American Indians learn and are successful.

A bit later, I would like to share some statistics with you, but first I offer this caution: when you are listening to statistical data, there is much that can be lost in the translation. I am reminded of a story about a modern translating computer someone in the United Nations decided to use to translate the slogan, "Out of sight, out of mind." The slogan was translated into Chinese and then French and then back into English, by which time it read, "Invisible, insane." As you can definitely see, something was lost in the translation. I am also reminded of my mother, who used to do a bit of translating for the court system in Oklahoma.

She broke the court up one time when she could not figure out how to say *trailer house* to an elderly Creek woman. She attempted to describe it because she did not really have a word for such a modern innovation. Mother, with many hand motions, talked about the house that runs around on legs. The little Creek lady got so tickled at the thought of such a thing that she was unable to continue with her testimony. A recess was called to allow everyone to settle down.

***"...where there is support for their success, American Indians learn and are successful."***

Sometimes, meaning is lost through translation. When an Indian student is exposed to the college campus for the first time, much of the system is a mystery with no meaning. It is up to educators to provide meaning and relevancy to that student. As educators, we are all the translators of the system and new knowledge. Without a translating ally, students really do not have a good chance of making their way through the system to become the educators and leaders and professionals of tomorrow's technological world. I presume that one of the reasons we have come together here is to express our concerns, to learn what can be done, and to recommit ourselves to the effort. To do nothing is to not believe in our history as strong survivors, or in the future of our greatest resource - our Indian youth. Although those of you participating in the CASET project are aware of the barriers that have an impact on our Indian youth, for the record I would like to briefly review our legacy.

## REVIEW OF AMERICAN INDIAN LEGACY

According to the 1980 census, American Indians make up approximately 1,534,338 people, one-half of one percent of the total U.S. population. American Indians in this unique native culture represent well over 400 different tribes with more than 250 separate and distinct languages and dialects. Perhaps, the single most descriptive word for American Indians is *diverse*.

Regardless of tribal affiliation, all American Indians have suffered grievous wrongdoing by Federal policy. The impact of Federal policy on American Indians must be reviewed to complete a basic understanding of Indian issues.

National Indian policy has undergone numerous shifts in direction in the course of American history. As previously stated, at times the view of tribes as sovereign and enduring bodies for which a geographical base (reservations) would have to be established and more or less protected, has prevailed. At other times, the prevalent view has been that tribes are or should be in the process of decline and disappearance and that their members should be absorbed into the mass of non-Indian society (the assimilation and termination policy).

From 1887 to 1934, one of the most disastrous pieces of legislation was put into effect. The General Allotment Act of 1887 (the Dawes Act) essentially authorized the President of the United States to allot portions of reservation land to individual Indians. This act was imposed without any requirement of consent of the tribes or the Indians affected. It summarily resulted in the reduction of Indian-held land from 138 million acres in 1887 to 48 million in 1934. Of the 48 million acres that remained, some 20 million were desert or semi-desert. Much of the land was lost by sale as tribal surplus or by individual allottees after 25 years by forced sales due to nonpayment of taxes. The assumption was that allottees would make their land productive during the 25-year tax-free grace period. No thought was given to the condition of the lands allotted or to the fact that most tribes were not culturally attuned to the life of farming or ranching. Other tracts of land were lost through the unscrupulous dealings of attorneys and business people who were appointed guardians over Indians and their land interests.

*"As educators, we are all the translators of the system and new knowledge."*

American Indians born after the turn of the century remember an ironic turn of events. In 1924, after a world war in which many Indians served, Congress passed a statute conferring citizenship on all Indians born within the United States. With citizenship firmly established, the next policy to have an impact on native tribes was *termination*.

In 1953, the special relationship between tribes and the Federal Government, established by treaty law, was terminated. Tribes were subjected to state laws, and Indian land was converted into private ownership and, in many cases, sold. Subsequently, Public Law 280 was passed as a compromise between termination and continuation of the relative immunity of the tribes from state jurisdiction. However, to some tribes, this reprieve was not timely enough to save their land or their identity.

A final policy matter that disrupted the life of American Indians is *relocation*. Initiated by the Bureau of Indian Affairs (BIA) as the solution to "unquestionably high unemployment" rates on reservations, the BIA offered grants to Indians who would seek work in urban centers. The primary result of this policy was to create populations of unemployed American Indians, who suffered all the usual problems of the urban poor in addition to the trauma of dislocation and loss of culture.

In spite of Federal policy efforts to dispose of American Indian culture, a tenaciousness is still apparent in its people. D'Arcy McNickle (1973), in his book *Native American Tribalism: Indian Survivals and Renewals*, observes that

> ...the generalized picture today is of a people that has survived in numbers, in social organization, in custom and outlook, in retention of physical resources, and in its position before the law. The situation might be described as a survival of fragments, of incomplete entities - but there we would miss the mark. Any people at any time is a survival of fragments out of the past. The function of culture is always to reconstitute the fragments into an operational system. The Indians, for all that has been lost or rendered useless out of their ancient experience, remain a continuing ethnic and cultural enclave with a stake in the future.

## CHALLENGES FACING AMERICAN INDIANS

### Socioeconomic Conditions

The American Indian has, indeed, endured many hardships but has maintained a cultural identity. The continuing dilemma, however, is that there are even greater challenges to be faced, in light of socioeconomic conditions. On a national average, American Indians have the shortest lifespan of any ethnic group, the highest infant mortality rate, the highest suicide rate, the lowest per capita income, the highest unemployment rate, the highest school dropout rate, the poorest housing, the most inadequate health care, and the smallest numbers in their minority group category - thereby often ignored in terms of minority advocacy. Factors influencing this general state of affairs are unproductive land holdings, lack of capital, lack of education, the cycle of poverty, and cultural dislocation and depression resulting from the governmental policies discussed previously.

The impact of these trends has a significant effect on the American Indian family. American Indians are unique in having a higher proportion of divorces, both in urban and rural areas, than any other race or ethnic group. American Indians also have a high proportion of separations. With the birth rate almost twice that of all racial groups except Hispanics, the average Indian family has an average of five members,

who struggle to survive on a median income of $12,256. Some reservations report much lower income levels. Overall, 29 percent of American Indian families live below the poverty level (1979) with unemployment rates higher than 13 percent.

Among Alaska natives, alcohol and alcohol-related problems can be considered the number one health problem and cause of death, injury, and incarceration. For all American Indians, suicide, alcohol abuse, fetal alcohol syndrome in babies, and cancer are among the leading causes of excess deaths. Further, 22 percent of all pregnancies are in unwed mothers under the age of 20. This last indicator could account for significant school dropout rates for females, and is a grim forecast of the children's future, in which one-fourth of the heads of household are women, with lower expected wage-earning capabilities.

Byler, in *The Destruction of the American Indian Family*, contends:

> The main thrust of federal policy, since the close of the Indian Wars, has been to break up the extended family, the clan structure, to detribalize and assimilate Indian populations. The practice of Indian religions was banned; children were, and sometimes still are, punished for speaking their native tongues; even making beadwork was prohibited by federal officials. Because the family is the most fundamental economic, educational, and health-care unit in society and the center of an individual's emotional life, assaults on Indian families help cause the conditions that characterize those cultures of poverty where large numbers of people feel hopeless, powerless, and unworthy.

## Education

With the American Indian family in jeopardy, it goes without dispute that the expectations of the parents for their children does not encourage them into educational pursuits. The overall educational attainment of American Indians is the lowest of all minority groups, with fewer than one out of three (31 percent) completing high school (Census, 1980).

The American Indian child is in trouble. Two studies support this observation:

> The lower expectations of parents, combined with lower educational performance and other factors, have an adverse effect on the self-esteem of Indian students. Higher percentages of Indian high school students reported themselves as perceiving life as not worthwhile, having a discipline problem, feeling unattractive, or feeling unpopular (BIA, 1988).

> The young Indian is troubled. The college drop-out rate is high. It is not his academic rating but the academic life that unnerves him. Forty percent of the Indian students who dropped out of one college came from the upper third of their high school graduating class. In fact, Indians with high academic aptitude drop out of college as frequently as Indians with moderate academic aptitude. More intelligent Indians drop out of school, percentage-wise, for emotional reasons than non-Indians (Havighurst, 1967).

The problems experienced in the early stages of the educational hierarchy have an impact on the numbers of American Indians getting out of the system and into leadership or professional roles. In 1980-1981, Indians earned only 3,593 (0.4 percent of) bachelor's degrees. The percentage of Ph.D.'s received by American Indians in 1983-1984 was only 0.2 percent. Educationally, since American Indians obtain only 0.6 percent of degrees earned in the United States, it is clear that parity in education has not been reached.

Of American Indians receiving bachelor's degrees, the largest numbers were in business management (636), followed by education (569) and social science (474). Nationally, 195 Indians received degrees in engineering, 65 in physical sciences, and only 18 in mathematics, in 1980-1981.

In 1980, the U.S. Department of Education began a comprehensive longitudinal survey of American high school students. The study involved surveying more than 30,000 sophomores and 28,000 seniors in 1,015 public and private schools across the United States. Although no special effort was made to include Indian

students in the survey, as a matter of sample probabilities more than 300 of the students surveyed were Indians. Since about 90 percent of Indian students are attending public schools as opposed to BIA schools, at any given time, this survey provides the best available information on the general socioeconomic background and performance of Indian students in American education (BIA, 1988). A significant finding of this study is that the Indian populations have the highest incidence of handicaps of any group. According to the study, 11 percent of Indian sophomores were in special handicapped programs, another 36 percent were classified as having some form of handicap, and only 53 percent were classified as "not handicapped" in any way. Indians exceed Hispanics in respect to being classified as handicapped. Fully 43 percent of Hispanic sophomores in public and private high schools came from non-English-speaking homes (entirely or predominantly), whereas 12 percent of Indian sophomores in public and private high schools came from such homes. Although this language is one case in which the figures for students in BIA and tribally contracted schools could differ significantly from those of the Indian students in public and private schools, it points out an interesting observation: Something more than bilingualism is affecting the success of American Indian students in the educational system.

Nationally, we all recognize that there are not enough American Indians pursuing science, engineering, and technology (SET) types of degree programs. I recently completed a year as president of the National Association of Minority Engineering Program Administrators (NAMEPA). This vital organization represents the best efforts to engage retention components and advocacy activity on behalf of minority engineering students. Unfortunately, this best effort is still not enough. As an American Indian in this organization, I was a minorities minority. The number of American Indians we serve is also underrepresented. There are probably 129 minority engineering programs across the country. Of these, 73 responded to a NAMEPA survey about their programs and numbers of students. Out of their 13,568 minority students, only 523 were American Indians. These 523 students were primarily in the Southwest: Arizona, Kansas, New Mexico, Utah, Oklahoma, and Texas. Unfortunately, we did not get a report from Nebraska or Colorado or North and South Dakota. In fact, North and South Dakota may not have any minority engineering programs. We have been sending information and calling for a long time and have not received a response. So, really, Arizona, Kansas, New Mexico, Oklahoma, and Texas are the pockets where American Indian engineering students are (1987-1988 figures). The highest enrollment is at the University of New Mexico, in Albuquerque, which has 60. There are 395 Hispanics and 19 Blacks in engineering at that same school. New Mexico State has 300 American Indian students, 631 Hispanic students, and 21 Black. Oklahoma is next, with 45 American Indian students - down from a few years ago with 70+ students. These figures reflect a dilemma that exists in that some schools do not code a student an engineering student until they have completed 30 hours of basic curriculum. Different schools count it differently. So please bear in mind some of the things that affect these statistics.

To continue: Arizona State University (ASU), which had the very first American Indian Studies program and reflects a school with historically strong interests in American Indian programs, has 37 engineering students. Next is Washington State with 36. Out of the top five states with American Indian students in engineering, the total only comes to 236 American Indian students. California Polytechnic at Pomona has 25, the University of Minnesota has 23, Lawrence Institute of Technology in Michigan has 22, California State University at Sacramento has 18, and the University of California at Davis has 16. Manpower studies a couple of years ago found that in one year, 1984, 90+ American Indian students received undergraduate degrees in engineering - I know that cannot be true. At the University of Oklahoma we worked long and hard to get seven graduates with BS degrees in engineering in that one year. That was in 1984 when the manpower figures were released. We did some checking at a few schools in California. One school that listed 14 graduates was in error; the *14* was supposed to be *4*. When we asked what tribes the students represented, we were told, "Well, there's one young man who looks Cherokee." Accurate figures are sketchy and often rely on self-identification. This can lead to absurd results, when students who cannot even spell their tribe's name identify themselves as American Indian in order to get a scholarship.

Students have a way of growing on you, and you on them. I have had nicknames that ranged from "Sergeant Mother" to "Mother Earth." But, always, there is mutual respect for what is being attempted in minority engineering programs. There must be support programs for these students - there is no other way. Every time, in the history of our somewhat shaky educational path, where there has been a strong support program there have been successes. Isn't that interesting? When the Indian Emergency Conservation

Work program was implemented to train carpenters, surveyors, mechanics, and engineers, they had 85,000 American Indian participants and had great success. When educational administrators were trained at the University of Minnesota, within a short time frame (two to three years) 13 American Indians received master's degrees and several received Ph.D.'s. In 1969 it was discovered that there were probably only a dozen American Indian attorneys in the world. Insightful individuals put together a program in the early 1970s, and within a short time they had 75 American Indian law students. I was in law school in 1975, and at that time there were 129 American Indian law students in the whole world. To reiterate: Any time you have a support program, you are going to have impact! So it is important that we reinforce what is going on in these programs, the people in them, and continued commitment from those companies and entities that can help perpetuate these programs.

***"Every time, in the history of our somewhat shaky educational path, where there has been a strong support program there have been successes."***

In 1983, in every school in every discipline, American Indian enrollment fell - except in engineering at the University of Oklahoma. That is significant, in light of the difficulty of obtaining an engineering degree. So I think that the message is clear: If you have a good support program, it is worth backing and supporting because it does make a difference!

## MINORITY ENGINEERING PROGRAMS AT THE UNIVERSITY OF OKLAHOMA

First Americans - Tomorrow's Engineers (FATE) is such a program. The students in these programs do not have to be excellent students. We must provide excellent programs, but we do not have to have excellent students, because once you get a student into an excellent program you are going to have success. Many of the students coming in to our FATE program were not necessarily classified as success-bound, as traditional measures categorize them. I want to emphasize this point strongly because NAMEPA and FATE frequently engage in discussions within corporations that only want to hire the 3.5 student or the 4.0 student. We say to them that our students have overcome a lot of obstacles to get to where they are, and that you have to consider human factors such as tenacity, persistence, and determination. The students that we "grow" in our program are extraordinary. They come from reservation, rural, urban, and in-between areas. They have been successful in some area of their life, even it is just successfully surviving high school.

The important factor is that we believe in them and help them. They do the rest. They take the tests, do the homework, struggle with the computers, and do without sleep. We provide the coffee, the pat on the back, and the scholarship opportunities. Support programs go beyond mere retention efforts. They include smooth transitions in and out of the program and the philosophy that no matter how long it takes - 5, 8, or 10 years - the student's success is the ultimate goal.

There was a study by Arthur MacArthur on "Why do Native Americans Drop Out of School?" This study was based on interviews, in which students cited the following reasons for dropping out:

1. Financial hardship

2. Cultural differences

3. The nature and quality of previous education

4. Discrimination

5. Lack of role models

> ***"We must provide excellent programs, but we do not have to have excellent students, because once you get a student into an excellent program you are going to have success."***

Nowhere is there an indication that students fail because of lack of ability. If the institution, the school, or the corporation will assume some of the responsibility to develop good programs, the student can do the rest. They can graduate and enter the technological world as contributors. A well-funded program takes care of a lot of problems, including things that happen "back home." Our program provided students the means to stay in touch with their families, especially if they were from out of state; that is, students could call home if they got homesick. We consider that a retention component. Another retention component is *advocacy*. Sometimes, I would stay on the phone for an hour just to talk to the right person at the agency or financial aid office to make sure that the student received his or her scholarship money. It works. For example, one student was awarded an $8 BIA scholarship for the year - $4 for the first semester and $4 for the second. It was just before Christmas and just before finals. I stayed on the phone for an hour to protest. I was nice but firm. By the time I hung up, the student's award had been changed to about $4,600, which was going to be retroactive. Advocacy works.

The 12 retention components are:

1. **Recruiting**

   Remember that one visit to a campus or one visit with the student is not enough. You need to establish strong links. In Oklahoma, four schools have lots of American Indians. One of the reasons for this high enrollment is that the schools are strategically located; the other reasons are really the strong links they establish with that school. You can really be creative with your efforts and have all kinds of success. Include mail-outs, phone calls, get-togethers to get to know the counselor and the math and science person, etc. Bring the students on campus. Let them see, meet, and talk with successful students.

2. **Admissions**

   Sometimes, it is necessary to read the application yourself and to make recommendations. I have seen students get in who are declared "high risk." Admission officers tell the students that they are not going to make it - but they can make it. All they need is that chance, that opportunity.

3. **Matriculation**

   This component really includes everything: how to budget your money, your time, where to live, how to get along with roommates, how to take tests, what the admissions process entails, how to register, and orientation to the campus.

4. **Academic support**

   This component includes tutoring, learning skills, getting to know faculty, and learning how to go up to talk to a professor about an exam grade. The latter is really hard for our students to do. But once they have done it, it is just beautiful. They get that look in their eye and say, "I'm gonna go talk to him." I

am just glad I am not that professor because they do learn assertiveness. We have gained support from faculty because they realize that the students and our program are serious about our business.

5. **Freshman orientation**

Ideally, if you can orient students, even if it is just for one day or a half a day, you will make a difference. They know where you are and who you are. One way that we really locked freshmen into our program was to give a small incentive stipend of $25 a month. They did not get this money unless they checked in with you once a week. The money could be used for a dinner, washing clothes, or whatever; there was no restriction on it. But the students showed up. They took it seriously. The statistics on our retention kept improving. In 1988-1989, there is more than $50,000 worth of scholarship/incentive money.

6. **Student study**

You must have space for students. They have to have somewhere quiet to study. The minority engineering office is open 24 hours a day. We have a computer, typewriters, and tutors. We trust our students; when you work with them that closely, you get to know them very well. Sometimes in the mornings I would walk in and find students asleep under my desk, in my closet, everywhere, just sleeping, after working all night on reports and computer programs. They have a rigorous study schedule and curriculum, so any way we can accommodate them, we do.

7. **Student organizations**

A lot of these students are what some refer to as "nerds." They are bright students, but they do not always have a lot of social graces, so we encourage group interaction. They learn from one another. We developed group settings where we could just sit and talk - it was like group therapy where a student would have a problem and we would all give him or her feedback. We would make suggestions to that person, and that seems to work better than just one on one. You have to have the one-on-one support, but the group support is important, too.

8. **Tutoring**

Again, we use peer influences. This is where you can make a lot of good things happen. We use the student who just got out of Calculus I to teach someone who is just going into Calculus I. It benefits both of those people: (1) For the tutors, the information is fresh and going over it again helps them retain the information. When you teach somebody, you actually learn a lot more than the person you tutor. (2) For the tutees, there are benefits beyond the homework assistance. They can learn informal things, as well, such as where test files are kept, what teaching formats the teachers use, etc. There is a lot of information sharing.

9. **Personal counseling**

Counseling may be extensive in focus. It includes study skills and personal sharing. I have been to class with students. I have taken notes with students, and I have walked many miles on campus. This is where I direct them to other services on campus. The first time, I will go with them. The second time they have to go alone. It is like being in medical school: you see one operation, and then you do one. You did not know that, did you? That is their motto. You see an appendectomy, and then you do one. That is really scary, but that is the philosophy we use in our program.

10. **Summer jobs**

Get out there and beat the bushes for the students. My daughter is completing her freshman year as a mechanical engineering student, and she is taking a position in a couple of days in Kansas with Mobil. There are 75 people in the town she is going to live in. There were two boarding rooms available; one is occupied but she is hoping she can get the other. She will be getting up at 6:30 in the morning, but she will be paid $10.50 an hour, which is incredible considering her age. But that really makes their studies relevant. If you can help place them in a summer position, do it!

11. **Financial aid**

12. **Scholarships**

The system is difficult to maneuver not only on campus but also with the tribal and the Federal agencies with whom you must deal. You must track applications for financial assistance - you have to be assertive. You have to show students how to be assertive. One of the biggest nightmares I ever had was with a student who wandered into the office at the end of October and said that he had not received any financial aid. After asking a few questions, I found out why. He actually had not really gotten a lot done. He had sent in his application, but he did not have a social security number, so they were not going to do anything with that application until he got the social security number. To get that, since he did not have a birth certificate, we had to get the application for a birth certificate from the state. That process required a little bit of cash, which he did not have. So I sent one application in. Four weeks later, we had not received it. His mother received it but did not know what it was and then lost it. So we had to go through the original process again. We did not give up, however. Two weeks before school was out in May, we finally got him his Federal and tribal moneys. He owed everyone in the world, and he wanted to take everyone to dinner. I absolutely nixed that. There are lots of things that you can do in a retention and recruitment program, but the most important thing is, of course, to graduate that student.

Thank you for your time and attention. I believe in our efforts on behalf of our American Indian youth, and I hope that what goes on during this conference will make a difference.

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# CULTURALLY MEDIATED SCIENCE EDUCATION

**Gregory A. Cajete, Ph.D.**

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*Gregory Cajete, a member of the Tewa tribe of Santa Clara Pueblo, New Mexico, is a designated New Mexico Humanities Scholar in Ethnobotany and Medicinal Practices. From 1974 to 1990, Greg was a fulltime professor in Integrated Studies at the Institute of American Indian Arts, P.O. Box 20007, Santa Fe, New Mexico, 87505, where he still teaches one course each semester. Greg holds a Ph.D. in Social Science Education, with emphases in Native American Studies and Native American Ethnoscience. He has been the recipient of the D'Arcy McNickle Fellowship and the Indian Education Fellowship. As the recipient of the Katrin H. Lamon Fellowship in Native American Art and Education he was selected a First Fellow for the School of American Research. Additionally, Greg is a practicing ceramic, metal, and pastel artist. His interests include the research and development of an ethnoscience curriculum geared to the special needs and characteristics of American Indian students. He has just recently completed his book, "Look to the Mountain: An Ecology for Indigenous Education in a 21st Century World." Please write Greg for details of publication.*

I am going to show you a tape produced by students in the video class at the Institute of American Indian Arts (IAIA). At the Institute we try to combine many kinds of activities students are doing in the arts with other classes, so the video class went out with the biology class I was teaching at that time, and filmed everything. So this is not anything close to a professional film. There are a few glitches and a lot of mistakes, but I think it really illustrates this concept I am beginning to call *culturally mediated science education*, a natural approach to teaching in the field. Then I have a huge number of slides I will show you. You are going to get bombarded with visual images, but they are very beautiful images in the sense that they are very fine pieces of art, so please bear with me. This is a 23-minute film, and then I will get right into it - so break out the popcorn and the coffee, and let's go for it.

**FILMSCRIPT**

**Field Trip: Science from the Native American Perspective**

*Hello, I am Greg Cajete, and I am a professor at the Institute of American Indian Arts in New Mexico. This particular videotape presentation is meant to illustrate the particular role during the process of implementing a curriculum called Science from the Native American Perspective. This particular curriculum was developed by myself at the Institute of American Indian Arts. It involved basically an approach to science which attempts to integrate cultured creative process and science as a cultural*

*system, within the presentation of science as a whole. It is an artistic curriculum which involves a variety of different teaching and learning methods, among which I included adaptations of traditional Native American methods of teaching and learning. The particular videotape was filmed at Bandelier National Monument in Bandelier, New Mexico. It illustrates a way of encountering and explaining the environment to students. It attempts to integrate cultured creative process and science as a cultural system, within the presentation of science as a whole.*

*This particular class is entitled Herbology from a Native American Perspective, and it illustrates a way of getting students to encounter the environment so that a particular lesson - in this case, viewing different kinds of herbs and talking about their various kinds of uses in Native American cultures. It allows students to become more intimate with their learning and allows students to become more involved in the actual process of science. The other courses which are included in the particular curriculum, Science from the Native American Perspective, include:*

- *The Creative Process*
- *Science or social science in the form of Social Psychology from a Native American Perspective*
- *Philosophy from a Native American Perspective*
- *Herbology from a Native American Perspective, and*
- *The Archetypal Elements (or cardinal elements) from a Native American Perspective, which basically involves students encountering the different elements of nature such as earth, wind, fire, and water, and relating those kinds of encounters to geoscience or geology.*

*The other course that is part of this particular presentation is Animals in Native American Myths and Reality. What is important about viewing this particular process is that it illustrates, as I said before, one of the very, very important roles which the teacher plays within the whole complex of the particular processing of the model. And that is, basically, encountering the environment, explaining the environment - the interacting process that is involved with both teaching the student.*

*One of the things I want to do on this field trip is, basically, to show you the kinds of plants that are available in this sort of environment. One of the most important things that you will begin to find out when you go on an actual trip to look for plants is the fact that certain plants grow in certain places. You can waste your time, to a great extent, if you do not have in mind basically where the plant would usually grow with each specific plant. One of the most important kinds of things to begin to think about is to remember places where plants grow. They grow in communities.*

*Generally, early during the springtime when the lilacs are coming out in the valleys, they are also coming out over here. The root of the mountain lilac is one of those kinds of plants that is most often used as an astringent. Any time you are talking about an astringent, basically, you are simply saying it is a material or a plant which causes a constriction, either in the skin or the blood vessels. That is very much like a vessel constrictor, and so the root of the mountain lilac is an excellent, excellent plant for that particular surface. You can grind up the roots and make a fine powder, and apply it directly to the skin as a weed medicine, or you can actually boil up the roots and gargle with it for the astringent effects for something like a sore throat. Again, this is one of the kinds of plants that I do want you to get a sample of, not here, but it is a very easy plant to recognize because it is calm. And it is one of the oldest kinds of plants in the world - oldest species in the continually evolving species plants in the world. It is a wound medicine, and the way it is picked is simply to scrape it off of rocks such as this, and grind down to a very fine powder. It is applied directly to cuts and bruises, and it actually has the effect of softening cuts and wounds that have been swollen quite a bit. It helps the blood to clot, and for that reason it was, many times, used as wound powder to stop bleeding - as one of the methods that was used to stop*

*bleeding. Again, because it has a very fine texture to it, because it is a very fine powder, it was used for that specific purpose.*

*Question:*

*Is it also a dye?*

*Cajete:*

*Yes. It is also a dye, correct.*

*This is called snake weed, from a rattlesnake. It is called the Pin-Hue; that is the Tewa name for it. It means "mountain prairie." Its main function is as a treatment for snake bites; that is why it is called the snakeweed. In New Mexico, in Hispanic herbology, this is called escorba vibrora, which is basically the same thing. The reason it was called that is because it was used specifically as a dressing when an individual was bitten by a snake, especially a rattlesnake. This, combined with another plant that you may not really see in the wild because it has become very rare, called osha, is used specifically for the rattlesnake bite. Again, the whole plant is boiled and made into a pulp and applied directly to a cut, or it can be dried and made into a powder and applied directly into the cut or wound. It is also used basically for insect bites, such as bees or wasps.*

*Question:*

*Is this a drawing ointment?*

*Cajete:*

*Oh, no - it has the quality, basically, of enhancing the degeneration of skin and of skin tissue, and the reason that it is used for rattlesnake bites is that venomous bites such as those of rattlesnakes have a tendency to very, very massively destroy skin tissue and underlying muscle tissue. That is one of the effects of venom in the system. So this has a counter-effect of treating the wound first, and drawing out the poison.*

*Basically, you can use this plant any time of the year. Most often you can use this part when it is out. The official name of this plant is lycopus, and it is a remedy that has been used for heart conditions in Northern New Mexico herbology for quite some time. It is a plant that is really useful for that purpose. The active ingredient in lycopus actually acts as a heart tourniquet. In Western herbology as well as Native American herbology, lycopus is one of the heart-specific herbs that is sometimes drunk for different kinds of conditions of the heart.*

*Again, we see that at this stage it is one of those kinds of plants that you can use as a natural dye. Specifically, picking the flowers, drying them, and powdering them will give you that deep scarlet red coating. One of the things to say to an artist is the fact that many, many different kinds of paints that were made in traditional times by Indians were directly derived from flowers and plants such as these that we picked, and simply ground down and mixed with a little oil. I encourage you, if some of you want to make a really interesting kind of painting, to gather some of these flowers and gather some of these things that I am going to be showing you. It is a very simple method. Simply get a mortar and pestle and grind it down to a very fine powder and then add a little bit of linseed oil. Mix it up really well, and you have an oil color.*

*In some cases, if it has a really pronounced tone, you do not even have to add the linseed oil. You simply powder it down and add some water to it and let it cake up, and then you have a nice water color that is washable and that you can rinse out. Again, most of the different kinds of colors that were derived in older times came directly from vegetable colors such as this. In the case of that lycopus, it is very inconspicuous.*

*The segment that you have finished viewing involves encountering and explaining as a part of the process - the role of the teacher - and the implementation of the curriculum modeled from a science point of view and perspective.*

*The next segment involves another part of the process. To illustrate this part of the process, we are going to show you a segment from another course, Animals in Native American Mythology. In this particular class, we hope to illustrate to you a process of remaking that integration. This, again, is another vital element of the teacher's role within the implementation of the clear tone model. It basically involves getting students involved with intimately interacting. In this particular course content, we are going to be specifically talking about the ways in which animals have been depicted in various forms of Indian art, in particular, cultural Indian pottery in various other pueblos. The important aspect of this particular segment is that it shows students how Native Americans viewed the natural world and how they convey that understanding and that perspective in the natural world into another form, in this case, art. It also illustrates a form of integration in which science concepts, in ways of conquering the environment, carried over into another form or another discipline, in this case, art. Mythology illustrates the holistic interrelation among science, art, mythology, and a variety of other dimensions of human thought.*

*The important thing to remember is that science, as I said before, is a cultural process. Based on that assumption, science can only come alive for students if one relates science directly to the cultural base from which these students happen to be coming from; in this case, about Native American students and the different cultural ways in which Native Americans have depicted animals in both art and mythology. Science can only come alive for students if one relates science directly to the cultural base from which these students happen to be coming from.*

*The segment will conclude with a presentation or some comments by actual students who, within the course, tell you the ways in which they feel the course has enabled them to gain a better perspective of themselves, Native American cultures, and science, and that interrelationship between humankind and our world.*

***Student:*** *What I have gained from this class is a desire, as well as looking into my own tribal myths and legends. Within each tribal legend I look into, it is an interesting thing - like celestial origin, earthly origin, comparing energies either spiritual or physical - and I am really enjoying this class.*

***Student:*** *I think the thing that is impressing me the most is the fact that there are certain misconceptions that people have about primitive art and primitive pottery. And yet the feeling that I am getting from the class is that we are studying art forms which are refined in a highly developed, aesthetic sense. There is a strong quality to the art which I think is very sophisticated and very fascinating. This class has brought very much an awareness to me, where animals are concerned. In the past, I have never really given it much thought as to how important animals were to us as individuals, and then as a whole as to what they represent. This class has just made me a lot more aware of the sensitivity, as it is used, and the relationship.*

***Student:*** *I have been living here just three years, and I have started now moving into Indian art and mythology, which is fascinating for me because I am comparing European mythology with the Native American, and the difference is incredible. My experience around this kind of mythology is a split between reality, and this mythology which was based on nature and also was not on contact so much with the animals and its nurturing. My question is how you bridge this split between this mythology and the present-day life, and I think this experience is very heavy and very difficult to live with.*

***[End of filmscript]***

I should tell you that we have a number of exchange students at the Institute. The woman you were listening to in the final commentary is a Swiss woman who was studying at the Institute and just graduated.

Let me first say that what I have attempted to do at the Institute, over a period of almost 13 years, is to evolve an approach to presenting the cultural perspective of American Indian people as it relates to the natural world. I am emphasizing that this was a 13-year process because it is a long time. It takes a long time to evolve and to perfect something like this. As a matter of fact, I still do not feel that the model is complete. It is going to take perhaps another 13 years to evolve and develop it to the point where I can truthfully say there is something really going on there.

***"...the teacher has become the central, most important, figure within the context of the teaching environment."***

One of the most important things I have encountered is the fact that the teacher has become the central, most important, figure within the context of the teaching environment. If you take a really good look, and really study the ways in which Indian people traditionally taught these sorts of things, you see consistently that there was a kind of a *mediated learning* that was very affective. You learned from people who cared about you, and with whom you had very intimate first-person relationships. That is the kind of philosophy, or approach, that I have tried to carry over into the teaching of science. The first step is that affective relationship between teacher and student, in which the teacher acts as a kind of mediator between whatever is being taught and what the student is perceiving.

The thing I think is most important to emphasize at this point is that, as a professional educator, I have really never been out of the classroom. In the last 14 years I have always taught full-time. In that process of being "in the trenches" for that period, I have a sense of what works and what does not work. I have tried to carry over that into that understanding of what works and does not work, in the development of this model. It is a model that I am consistently and constantly innovating upon, and I have reached the point, I think, in the last two years, of being able to come out and talk about the model. Not so much as an attempt to try to preach that this is the model to use - because I do not think there is any one model that you can really truthfully say is *the* model - but, rather, to try to stimulate some creative thinking, some creative learning on the part of teachers. As you saw in the film, we were trying to reach teachers in this particular film. That was the students' assignment, to film a video - this presentation - to be presented to a particular audience. That audience was teachers - teachers in the field who wanted to get a sense of what actually occurs within the context of this particular model.

So, before I go any further, I want to show you some more slides and get you a little more involved, visually bombard you with the kinds of things that I approach or the kinds of things I use within this curriculum and the seven courses that I teach. I have given you two handouts. The first one is an article that I have just completed for the ERIC Digest System, entitled "American Indian Education: Motivating American Indian Students in Science and Math" [EDO-RC-88-02, January, 1988, Gregory A. Cajete]. This has practical approaches that are useful to most teachers and most people in the field. The other article was published in the *Baltimore Sun* about three years ago ["The 'Ethnoscience' Approach to Education," Oct. 27, 1985, Judith Gaines]. I had the reporter, dragging her along and climbing cliffs and all those sorts of things, and she was interviewing me as I was actually doing one of the herb walks. The article gives some of the kinds of thoughts I have in relationship to that curriculum.

One of the things that really throws a lot of scientists is a statement that I always make: I do not believe there is any such thing as objectivity. That really catches their attention. It gets people very angry, especially people who are in the sciences, because in a sense there is a kind of mythology that you are conditioned into in the process of going all the way through to the Ph.D., that science is objective. Actually, what the scientific method does is reduce your own subjectivity to a minimum. But as long as we are human people, as long as we are conditioned within a particular kind of culture, that mindset - that unconscious conditioning - is going to carry over into the kinds of things that you do as a scientist, the kinds

of problems that you actually look at, and the way that you look at them. So, the scientific method is actually a method to reduce your subjectivity to the minimum - and that, I guess, could be called objectivity. But in a sense, in the way I view things, there is really no such thing as objectivity. It is one thing - it is subjectivity, and the way you deal with it - on a continuum. I usually say that at Los Alamos, when I give the talk to some of the physicists, and we get into some really lively discussions about what science is all about.

In studying and developing this model, I first looked back into my own background. I looked at the ways in which I was taught, and I tried to figure out what those key elements were, what kinds of things were involved in my upbringing and my learning of Santa Clara traditional pueblo ways, that had a direct effect or direct carry-over that I could use in the presentation of a subject like this.

> ***"...[Cultural] mindset - that unconscious conditioning - is going to carry over into the kinds of things that you do as a scientist, the kinds of problems that you actually look at, and the way that you look at them."***

One of the things that I found was that idea that everything is interrelated, so I used this concept, which is called the *mandala*. A mandala is a very ancient kind of symbol. It basically represents how things are interrelated within a whole. I transferred that way of thinking and that way of looking at a curriculum over into curriculum design. What I did was begin to think in terms of an American Indian mindset. If you take a good look at all Indian tribes, you see there are not only four directions - North, South, East, and West - there are actually seven. Those seven directions are looked upon in many different ways by different Indian people, but there is a commonality, a sense of what direction is - and it is not just a physical direction. A direction can also mean a kind of mindset, a way of looking at something, a perspective or a dimension.

Almost regardless of tribe, Indian people traditionally have designated directions with a color, a particular plant symbol, a particular animal symbol, and, applied with that is a way of looking at things. Carrying that over into curriculum design, I placed the first course that I developed in the *Center*, that is the place of spirit balance, the place of creative thought, the first thought, and I associated that with the Center. One of the kinds of things that this evolution, this development, of the curriculum forced me to do was to get down to the basics of what I was trying, as a teacher, to get across to my students: Is it the course content or is it a process or is it a way of looking at things? As it turns out, it is all of those three things.

I looked around for something I could use as a kind of tool that would allow me to involve all the other courses that surround this particular center. What I came up with was that I am actually trying to teach them how to think. I am trying to give them strategies and perspectives of thinking, ways of handling and looking at natural phenomena which are not just the simple logical, rational, scientific ways, but encouragement to look at phenomena in as many ways as possible. That is, basically, the creative process. So there is an entire course, before I begin the curriculum, that involves creativity. It is a huge amount of material and brings in various other people to talk about the nature of the creative process in art, science, and social science. I tried to give students a sense of the territory, a sense of a strategy or way of thinking. This course is a full four-hour course, jam-packed with lots of different things. A lot of different people helped me to bring off this course.

The next round is representation of the *East*, the beginning of wisdom. I associate the philosophy from an American Indian perspective. We look at American Indian philosophies of nature and compare them with Western philosophies to get a kind of comparison between these two ways of looking at the natural world.

The next course, and the next direction, is the *West*. The West among my people represents an understanding of self and groups; it is the place of social well-being. We get into the social psychology of Indian people. First, we look at methodology - how Indian people put together their societies. Then we

come into contemporary times, and we take a look at some of the hard problems such as alcoholism, drug abuse, and everything under the sun that is related to that - again, that is a full course.

We go into the next course, the *South*, which is health and wholeness. It is also associated with plants; we get into herbology. We talk about medicine, we talk about American Indian healing perspectives, we talk about holistic perspectives of health - the whole gamut of things that come into play there.

*North* is the direction of the animals, the direction of inner being. Students take a look at animals in American Indian myth and reality, at wildlife ecology and biology, as well as at myths about animals. We go from that point into the primal elements which I also call the archetypal elements, and we take a look at geoscience. We take a look at a concept that Indian people have that is very much a part of ecology. It is called the *Earth Mother concept*, but in ecology it is called the *Gaia hypothesis*. That is the idea that the earth is a living, breathing organism and that everything is interconnected.

Then, from that point on, I finish with astronomy from an American Indian perspective, and that puts the cap on it - it is the *Above*, the place of the Celestial Father. We talk about creative cycles, astronomy, and architecture, especially as it relates to Native people and how that has affected the way in which they perceive space and time. We talk about cosmology and mythology.

I made two diagrams, one for the right brain and one for the left brain. I have used circles for the different kinds of things that I see coming into play - theoretically, I guess you might say - in this process. Again, creative thought, holigizing, making meaning, the things that I am after, establishing some sort of meaningful communication about science, about the natural world with students. I am also after a kind of thing called *basic science literacy* because I think that unless Indian students have a sense of science, they cannot move to the more specialized steps. All people need literacy in science - that basic foundation of literacy and science or math or whatever it may be. Unfortunately, we get students to try to go to college and try to take on those hard courses in math and science, but we have not taken care of that basic science literacy. That is what I am trying to do for the total Indian population as a whole, in education.

Then we get into American Indian philosophical perspective and Western philosophical perspectives and comparison and contrast. You have the creating process, you have the culturing process, the developmental learning process, the experiencing process, all coming into play and mixing up. It is still a linear process. When I am teaching this model to teachers in the field, this is very important because some teachers will not understand the model unless you put it into a stepwise sequence. That is what this is, with an outcome, a product right here.

These are the things I am after, the specific things I focus on as a teacher: first of all, learning as a creative process; secondly, affective learning and cultural relevance; and, thirdly, especially, paying great attention to student learning styles. I actually have a full round in which I present each lesson. The first round involves the discussion method. As a teacher, I am trying to motivate students. I am trying to get some real excitement going about what I will be presenting to them. So there is a lot of student interaction. The learning process involves integrating, trying to get the student to integrate the experience with something in themselves. The second part is where you do the traditional teaching that most teachers are most comfortable with, and that is information-sharing. That is where the teacher is doing as I am doing to you - presenting; the teacher is acting. Learning involves a formation of concepts and ideas, and you get into the principles, the classifications, the theories of science. The third part of the process involves the teacher's coaching and encouraging. The teacher is trying to get the students to move and to do something in relationship to what they are learning. The learning involves practice and personalization of concepts. Finally, facilitating self-discovery, the teachers evaluate and remediate. Learning involves integrating applications with the experience. This is where I get the students to stand up and to make some sort of presentation in relationship to what they have learned. That is my way of finding out whether they have really understood some of the basic principles and concepts. I have adapted Bernice McCarthy's format method, which is teaching to the right and left brains.

So, these are the kinds of things I do. We go out into the field, especially in the herbology class and the geoscience class. Most of the time is spent in the field, actually, half of the time of the entire course is spent in the field. I know that a lot of schools cannot do that. The Institute has been good to allow me the leeway and freedom to be able to take students out on a pretty constant basis.

**SLIDES**

Here, I am showing students how to make a yucca brush. What I try to do when I go out on these field trips is to show them as many different kinds of uses of plants as I can possibly think of. That way, they can see that Indians had a multidimensional perspective of the things around them, that in one case a plant may be used specifically for food, and in another case for medicine, and in another for practical purposes such as making a paintbrush. That perspective is seeing multidimensional things in the environment.

We sit around and we joke. That is where I get to learn about the students. I get to be a part of their world, their ways of understanding things. That is very much a part of this concept of mediated learning; that is the way I was taught. I simply transfer that into the way I teach, as well, asking questions, having them go out and discover things for themselves. These students are going to take a huge amount of this rabbit brush, boil it up, and see if it really works as a natural dye, because they wanted to try that and see the different kinds of things they could use that for, as artists. I am very strict with the kind of outcome that I want from the classes that I teach, so the students have to take prolific notes. They have to be able to apply those basic academic skills, as well have fun at the kinds of things that we are doing.

Mr. John Stokes - as did Mr. Larry Little Bird - taught among the Australian aborigines and learned how to play the Australian *digeredo*, which is used to call animals during aboriginal ceremonies. He is teaching students the concept of the digeredo and what that means. Here, he is teaching students how to track - he is also a professional tracker.

Ed Wapp came in to do a presentation on ethnomusicology. I have a t'ai chi instructor who gets students to mimic the movement of animals because t'ai chi is, for the most part, mimicking - stylized mimicking of the movements of animals. So we do some t'ai chi classes, which has effects holistically, throughout the system. Another fun thing that we do is get together and have each person pick or be assigned an animal. The students make an animal mask, and they may have to study that animal. This is biology; it is behavior in the environment. They make a presentation which is both artistic and factual about the animal that they have chosen. So, you can see that young woman making a mask. Here, the whole group is making animal masks based on their own facial features.

Here is an eagle transforming itself. Here, we are out in the field doing what is called *duck walk*, a t'ai chi exercise. One of the things I do to make Indian mythology come alive is that, after we have studied American Indian mythology about animals intensively, we dedicate the second half of the course to actually putting together and producing a myth about the animal.

Here, the students got together in Santa Fe, and they are ready after having rehearsed and produced a play taking on the characters of various animals. This is Deer Woman. These are plays, two- or three-act plays, which the students themselves develop based on their sense of what the mythologies were about, and these are the characters being played here.

There is the serpent [slide]. This figure here is *Masum*, which the students came up with as the name for the all-prevailing forces in the natural world. There is Masum again, here is the eagle, there is the bear. The students have a great time doing this, but in the process you have to really research that animal if you are going to portray it. You have to research it not only in terms of movement, but also, especially in this case, you have to get a sense of how that mythologic figure actually plays, in respect to certain things.

Another thing we get into is American Indian astronomy. Here is a depiction of the Moundbuilder people and their worship of the sun. One of their major ceremonies during the summer solstice was to sing up to the sun and to dance to the sun. We get into the nature of American Indian ritual. Here is a sun dance. The reason for getting into rituals is to give Native students the sense of how understanding natural processes or natural phenomena carried over into native ritual. In a sense - if Clara Sue Kidwell were here - she would say, "Ritual was the way Indian people represented their understanding of natural forces in the world." It is very similar to what the experiment tries to do in natural science.

You can see in Indian mythology the whole exploration of different aspects of the human condition. This is the myth of the hummingbird [slide], which talks about courage and character and animal transformation. Here is a myth from the far north, the Woman Who Married the Mountain, which talks about a mythological relationship between a person and a mountain. Mountains are not only natural geography.

Indian people have always had relationships with special mountains. There are reasons for that; there is a whole ecological mindset which surrounds that symbolization of the mountain, and it comes through myth.

Here is the myth about the Woman Who Married the Bear. It talks about relationships between Indian people and very special animals within their environment, and how animals should be treated with respect.

We have myths about natural relationships. Here is the Navajo myth about the First Man and First Woman and their commemoration of one of the sacred mountains in Navajo country. You can see the plants and the various animals that are depicted with that directional sense of space that we were talking about, and how Indians depict it in an artistic way.

> ***"'Ritual was the way Indian people represented their understanding of natural forces in the world.' It is very similar to what the experiment tries to do in natural science."***

We talk about human frailty, the human perspective of things. This is like *The Birds*, Alfred Hitchcock's birds, but this is the Butterfly Woman - the butterflies are punishing her for leaving her husband and running off with this guy over here.

Creation of the world - all the creation myths are so packed with information and understanding that I do not think we will ever really decode everything about the traditional Creation of Indian people and Native people. Here is the first man being created out of a pea blossom or pea pod by Raven.

We talk about conceitedness [slide]. This myth is a child's tale about the opossum who had a very fantastic and fluffy tail and did not let anyone not know that. The rabbit and the cricket tricked the opossum into shaving his tail. The opossum thought he was going to grow a more magnificent and more beautiful tail than he had, and instead nothing grew, so that is how the opossum has a naked tail.

Here is a coyote, and how coyotes stole the fire from the shamans of Obsidian Mountain. Here is another tale of conceit. You can see even the little mice with beach clothes on, and they are laughing. It is a tale of a warrior who thought himself to be very handsome and wanted to be even more handsome. He was tricked into putting on this buffalo head by the little animals here, and again he is taught a lesson. He can't take the buffalo head off, and he is running about.

We talk about star myths and American Indian relationships to the cosmos. This is the myth of Scarface. It is a Blackfeet myth that talks about the relationship that Indian people have, or the perspective that Blackfeet people have, in relationship to the sun, the moon, and the evening star. It tells also about the origins of the sun dance of the Blackfeet.

Here, you have the great turtle myth among the Iroquois. This is also a symbolic representation of the Gaia concept in science. We get into American Indian herbology, we look at the role of the shaman, what his perspective was, what his role was within the society. We get into the nature of disease, epidemiology, and we study extensively the kinds of things that happened to Indian tribes after the first contact - the incidences of measles and diphtheria and smallpox. Because of these sorts of things, Indian people started to really develop herbology and attempt to respond to these illnesses. There was a renaissance of lots of different approaches to medicine when these sorts of things were happening among Indian people.

We talk about Indian foods and nutrition and agriculture, the different systems of planting, the *chinampas* among the Maya - one of the most productive systems of agriculture that has ever been invented. We studied that extensively to see how it works and why it works:

- The terrace systems and the domestication of animals.
- The communal hunting of animals and how that was ecologically controlled within an environment so not too many animals were killed.

- The relationship between Indian people and certain very important plants - among the Pueblos, corn, and the different ways in which corn was grown, the different kinds of corn, the different uses and applications of corn.
- The relationship of the Plains Indians to the buffalo.
- Wild rice and its gathering, and the relationship of the people of the Great Lakes to that very important plant to them.
- Preparation of various kinds of naturally occurring foods in their environment, such as maple sugar and the making of maple sugar.
- Various preparations of corn - we get students to actually prepare them.
- Potatoes among the Incas.
- Irrigation systems and the development of agricultural systems in societies, and how that was affected by plants that were used.
- Domestication of various other kinds of plants, such as the water lily.
- Indian hunting and the whole concept of hunting as a holistic process, and how that forms and develops the mindset of a particular culture, especially if it is a hunting culture like the Eskimo.
- Indian fishing in the Northwest and the nature of fisheries.
- The building of birch bark canoes - which can also be used to study mathematics.

*"...you learn and retain most those things with which you have constant connection or constant exposure from a variety of different perspectives. That is what I try to do with the development and involvement of this curriculum."*

I tried to finish and pull it together by giving students the sense of how Indian people viewed the natural world from that holistic perspective. It is one thing to say that Indian people view the world holistically, but unless you reinforce that with some tangible examples that students make connections with themselves, then it is very much a hollow word. It is a fact that you learn and retain most those things with which you have constant connection or constant exposure from a variety of different perspectives. That is what I try to do with the development and involvement of this curriculum.

I want to leave you with some final words. I was trained in a model of teaching that was not of my making, but simply a model of teaching that I had to go through to reach this point. But I have had some time to reflect, having gone through the process of developing this ethnoscience model. One of the things that I have begun to see, as an Indian educator, is that there is a greater context into which this sort of model fits. To a large extent, Indian educators are developing parts of that greater context, and that greater context is what I call an indigenous model of Indian education. What we are going to achieve is not only Indian education, but truly revolutionary ramifications for mainstream education.

I view the development and the articulation of that model as being essential as the next step to this thing called self-determination. For quite some time, we have tried to adapt our Indian students to a model and to a system, and with some success we have been able to do that. But we have reached, I think, the point

point where we have to have a model informed within our own culture. We have to begin to develop and articulate that model, and to infuse the kinds of educational systems and approaches that we have now with our understanding of those values and of those perspectives that we hold, as Indian people, to be valuable. I think as that model evolves, what we are going to achieve is not only Indian education, but truly revolutionary ramifications for mainstream education. It is in a sense not only a mandate, but essential, that Indian people take on more of the challenge of developing an indigenous perspective of education and integrating that philosophy into education for our children and our people. I think we are just at the very beginning. The idea is there - we have begun to see the need for it. It may not happen for 20 years - it may not happen for 30 years, but I think what is very important is that people start thinking that it can be done, that it needs to be done, and that it has to be done.

***"It is in a sense not only a mandate, but essential, that Indian people take on more of the challenge of developing an indigenous perspective of education..."***

I will leave you with saying that this is one of the most important challenges that Indian people have to face today. I have studied extensively, for instance, the Japanese system of education, and I have studied the system that is used in Israel, trying to find what other cultural groups have done in reference to education. What I have found, especially among the Japanese, is that their system seems to be so effective and so powerful because they have been able to integrate their society's values into their educational system. Those values are reinforced in the educational system consistently: working together in groups, self-sacrifice, hard work, the lifestyle of the Japanese farmer. They transferred that ethic, that perspective, into business and into education. About half of us are now driving Toyotas because of that. There are examples of the power of that kind of infusion or integration, of some basic cultural values that are very important to the survival of a people, into an educational system.

The Israelis have done the same thing. I think that it is possible for Indian people to do that. We have to begin to think along the lines of an indigenous model of education informed by those values and ideas.

Thank you.

## QUESTION AND ANSWER SESSION

I would like to ask the group what you think, of the idea of the indigenous model. I do not know why it is a new thought to some people.

Question from the floor:

Can this be done "by the book"?

The extent to which I have been able to get this model into the public school system has been to round up interested Indian and non-Indian educators and give them a workshop for one week of 8:00 to 5:00 intensive training, to give them a sense of how to use the model. That is as far as I have gone. So, what I do, rather than pound my head against the system, is try to attract interested teachers and sit down and talk about it. They can see how I use the method, then they develop the units and other things, and they try to introduce it into their individual classrooms. It seems to be effective. But because of mandated and competency-basis philosophies, it is very difficult to get this sort of perspective into the public school classroom, unless the teacher takes on the role of doing this. It is very difficult to do any other way.

Question from the floor:

What is the ideal environment for that?

Well, I found out that the ideal setting is an Indian school like IAIA, because I have support systems to support and enhance all the kinds of things that I am doing here, and that is not necessarily so in another setting. The second most ideal situation is in a public school that does just this in one class, whether you call it Culturally Mediated Science, or Ethnoscience, or other things. That is the other possibility.

Question from the floor:

Do you think that this would work, for instance, in the supplemental programs such as Title IV?

Yes, it would. It also works well in summer programs.

The other thing that I am getting at is motivation. Motivation is a very interesting psychological process, and it is one of the most important things in getting the student interested in science, in giving them a sense of what Indian people have done in science. After this comes interest. That is where it begins - that motivation and that interest, let's say in the uses of herbs, which then translates into the field of botany. I have had a couple of my students become nurses, and although they are very fine artists, they moved into nursing because they got interested in plants. When I gave this course, a lot of students were very interested and were really pushing American Indian astronomy, really getting excited about it. As a result, some of them are moving toward wanting more courses in science that relate to astronomy. Of course, they will then see the need to take physics and other things. The essential thing is going back to that affective teaching, and that is something that the teacher has to develop. Unfortunately, half of the teachers that taught science were ex-coaches, and although they are good people, many of them really should not be teaching science. They do not have the affective relationships. It is hard for them to establish it - not that there is not an affective relationship in sports. You do develop an affective relationship for the game or for your team players, but that is a different kind of affective relationship.

Question from the floor:

Have you applied this methodology to training teachers and sharing the knowledge with them?

Yes, at the University of Arizona and at the University of New Mexico, we sponsored a workshop in Santa Fe at the Institute. I was going to do some more, but the whole thing fell through. I have done two workshops where I have tried to do that with teachers. I have followed up with those teachers, and most of them have used the model, not only for teaching science but also for other courses. The model itself can be used to teach practically any subject, not only science. But again, it is an integration of science and social science - it is an integrated humanized approach to presenting science.

Question from the floor:

What percentage of students are taking your classes?

A very small percentage, usually. I have anywhere from 10 to 15 students in any one class. We are going to start a whole new arm of the Institute. It is not going to be only art now -it is going to be cultural studies as well.

Question from the floor:

Would you ever come to a place like Minnesota and do a presentation to the policymakers? What you present here is lacking in their education, so, when they make educational decisions, such as choosing the curriculum, they do not have this background.

Oh, yes, I would. At this point I see the need to do that, and I have been trying to do that as well as I can between teaching periods at the Institute.

Question from the floor:

What kinds of things do you do to spark creativity?

Stu [Stuart Tonemah] has a whole batter of courses for creativity. There is a huge amount - it is a self-contained course and it is pretty intense. Actually, we go into the whole nature of creativity. What is creativity, how does it express itself in art and science and humanities, and how do people who are creative in art or whatever perceive creativity? It is a problem, because creativity is an individual thing. It is a very subjective perspective.

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# BUILDING A PIPELINE: THE CONSORTIUM FOR GRADUATE OPPORTUNITIES FOR AMERICAN INDIANS

**Clara Sue Kidwell, Ph.D.**

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*Dr. Kidwell is on a year's leave from the University of California-Berkeley where she is Associate Professor in the Department of Native American Studies. She was instrumental in the organization of the Consortium for Graduate Opportunities for American Indians whose objective was to encourage American Indian students to pursue degrees in the natural sciences, social sciences, and humanities, and then to become college teachers. She has served on the Minority Graduate Education Committee and the Graduate Record Examination Board. Among her publications on the history of American Indians and science are Science and Ethnoscience: Native American World Views as a Factor in the Development of Native Technologies, and Aztec and European Medicine in the New World, 1521-1600. Of Choctaw/Chippewa parentage, Dr. Kidwell continues to share her knowledge and enthusiasm with others through lectures and presentations in diverse forums. The Consortium, which moved to Northern Arizona University, Flagstaff, AZ 86011, is presently inactive.*

**ABSTRACT**

In 1983, a proposal was submitted to the Ford Foundation for a program to develop a network of faculty members at 11 colleges and universities to identify and encourage American Indian students to pursue graduate programs. After a rather lengthy process of discussion with program officers at the Ford Foundation and the Carnegie Corporation, the proposal was funded, and in 1985, representatives of the 11 institutions met to plan future activities of the Consortium for Graduate Opportunities for American Indians. The objective was narrowed to encouraging students to pursue degrees in social sciences, humanities and natural sciences and to become college teachers. The original 11 member institutions included two Indian-controlled junior colleges, four predominantly undergraduate state universities with significant numbers of Indian students, and five state universities with a wide range of graduate programs. Four other institutions have joined since 1985. The Consortium has provided workshops to students on the campuses, published an informational newsletter, and held two faculty-student conferences. Although foundation funding is ending, a network of contact people is in place, the campuses are beginning to do their own workshops, and plans are being made to seek other funds for special projects.

There is a definite need for Indians in technical fields, science, and engineering. Chief Mankiller spoke to that issue this morning. My father told me about a young Indian veteran who signed up for the Navy and went away. He learned electronics as part of the training he got in the Navy. As it turns out, this guy was from a very poor reservation, and there was no indoor plumbing and no electricity when he left. When

he got back, the BIA [Bureau of Indian Affairs] had at least built a large communal bathhouse with flush toilets. They still had not run the electricity. So the young Indian veteran used his electronics knowledge from the Navy. He ran the wires. He put in the lights. He thus became the first Indian to wire a head for a reservation.

But seriously, if you look at the representation of American Indians in science and engineering fields at the doctoral level, Nina Kay gave us some statistics this morning, Ph.D.'s given to American Indians in this country constitute about 0.3 percent of the Ph.D.'s that are granted. In 1981, the figure was 89 doctoral degrees, and about 50 percent of those were in the field of education. True, we need teachers. We need to take control of our own school systems. But we also need scientists, engineers, and technicians.

***"We find the leaks at all levels or all joints of the pipeline. And - as I like to say - by the time we get to graduate education, we are down to the drips."***

In 1981, I joined the Graduate Division at the University of California at Berkeley as an associate dean. I have been teaching there since 1974, and from my role in graduate education, I started looking at the figures for Indian representation and graduate programs throughout the county, the very small numbers. If we constitute - depending on how you count - 0.6 percent of the county as a whole, and we are only 0.3 percent of doctoral degree holders, I would say we are underrepresented. And, looking at the statistics, I see that all along the pipeline of education for American Indian students there are leaks, from lower rates of graduation from high school, through lower rates of attendance at college, through lower rates of graduation from college. We find the leaks at all levels or all joints of the pipeline. And - as I like to say - by the time we get to graduate education, we are down to the drips.

## ESTABLISHMENT OF THE CONSORTIUM FOR GRADUATE OPPORTUNITIES

The small numbers, then, were of concern to me. I was able in working with a friend of mine at Berkeley (which has had a successful program in the School of Public Health and Social Welfare to get American Indians into master's degree programs in those fields) to structure a proposal we took to the Ford Foundation for building a pipeline to get more American Indians into graduate programs. In part, our negotiations were shaped largely by the Ford Foundation's concern with turning out more people who are college teachers. This is one of their major policy thrusts. The program officer at the Ford Foundation kept hammering on how few Indians there were with Ph.D.'s. If you look at the Ph.D. as a teaching degree, something that prepares a person to do research and teach at the college level, we definitely saw a need there. Indian communities are increasingly trying to take control of their own educational systems, and one way that they do that is establishing their own community colleges. Using those community colleges as a way to higher education for Indian people means that the quality of education they offer must prepare students to go on to four-year institutions. Indian people as role models in those colleges are important; Indian people who have been through graduate education themselves, to tell their students what it is going to be like, are important.

So we worked to establish the Consortium for Graduate Opportunities for American Indians to create a mini-pipeline of our own, to try to develop a process by which Indian students could be identified and encouraged very early on in their academic careers to go on and to get advanced degrees. Ideally they would get Ph.D. degrees so they themselves could go back to teach the next generation of Indian students and Indian scholars. Our pipeline was built with two Indian community colleges, Navajo Community College (Tsaile and Shiprock branches) and Haskell Indian Junior College. My parents graduated from Haskell in the late 1930s, and I taught at Haskell from when it became a junior college in 1970 until 1972.

We identified the two Indian community colleges as primary feeder institutions. We had four secondary feeder institutions in primarily undergraduate state institutions that serve significant numbers of Indian students. Part of this was based on looking at the statistics, and part of it was based on contacts I had made by traveling around and being involved in higher education for Indian students since 1970. Our four institutions were: Ft. Louis College in Durango, Colorado; Northern Arizona University (NAU) in Flagstaff; Northeastern State University in Tahlequah; and Southeastern Oklahoma State University in Durant. The Indian populations in those four undergraduate institutions and in the two Indian Community Colleges in 1984 when the project started totaled about 3,000 Indian undergraduate students. We looked at that as a potential pool. Then we identified some state universities that had significant numbers of graduate programs to which we could try to recruit those students. Three campuses at the University of California signed up: UC-Berkeley, largely because the consortium was based at Berkeley, and because I am based at Berkeley; UCLA; and University of California at Santa Cruz. Outside California, at first we had the University of Arizona, with its Indian Studies program, and the University of Utah. And then eventually we broadened out to bring in the University of Alaska, the University of Kansas, Montana State University, and the University of New Mexico. We thus have a group of institutions which have a significant pool of Indian undergraduates, a range of graduate programs, and Indian faculty members working in graduate programs.

***"Indian people who have been through graduate education themselves, to tell their students what it is going to be like, are important."***

The way the consortium attempted to get people together was by putting out a newsletter and by having staff travel to the campuses to give workshops for students. We also invited faculty members simply to talk about the process of getting into a graduate program, what graduate education is about, what is important in terms of getting together a good application to graduate school, and the process of selecting a graduate program and what to look for. The workshops became our primary point of contact with the students and faculty simply to keep in people's minds the idea that Indians have the potential to go to graduate school. Not that all 3,000 of them are necessarily going to be interested, or necessarily have the potential - but there is a pool that needs to be cultivated, and faculty members are really the key points. They are the ones who, by their own example and by their interests, are going to be able to talk to students most effectively about what graduate school really means.

We also put out a newsletter which we circulate or have circulated on a fairly regular basis. Over the course of the three years the project has been in operation with the Ford Foundation funding, we have contacted about 500 students altogether. Some of those have already graduated, some of them have moved on, and some we have lost contact with. But there is still a pool of about 250 students who have attended workshops or conferences put on by the consortium who still constitute our working pool of contact people.

One of the ways Indian students do get interested in graduate education is through the existence of programs on their campuses which operate throughout the year. The consortium simply goes in and does one-shot workshops on the campus. We have only one chance to contact people. But those people who have things like MBRS programs or MARC programs, or special support programs for Indian students that operate throughout the year, are going to be very important because they are the ones who are able to get faculty and students most directly hooked up. Through the activities of the consortium and the staff, we have been able to put together a network of faculty and staff at our institutions. We published a small directory that lists everybody who has been on our mailing lists. We hope to continue to keep the newsletter and the directory in the minds of those faculty and staff members, with the importance of encouraging students to go on to graduate school. Our network has been strengthened by two conferences we held in which faculty and students have met together. We held one at Lawrence, Kansas, in April, 1987, and we held one in November, 1987 at the University of New Mexico campus. We had faculty and students

from all of our institutions at the conference in Albuquerque, and most of our institutions at the conference in Lawrence. Students gave presentations about research they had been involved in, and their fellow students and faculty members constituted the audience. Some of the most effective presentations were those made by students who had training throughout the year in the MARC or MBRS programs. For those of you who are not familiar with all of the acronyms, MBRS is Minority Biomedical Research Support program (funded by the National Institute of Health (NIH), and MARC is Minority Access to Research Careers (an honors subset of the MBRS program, also funded by NIH). These programs bring students and faculty members together. The faculties sponsor and supervise student research throughout the year. Most of these are biomedically oriented; they are intended to get people into Ph.D. degree programs in areas of research in the biological sciences. Those existing programs became an important part of the network of faculty members, students, and other people that we were trying to create with the consortium. The existence of these programs will, we hope, inspire other institutions that serve Indian students to set up these kind of activities.

***"The workshops became our primary point of contact with the students and faculty simply to keep in people's minds the idea that Indians have potential to go to graduate school."***

Of the institutions in our consortium, Ft. Louis College, Northeastern, and Montana State have very active programs through the MARC or MBRS programs. In a sense, then, we are piggybacking on an existing situation to encourage Indian students to go into biological sciences. But I think that the model of networking - bringing people together for conferences and showing Indian students that they really can do it - is very important. The conferences were fascinating because the student presentations covered a wide range of areas from Indian arts and Indian literature to drip irrigation of trees and improving milk production in dairy cows. We heard a lot about a lot of different things. The students who got up to give presentations were, by and large, terrified; yet, I think after it was all over they really felt good about their ability to get up and talk to other people about what they were interested in. It may have simply been that they were grateful to have survived the experience at all, but I think it really did give them that boost and confidence and maybe the inspiration to think that, yes, they too can go on, and they too can do graduate work.

The consortium has now left the Berkeley campus. Basically, what that means is that the files and our computer and database system have moved to Northern Arizona University. It has been taken over by Dr. Patricia Barron, who is the Assistant Dean at the Graduate School at NAU. The Ford Foundation funding has ended, but I think we have been successful in getting people's attention about the need to increase the number of Indian students, and also to begin to put in place on college campuses some of the activities the consortium sponsors. We have identified liaison people on each campus who, we hope, will continue to give workshops for students and talk to them about the process of applying for graduate education - putting together application materials, writing a statement of purpose, taking the Graduate Record Examination - all the things that are necessary for successful application. Also, we hope people are now more aware of the fact that Indian students constitute a significant pool of talent and potential. Sometimes it is hard to look out at a whole classroom of students and decide what it is that makes somebody a candidate for graduate school. Obviously, graduate school is not for everyone. It is a long and difficult road, it is an intellectual challenge, and it is often an economic challenge that terrifies students from the very beginning, because they simply are not aware of the different ways people actually can finance a graduate education. But the talent is definitely there.

Some of my own really rewarding teaching experiences came at Haskell Indian Junior College. I remember one student who was in my history class. He could not care less about American history. He was Apache, from Arizona, and his main objective in life was to go out and ride the rodeo circuit every summer. But I could tell by his performance in class that this kid had something going for him. I called

him in once and went over the last test with him. I said, "I know you can do a lot better than this." I gave him a few things to study, and, the next test, he aced the exam. It was really a spectacular turnaround, and his attitude in the class and his performance really changed. I do not want to entirely take the credit for it, but the fact that I singled him out and told him he could do it did make a difference.

Sometimes you think students are not learning anything. I had a Seminole student from Florida in my class - very shy, never looked at me, kept his head down - the stereotypical Indian student. It was a small, all male class - also in American history - and one student, a creep from Oklahoma, kept dominating the conversation. He would chatter on like a chipmunk. But Joe Nobilly never said anything, until one day when I asked him, "Mr. Nobilly, what is a tariff?" He raised his eyes like a startled deer, looked at me, and said, "A tariff is a tax on imports and exports." A breakthrough - he said something. After that he would smile and would wave at me on campus. I do not know whatever happened to Joe Nobilly. I doubt seriously he went to graduate school. But once in a while you make those breakthroughs, and you realize that the potential is there and you need to do what you can to encourage it.

The Consortium for Graduate Opportunities for American Indians has been trying to inspire people teaching at our member institutions with that idea - that there is talent. We have a few people on a few campuses now who are on the lookout for Indian students to encourage and, in some cases, identify to the consortium office, where we refer them to other institutions so they can receive information about graduate programs. There is a long way to go as the consortium continues to evolve. We hope we are able to get funding for more projects like our conferences, perhaps some faculty conferences such as this conference, to bring people together to share ideas about what works in terms of program development. The facts that people have been receptive, that our activities are still going on, that people on campuses are now maybe paying more attention to Indian students, I think, will ultimately help. It will ultimately help to produce those people who are going to make the decision to go through the whole process - getting a Ph.D. degree, and going back to teach either on their own reservations and community colleges or in institutions like Fort Louis, or Northeastern Oklahoma State University, or Durant - a real commitment to producing the next generation of Indian scholars and Indian leaders, and people who can really wire ahead for reservations.

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# FLUTE SONG AND OSAGE PRAYER

**Jerry C. Elliott**

**Configuration Engineer**
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*Jerry Elliott, an Osage/Cherokee, is a native of Oklahoma City. He received a Bachelor of Science degree in Physics from the University of Oklahoma and has been employed at the Johnson Space Center for 28 years. He is recipient of many special honors and awards, including the Bausch and Lomb National Science Award, the Presidential Medal of Freedom for his role during the aborted Apollo 13 space mission, the Science and Engineering National Achievement Award, and the Bronze Halo Award by the Southern California Motion Picture Council for outstanding contributions to humanity. In addition, he is listed in Who's Who in the South and Southwest, Men of Achievement, World-Wide, Personalities of America, and the International Directory of Distinguished Leadership. He remains committed to his heritage and his profession through his affiliation with numerous societies, including the American Institute of Physics, American Indian Engineering Council, American Indian Science and Engineering Society, American Association for the Advancement of Science, and Native American Science Education Association.*

Every time I hear applause, I feel like sitting down, because that is probably the best it is going to be. This is impromptu. If you are reading from the agenda what is supposed to happen here first, Norbert is supposed to be first. I thought this being the last time here on this symposium that we will be together, it would be appropriate to share a little bit of culture to start things off together this day. There are a lot more worthy people sitting here than I am to do that. So with your blessings, I would like to do that.

I brought my flute because I wanted to share just one quick flute song with you. My brother sitting over here from Kiowa country knows a little bit about flutes - probably a whole lot more than I do. But in days past, people used to get up early, and the first thing done was to give thanks. The very first thing was to say, "I have another day here." And that was symbolized by the sun coming up in the morning. The sun gives us a fresh new day - gives us time to start our day all over. So people used to play a flute song called "The Sunrise Song." Now, you know how that sun comes up every morning? There is some man out there, some guy out there playing the flute song and bringing that sun up. Well, the sun is already up today, but this is going to be for your sunrise tomorrow. The Sunrise Song is used to say, "Thank you," when that sun starts coming up.

[song]

Did you see the sun come up? [Applause]

The other thing I would like to do with your blessings and permission is to start the morning off with a little prayer because as we bring the sun up, we must be mindful of the gift we have been given, another day to live. Let us also be remindful in our prayers that no matter whether we are Black or whether we are Indian or what we are, there are two things we always remember when we get up: (1) We are all

human beings, and with that we are all one. (2) We must learn to respect difference and must realize we all have imperfections in our lives; we are never perfect. We are blessed to be here and so we share thanks for that with each other. So I want to share a family prayer I have permission to share. It is not my prayer but the family's prayer. And so if you would just bow your heads a moment, I would like to say it.

[Prayer in Osage]

Bless all these people. Return home safely.
Thank you. Amen.

# PROCEEDINGS OF THE FIRST HISPANIC SYMPOSIUM ON INCREASING PARTICIPATION IN SCIENCE, ENGINEERING, AND TECHNOLOGY CAREERS

August 9 - 12, 1988

# HISPANICS IN SCIENCE, ENGINEERING, AND TECHNOLOGY

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(SET) Careers

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**IN MEMORIAM**

**Miguel Garcia**
**(1923-1989)**

*Miguel Garcia, who passed away on September 10, 1989, was born in the Watts area barrio of Los Angeles, California, on July 29, 1923. From the very beginning of his life, Miguel Garcia - "Mike" to his friends - displayed the drive and intellect which would ensure his success.*

*Unable to speak English until he went to kindergarten, Mike Garcia came from a home where the parents devoted their energies to seeing him acquire the formal education they had not had. When Mike was in the fifth grade, his father and some friends employed two graduate students from The University of California at Los Angeles to tutor their children in proper Spanish. The parents were similarly eager to see that Mike would master the English language and excel in all of his academic studies. However, Mike's father arranged for his son to have practical education, too: working in the Compton and Long Beach fields so that he would know what it was to work with his hands and to earn some money.*

*At first Miguel's teachers were unaware of his growing potential, and most were not concerned. At last one teacher recognized the young man's quality and encouraged him to pursue his dreams. Fired by her faith in him, Miguel Garcia, the boy from the barrio, studied algebra, became president of the student body, and graduated from high school in 1942. After service in the Army, he earned a degree from Loyola Marymount University in Los Angeles. There was no stopping him now! In college he enrolled in the U.S. Air Force ROTC and earned a commission. Then he added a Master's Degree in Business Administration from Syracuse University. He married his childhood sweetheart, and they raised eight children, one of whom became a Dominican priest in Chicago.*

*Retiring from the Air Force in 1976, Mike founded the Colorado Minority Engineering Association (CMEA) in 1978, serving as its Executive Director from 1980 until his death, and singlehandedly raising most of the funds for the program. Often he waived his own salary in order to keep the program going.*

*We salute his heroic and unselfish life, a life in which he showed great compassion for other people. Talking about his brainchild, CMEA, and his efforts on behalf of minority education, he said, "Somewhere in my life I took inventory and decided there were certain things I wanted to see done in my lifetime. I decided [to] get them started."*

*John Q. Taylor King, Ph.D.*
*CASET Director and Chair*

# A VIEW OF HISPANICS IN ENGINEERING AND SCIENCE

**Jose R. Perez**
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**Vice President, 1988**
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*Mr. Perez, a native of Laredo, Texas, received his bachelor's degree in Business Administration/Marketing from Texas A&M University and his master's degree in Public Science Policy and Administration from the University of New Mexico. His career with the NASA/Johnson Space Center has covered a span of 22 years, during which he has served as Equal Opportunity and Contract Compliance Specialist, and Deputy Chief of the Equal Opportunity Programs Office. In late 1988 Perez joined SER Jobs for Progress of the Texas Gulf Coast, Inc. as Executive Director. He remains active in the Mexican-American Engineering Society.*

In order to be very effective in dealing with the Hispanic problem of dropouts, unemployment, and so forth, we need to involve government. We also need to involve industry, because they are part of the whole scenario that can have an impact. And we need them desperately.

This is not just a Hispanic problem. We have to view it as a national problem, not only for Hispanics, but also for the whole engineering and science fields. In fact, we need to look at the global markets. For instance, it has not been very long since we - Americans - were the masters of technology and the providers of automobiles, steel, and television sets to the whole world. All that has changed. Just now, we are getting to see some of the American companies in the steel industry, for instance, refurbishing their equipment and updating it, going into robotics, so that they can compete with the rest of the world. We have lost our competitive edge. The same thing has happened with televisions. A lot of the electronic equipment has been invented in this country. However, when it comes to manufacturing, we have not had the engineering or technological skills to be competitive with other countries. As a result, most of the televisions we buy are being imported. We have only two companies in the United States right now that are manufacturing televisions. We invented the VCR, but we do not have a single American company that is producing VCRs in this country. We have a lot of competition, and it is just the beginning. It is going to get worse.

As we look at the statistics, we find that the number of engineers that we are producing in this country is smaller than the number of engineers produced, for instance, by Japan. At this rate we are going to have big, big problems in the future. Japan's land mass is about 4 percent of the land mass of the continental United States - it is a country smaller than the state of California. Yet 20 percent of Japan's graduates received degrees in engineering, whereas

only 6 percent of our graduates go into engineering. That 6 percent equates to about 60,000 engineers in a year, as opposed to Japan's 23 percent, which equates to more than 65,000. Now, when you compare us with countries like the Soviet Union, the balance is even more tilted in their favor, because they are graduating 300,000 engineers per year. I am not even going to talk about some of the other European countries with which we are competing in high technology. As we look at the problems that we face today, we find that many, if not most, have to be solved by scientists and engineers. We have heard about energy today - one of these days we are going to run out of fossil fuels and other finite raw materials. We are going to have to utilize solar energy, geothermal, nuclear, and other types of energy. Astronaut Franklin [Chang-Diaz] alluded to this in his speech this morning. We are going to need more engineers and more scientists to do this. Where are they coming from? That is the big question!

Of course, the loss of industries to other countries has affected our balance of trade. We are all well-familiar with the imbalance of trade that we have. We are importing more than we are exporting. What does that cost? It costs lots of jobs. Not only that, but these countries that are selling their goods and services to us are using their profits and coming back into the country to buy our real estate. It is happening right here in Houston. Some of the major buildings downtown are being bought by foreigners. They are buying our banks - they are even buying our companies. The auto industry has gotten to the point where it needs a joint venture between Japan and us so that we can produce their cars here in the United States. We adhere to the concept of free enterprise. I am sure you are all aware that we have come to an agreement with Canada which allows products duty-free entry between both countries.

Yet, on the other hand, just last week we got approval from Congress for a trade bill that will permit the United States to set quotas and tariffs on countries that are not allowing some of our products in. That will solve some problems, but that is just a band-aid type of solution. The real answer is that we have to become competitive - we need to produce the products at a good price and in good quality. Some of these bills, like the trade bill, have made us a lot of enemies. The Japanese are very disappointed. They are very angry with us because we are not going to allow as many of their products to come in. The people that stand on free enterprise are very unhappy. It is very difficult to keep everybody happy. The best way to cope with this problem is by having that competitive edge - being able to compete with the whole world.

***"50% of Hispanics are dropping out of school before they finish high school, a statistic which is atrocious."***

I was looking at some statistics that indicate that by 1995 the number of jobs for scientists and engineers will increase by 40 percent. The number of jobs for all other occupations will increase by only 15 percent. That is where the money is. That is where the jobs are going to be. Talking about economics, let us talk a little bit about Hispanics now. I came across statistics that show that 50 percent of Hispanics are dropping out of school before they finish high school, a statistic which is atrocious. We have the highest drop-out rate of any group in the United States. The dropout can hope to earn something like $8,300 a year, on the average. An individual who finishes high school can hope to make something like $12,500 a year. Once you have graduated from college, the average salary is about $25,000 a year. However, if you can get into engineering and science, the average can run into the $40,000 bracket. We know that the jobs are going to be there. We know that they are needed. The companies today are vying for engineers. Today an engineer can earn something like $28,000, fresh out of college.

I am going to quote some of the results from a recent symposium dealing with the shortage of scientists and engineers: "The United States will suffer a serious shortage of

scientists and engineers during the rest of the twentieth century unless trends are reversed." The shortage is likely to occur at a time when America faces great technological competition from Japan and other nations. There is evidence that we are facing a real human resource challenge in America today in the future of the scientific and engineering profession. So not only do we, as Hispanics, have a problem here, but the whole country has a problem. It is going to be a bigger problem if we do not start activating programs that will be successful in not only attracting youngsters into engineering and science, but in holding and keeping them on that track. So far, Hispanics comprise 2.4 percent of engineers, 2.7 percent are going into computer and information sciences, and 2.5 percent in mathematics. About 10 percent of our students are going into languages. There is nothing wrong with that, but the work of the future is in engineering and science.

*"The work of the future is in engineering and science."*

I have not even touched on aerospace. As you may well know from the newspapers, NASA has just been funded some $900 million to start on our Space Station project. This is a long-term project. We are just starting with the design work. McDonnell Douglas had been awarded the contract, but when the funding did not come up a year ago, they had to lay off about a third to a fourth of the workforce they had hired. Experts from this area had been hired to work on the Space Station, and now the company had to let them go. Those people could not wait around until we got funded for the Space Station. They have gone on to do other things. One of the big problems that we have in aerospace today is determining how we are going to meet the programs of the future, not only the Space Station project, but also other programs that we have on paper and that we need to do. We are talking about a Moonbase, eventually. We are even talking about joining hands with the Russians and going to Mars. But where are the experts to implement all those programs going to come from? It is going to be a very serious problem for all of us in the space industry. We are talking not only about Hispanics, but about all scientists and engineers.

Let me talk now a bit about the Mexican-American Engineering Society (MAES) and what kinds of things we are trying to do to alleviate this problem. Our acronym, MAES, is very close to *maize*, and I think it serves a symbolic role. It tells something about what we want to do because maize, which is corn, was the foundation, the staple, that allowed the great civilizations of America to prosper and flower. Some 5,000 years ago, the Olmecs came upon corn and domesticated it, and that provided them with food so they could settle and not have to be nomadic anymore. The Olmecs established the first civilization in the Americas. They are called "the mother culture of the Americas." Some 20 different civilizations branched out from those Olmecs. The first thing that they had to do was to have a staple food before they could produce or set up the foundation of civilization. That is how we selected our name, which equates to maize.

We established MAES in 1974 in California. A local chapter was established here in Houston in 1978. We are organized into three different tiers: the professional level, the university and college level, and the high school level. We work very closely with the University of Houston and with Texas A&M University. They have chapters there, and we are helping them with scholarships. The main purpose of our organization, however, is to assist Hispanic youngsters into the careers of engineering and science. We do this in a number of ways. We go talk to them at the high school, middle school, and even at the elementary school level, about what engineers do. Most of our membership is aerospace-related, so we have a chance to talk to them about space and what kinds of things we do here at the space center. We also help them with scholarships. At the high school level, we have a very strong chapter at the magnet school for engineering, which has over a hundred members. We are establishing

chapters at other high schools, such as here in South Houston. Now we want to expand our activities to let these youngsters know what the future holds, what kinds of opportunities there are, and to encourage them to seek those careers.

*"We provide funds for college chapters for their expenses so that they can visit the high schools and tutor the students needing help in mathematics or science."*

We have a program called PACE, which is Promotion and Awareness of Careers in Engineering. We have received a grant from NASA for the last four years. We provide funds for college chapters for their expenses so that they can visit the high schools and tutor the students needing help in mathematics or science. They also participate in career days and help with space projects for space fairs. This is funding that we have been able to put to good use. A lot of students who have participated are now going to college and are pursuing careers in science and engineering. It helps the high school students and also our college students because it provides them with opportunities to develop leadership qualities. For example, they can plan programs and prepare different projects in which the students can participate. We leave the program pretty much up to them, with some monitoring by the professional group.

We give scholarships, and this year we are going to be giving out some $9,000 in scholarships. One of the things that we want to do is to find out how effective our program is. It is very important for us to see how we may be able to improve our program. We are conducting a study, and have a questionnaire to be filled out by the participants at the high school level, on the space program. We are asking them questions such as how many mathematics courses they have taken, what kinds of mathematics courses they are taking now and have taken in the past, and whether they plan to take the SAT (taking the SAT will indicate they plan to go on to college). We also ask them whether they participate in career days, science fairs, committees, and other activities. We ask them whether they have relatives in engineering and how they found out about engineering. Were we the first ones to talk to them about engineering opportunities, or did they find out from somebody else? In other words, we want to know what it is that is motivating them to go into engineering so that we can find out what kinds of things we need to do to expand that process.

We also ask them about our own program of tutoring and counseling, to see how effective that is. We are doing a very specific analysis of our own program so that we can improve it in the future. We are going to be studying our scholarship recipients. A lot of times, students going to college have grandiose ideas of what they are going to be doing. They have done well in high school, and we have given them scholarships. Then we lose track of them and do not know whether they have continued in engineering and, if not, why not, and what kinds of barriers they have encountered. This is another area we are studying to see how we may be able to help.

In conclusion, let me state again that I hope that we get other very important areas of the country involved in this process. I know that the Department of Defense is very interested in this. What I am seeing on television and in newspapers indicates that many people are concerned about the problem. I hope that we can find some solutions, some ways in which we can help. I would like to leave you with this thought: A human life is like a single letter in the alphabet - it can be meaningless, or it can be part of a great meaning.

Thank you very much.

## QUESTION/ANSWER SESSION

Question from the floor:

There is a local chapter in Odessa [Texas], right?

Yes, that is correct.

Question from the floor:

Would any of these functions, as far as MAES is concerned, provide some kind of endowment? For instance, as a continuation of enrichment courses (college or high school) to be part of an eventual type of financial assistance so that we show the students and give something like a scholarship fund?

Well, I hope that we grow enough that eventually we will to be able to do those kinds of things. Right now, our annual banquet is our fundraiser. The money that we travel from that banquet will go eventually toward scholarships. We are also helping fund students at Texas A&M University who are going to some of the summer programs. There are some students who do not have the hundred dollars necessary to get to Texas A&M to participate in the two-week program. They participate in mathematics courses, but there are some students who do not have the money to be able to go, and we are helping fund some of those students.

Question from the floor:

Does your organization have some sort of industrial advisory council? Our organization has one made up of different executives of different companies who give us advice and are willing to give us funding according to the program, whether we like it or not. We just started that this year, and it has been very successful as far as leading us in the direction of what types of programs are offered.

No, we do not have advisory councils. We are working on several projects at the national level, and that is one of them.

Question from the floor:

You started MAES in 1974. In those long years, have you seen any growth or effects in terms of what you have done? How does that influence some kind of ripple effects?

Well, we like to think that some growth has occurred. Right now, we are conducting the study that will give us the statistics to see whether we really have achieved what we think we have achieved. This past year, we participated with the Houston Hispanic Forum, an organization that brought together to the University of Houston about 4,000 students from all over the city and surrounding area for presentations on engineering, medicine, law, and other careers. This is only the second year that we have done that, and it is primarily for Hispanic students. It has been very well-received. It is something that is needed.

I do not know whether counselors know enough about engineering and science. Let's face it: Most of them have been educated in social studies, so a lot of them are not as well-versed

in engineering and science - what science takes and what kinds of opportunities there are. We tend to blame the counselors, and rightly so, because they should keep up with what is happening, what opportunities we have, and what needs we have. I do not know if that is the problem, but for some reason, the information is not getting down to the students. Somebody mentioned that he came across a student who graduated tenth in her class - tenth in a group of 300 - yet no counselor had ever talked to her about going to college. So the school system is not providing the information. Of course, the information should have been provided at the middle school level. But even at the high school level, the graduating senior level, the word is not getting through.

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# ENLARGING THE POOL OF POTENTIAL HISPANICS ENTERING THE SCIENCE, ENGINEERING, AND TECHNOLOGY CAREERS THROUGH FAMILY SUPPORT AND EDUCATION

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I am very pleased to be here, not only to inform you about the AVANCE organization, but also to speak to you about the importance of early childhood education and family support as the basic foundation for enlarging the pool of potential Hispanics entering the fields of science, engineering, and technology (SET).

Today, 40 percent of the Hispanic population drops out of school, and of those who graduate, 25 percent are illiterate. The problem will only worsen, since it is projected that the Hispanic population will double in size by the year 2005 and become the largest minority group in the country. It is projected also that by the year 1990, Blacks and Hispanics will constitute 30 percent of the U.S. population. Today, in states like New York, California, and Texas, where there is a concentration of Hispanics, minority children already constitute the majority.

This nation, and especially those states with a concentration of Hispanics, cannot afford not to act. One must do something about the problems that Hispanics and minorities face, not only for altruistic reasons or as a matter of social justice, but also for economic reasons and for the preservation of our democracy and freedom.

The problems that Hispanics face begin early in a child's life. Many children come from poor families with limited environmental stimulation and from homes where the parents do not realize the important role that they must play in the child's educational process.

Let me begin by sharing with you some basic principles of education. Burton White, in his 16-month research study (White and Watts, 1973), found that all children, regardless of family environment, seem quite similar during the first year of life. However, by the age of two, one can begin to see differences between children and can determine which ones will be the most competent. The parent, as early as the first year of life, has a great influence on the child's physical, social, emotional, linguistic, and cognitive growth and development. By the age of three, a child begins to form morals, values, and attitudes. This is the time that the foundation for learning is being firmly set. A renowned educator, Dr. Benjamin Bloom, stated that by the age of four, a child will have learned half of what he will have learned at age 17. If the child's foundation for learning is strong early in life, then he or she has a greater potential to build on that foundation. But if it is weak early in life, it tends to be more difficult to learn the concepts and skills taught in school, especially in the SET fields.

***"I will venture to say that most of those who succeed academically - and who make it through the special SET enriching programs - come from strong families where education was stressed and supported in the home."***

Therefore, if we want to begin to change the drop-out statistics among Hispanics and enlarge the SET pool of Hispanics, the intervention must begin in the home during the child's formative years - before the child is 3 years old. During this period, language development is critical, character and personality develop, and the foundation for learning is established. In addition, it is a period when children can develop a positive self-concept, and when they can learn not only to love themselves but also to love their families and, eventually, humankind. Based on the early interactions that children have had with their parents, it is also a time when they can learn to trust and respect others, when their natural curiosity can be nurtured, and when the rudimentary skills for independent analytical thinking and problem solving can be developed.

There is a relationship between thought and language. Boris Vygotsky, the psychologist said, "That intelligence is the point where language and thought meet." Can one develop higher-level thought processes without an emphasis on a purposeful attempt to stimulate meaningful language?

If learning begins early in life, then we can say that education begins in the home, and that the child's first and most important teacher is the child's parents. But who trains the parents to be effective? Family support and education programs like AVANCE help parents understand the important role that they play in the educational process and provide the needed support to overcome the obstacles that impede effective parenting. Being an effective parent does not come naturally. One has to learn the skill and have the opportunity to observe proper role models. Parents must feel good about themselves so that they can, in turn, help their children feel good about themselves.

The American family has changed tremendously in the past two decades. Today, approximately 70 percent of mothers with school-age children work outside the home, full- or part-time, as do more than half of the mothers with preschool-age children. Increased mobility and the breakdown of the extended family has affected greatly the stability of the family and the way parents rear their children. Many families live in neighborhoods, subdivisions, condominiums, and apartments where they hardly know their neighbors. Many lack appropriate

role models to guide and nurture their children adequately. One of every two families ends in divorce. Even though the American family has changed so much during the past two decades, government, the schools, and the workplace have not effectively responded to the changes.

Nearly one in four children is poor. There are eight million more poor Americans today than there were a decade ago. Half of the children who live in poverty live in single-parent families, and half of single-parent families fall below the poverty line. The conditions are worse for minorities: Fourty-three percent of Black children and 38 percent of Hispanic children are poor. Nearly 50 percent of the poor are paying half of their income for rent and utilities, and nearly a million more units of low-income housing disappear each year. The welfare benefits have lost a third of their value over the last 15 years. If these parents do not receive the support and assistance that they need to help them nurture and guide their children, then their children will not be able to learn and to develop as well as they should.

The traditional schools are unable to address the complex set of problems that the children bring to the school. The schools need to be modified, and the families need education and support if we are to help Hispanic children succeed in school and in life.

In August 1988, the Chief State School Officers Summer Institute in Boston placed early childhood education and parent education as their number one priority. They realized that there must be a partnership between the school and the home, and that the schools need to be modified to address the needs of the changing family and the high-risk minority population. The partnership includes collaboration with community-based organizations such as AVANCE to offer parent education and family support. The commissioners discussed making school buildings available to families for day care, adult education, and job training. Other issues discussed were the possibility of schools opening earlier, closing their doors later, and remaining open 12 months a year.

The schools cannot do it alone. Compensatory programs offered to minority children are not working. Consequently, Hispanic children and other minority children are dropping out of school in disproportionate numbers, usually around the eighth grade.

One will find exceptions, but I will venture to say that most of us sitting in this room, and those who succeed academically - and who make it through the special SET enriching programs - come from strong families where education was stressed and supported in the home. Like Dr. Chang-Diaz, whose mother triggered his interest by providing a stimulating environment with science fiction books and imaginative props, we who have succeeded have had strong parental support and guidance. For my husband, too, life could have been very different, had my mother-in-law not worked in the home of a woman who talked and read to her children and stressed and supported the value of education. All that my mother-in-law learned about childrearing as a domestic worker she applied to her own children, for she knew then what she needed to do. As a result of her foresight two of her sons, one of whom is my husband, became engineers, and another is a medical doctor. Minority children living in poverty, however, may not receive this type of parental encouragement.

Upon graduating from college, I became the schoolteacher of a group of 35 first-graders from four classes, on whom teachers had already given up. The children were labeled slow learners and "vegetables," and it was determined that they were going to be retained.

I considered the job a challenge. It was not long, however, before I felt the frustration. Even though they were not vegetables and though they were capable of learning, the children were just not prepared to meet the academic demands of the school. Initially, I thought it was just a language problem, of Spanish-speaking children not understanding the English language. But I soon realized that the children were not proficient in either English *or* Spanish.

Other problems became evident. I saw a six-year-old child hold a pencil like a dagger, and some children were unable to construct a circle. Some children were not clothed adequately in the winter, others were inadequately fed or were bruised, and others had lice. I was instrumental in having a school policy changed that had kept children with lice from coming to school. These children were being denied an education because of a health problem.

These children had everything going against them. The children were doomed to fail in the first grade because of the conflict between the home and the school. The school was not designed to work with children who were not at the expected level of development. The school was not able to compensate for what should have been done early in life, or to assume the role of the parent after the child entered school.

*"Can we afford to lose even one of these children? I do not believe so. Every child counts."*

Ironically, the school assumes that all parents have done their part in preparing children prior to their entering school. Unfortunately, in many homes of high-risk children, parents who are under great stress due to economic conditions have not been able to meet adequately their children's needs for healthy growth and development and for future academic success. The children entered my class with limited language proficiency in both English and Spanish. They lacked mastery of many basic preparedness skills, and they exhibited behavior indicative of the prevalence of physical punishment in the home. Many times the children become the victims of their parents' frustration because they did not receive the support they needed. For example, when I would approach some children, they would cringe, thinking I was going to hit them.

The school system is designed for children who come from stable families that provide a lot of resources and positive verbal and environmental stimulation. Many children come to school with too few relevant experiences to be able to succeed academically. Many come from families that are not functioning well for lack of support and education. One cannot assume that all parents know what is expected of them, nor can one assume that they are stable and in control of their own lives and those of their children.

*"Many children come to school with too few relevant experiences to be able to succeed academically."*

I administered an attitudinal survey to the parents of the children I had taught for one and a half years. The results of my informal survey indicated that all the parents wanted a better life for their children than they had had, and that they knew that education was important. When asked to indicate when children start learning in life and who was the child's first and most important teacher, however, mothers responding to the survey said, "Children start learning in school, and the first-grade teacher is the first teacher." When asked the question, "What do you consider your role to be as a mother?" they responded that their role was to take care of the child's basic physical needs. They also stated that they did not know whether their children were going to graduate from high school, but that they felt that they would at least complete the seventh or eighth grade. They definitely knew that their children were not going on to college. Paradoxically, while the school assumes that the parents did their part in preparing the child for school, the parents believe that they have no part in the educational process - and the child is the victim.

All parents need support and information to help them help their children grow and develop to their fullest potential. If they do receive it, the pool of potential Hispanic engineers

and scientists *will* increase. These children will have a much better opportunity to be reared in a nurturing, stimulating environment that will help them reach their fullest potential and trigger their interest to enter SET careers. The parents would be more supportive of their children's education and the special SET programs. Even though we would desire that all children aspire to pursue these fields, AVANCE's basic goal is to help these individuals become productive, contributing members of society.

If the parents do not receive support and information in helping their children, then the consequences may be that many of the students will not be allowed to enter the special SET programs, they may drop out, or they may be asked to leave the program because they cannot "cut it." Many may drop out of school.

Can we afford to lose even one of these children? I do not believe so. Every child counts.

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# THE EDUCATIONAL ACCESS PROGRAM FOR HISPANIC YOUTH

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The idea of developing an Educational Access Program for Hispanic Youth stems from years of personal experience within the Hispanic community. This experience encompassed teaching, advocacy, and service on the boards of such organizations as La Sed and the Sabor Latino Scholarship Fund in the State of Michigan.

Michigan is located in the Midwest and is surrounded by the Great Lakes. It is known as an industrial state, because of its automobile factories, as well as an agricultural producer. Of its 9.5 million people, 1.8 percent - 168,000 - are Hispanics. Many of the Spanish-speaking families have roots in Michigan that go back for several generations. They have been employed to build railroads, to work in the factories during World Wars I and II, and to harvest crops (beans, sugar beets, potatoes, and cherries) as migrant farm workers. Many of the farm workers have left the fields for the factories in favor of shorter hours, better pay, and some benefits.

In recent years, other Spanish-speaking people have settled in Michigan. The Puerto Ricans came seeking improved living conditions and employment. Cubans who left their island homeland in the name of freedom landed on the shores of Florida and then ventured north. Refugees from Central America fleeing persecution and instability sought peace and acceptance. Mexicans made their way to Michigan as always, dreaming of an improved lifestyle and economic security. Many came to Michigan because of relatives or friends who settled in the area, or as a result of a church sponsor.

Within the state, pockets of Hispanics are scattered in several cities. The greatest concentration of Hispanic people is in the metropolitan Detroit area. The population of

metropolitan Detroit is 4.5 million, 80,000 of whom are Hispanic. Hispanic households are found throughout the city and in its suburban environs. A rather large barrio is located in southwest Detroit. It is here that many low-income families settle until their economic conditions improve and they can move to other locales.

*"The success of the Educational Access Program for Hispanic Youth is due to four necessary elements: flexibility, parental involvement, adequate funding, and a responsive faculty."*

Madonna College is a growing liberal arts college that offers all the benefits of a personalized learning experience combined with solid career preparation. Founded in 1947 by the Felician Sisters, the college has more than 4,000 men and women enrolled in 50 undergraduate and graduate majors and career programs. Located in the city of Livonia, Madonna's 49-acre wooded campus is easily accessible via major state highways.

Madonna College is recognized nationally for its enrollment of deaf students in an integrated deaf/hearing campus, and for its pioneer degree-granting in sign language studies and interpreting.

## INITIATION OF THE EDUCATIONAL ACCESS PROGRAM

Madonna College became involved in a precollege program for Hispanic youth because the college administration recognized the signs of educational neglect and the need for educational programs on all levels.

The Educational Access Program at Madonna College was born around a table at La Sed (Latin Americans for Social and Economic Development), a social service agency based in southwest Detroit. The president and the dean of the college, along with community leaders, met with a group of Hispanics who voiced their fears and problems and gave concrete examples of the seriousness of the situation.

As a result of these joint meetings, a proposal was written by the Development Office and submitted to FIPSE (Fund for the Improvement of Post-Secondary Education), an office of the U.S. Department of Education. It was funded for two years for the amount requested and received supporting funding from Madonna College.

In keeping with its mission statement, Madonna College endeavors "to instill in its students Christian humanistic values, intellectual inquiry, and commitment to serving others through a liberal arts education, integrated with career preparation and based on the truths and principles recognized with a Catholic tradition."

Madonna College responded to the expressed anxieties of local Hispanic educators, parents, and community leaders who witnessed capable youth dropping out of high school at an alarming rate. Of those who did persevere through four years of high school, only a meager 2 percent pursue higher education.

## GOALS OF THE PROGRAM

The purpose of the Madonna College Educational Access Program is to provide Hispanic youth the opportunity to acquire fundamental skills in mathematics, science, and communication. Students in the junior and senior years of high school are provided the

opportunity to increase their abilities in the use of written and spoken English and to use mathematics and scientific principles effectively. These basic competencies will become the tools for increased preparation for application and acceptance into college with eventual entry into workforce areas that have been underrepresented by Hispanics, including science education, engineering, and computer science. This program is a model with applicability to groups of learners whose educational progress has been impeded by adverse economic or social circumstances but whose potential could be greatly developed through educational access programs.

In its fourth year, the program is essentially the same except for minor changes and adjustments. With continuous efforts, the program strives to achieve the goals initially set forth for its participants:

- To develop a more positive attitude toward education than has existed.
- To continue on in higher education.
- To increase abilities in mathematics and communication.
- To increase knowledge of science-related careers.
- To cultivate the ability for students to identify their aptitudes.
- To create an awareness of career opportunities and their relation to self assessment.

## FUNDING

What has changed is the source of funding (see Table 1). After a two-year grant from FIPSE (1985-87), the Educational Access Program was funded for an additional year (1987-88) by the State of Michigan, Office of Minority Equity (OME). In 1989, it will be funded by the American Institute of Physics (AIP) through the newly established Meggers Award, a beneficial grant designed to support projects for the improvement of high school physics teaching in the United States.

**TABLE I**

**FUNDING FOR THE EDUCATIONAL ACCESS PROGRAM**

| Year | Source | Amount | Madonna College | Total |
|---|---|---|---|---|
| 1985-86 | FIPSE | $51,238 | $24,343 | $75,581 |
| 1986-87 | FIPSE | $54,550 | $23,031 | $77,581 |
| 1987-88 | OME | $49,502 | $12,376 | $61,878 |
| 1988-89 | AIP | $13,200 | $6,040 | $19,240 |

## DESCRIPTION OF THE PROGRAM

The Educational Access Program coincides with the school year. Recruiting begins in September and continues through December. The recruiting is conducted in both public and parochial high schools, through counselors and teachers, in the media, through newspapers, newsletters, and Spanish radio programs, at social, religious, cultural, and educational gatherings, and through the dissemination of bilingual fliers in stores, schools, churches, and public places. Before each series of workshops, at least 5,000 fliers are distributed.

In January, the mathematics workshops begin. A pretest that serves also as a placement test is administered. The mathematics section of the Stanford Test of Academic Skills is used, and the scores place students in accordance with their mathematics knowledge in small groups of 10 to 12 students.

Scheduling was a problem in the first year. Because classes were held on Wednesdays from 4:00 to 6:00 p.m., after the regular school fare, the students were too tired from the activities of a regular school day. Therefore, the following year, the workshops were scheduled on Saturdays from 10:00 a.m. to 12:00 p.m. The change proved to be beneficial to the students as indicated by improved attendance, and more intensive learning took place.

The Saturday mathematics workshops were held from January to March and were followed by English workshops using the same format as prior workshops. The vocabulary and English sections of the Stanford Test of Academic Skills were administered to the students. The accent of the workshops was on composition and vocabulary improvement.

The ability of bilingual students to speak and write both English and Spanish well is meaningful and significant since the majority of students speak Spanish at home and English outside the home. Too many of the students, however, speak neither language well. In terms of higher education, the students are reminded consistently that competent writing and speaking skills are essential for college survival.

Actually, the English phase of the program has been the least successful. The motivation that is so evident in the other subjects is lacking. Students feel that since they speak English daily and take an English class every year of their school life, there is no need to devote special time to it. Too many Hispanic students fail to realize that their ability to speak English does not equate with their writing competency.

> ***"The instructors are urged to treat the students as precollege students, and they have responded to that designation."***

After the mathematics and English workshops, a six-week summer school was executed according to the proposal. It was an ambitious effort to expose students to as much as possible. The intentions were good, but the program became too fractured with three weeks of career development, two weeks of human and social relationships, a sequence of cultural awareness, and an overview of engineering specialties.

Students requested solid subjects to study in the six weeks to replace the fragmented offerings. The solid subjects decided upon were mathematics, computer science, and physics, because they could fit easily into all three tracks of study: Track A, Career Exploration; Track B, Precollege Development in Mathematics/Science; Track C, Pre-Engineering.

During the summer schools of 1987 and 1988, the concentration was on physics and computer science with notable success.

Once again, pretests were administered before placement. To ensure that the students are comfortable with their classes, they are asked to place themselves in the classes for which they

feel best suited. Most are placed well. Adjustments are made, however, to accommodate the few who request it. Academic success is the end, and so tremendous effort is made to achieve that goal.

The Educational Access Program has been defined. It is not complicated or even innovative, but it is an idea that is getting positive results and is worth replicating. Students participating in the program stay in school and are imbued with a desire to learn and matriculate into college, and education takes on value for the students and their parents.

## NECESSARY ELEMENTS FOR PROGRAM SUCCESS

The success of the Educational Access Program for Hispanic Youth is due to four necessary elements: flexibility, parental involvement, adequate funding, and a responsive faculty.

*"The success of the Educational Access Program for Hispanic Youth is due to four necessary elements: flexibility, parental involvement, adequate funding, and a responsive faculty."*

*Flexibility* is a necessary element in the program since the turnover for each series of workshops is about 65 percent. About 35 percent of the applicants are former participants, but 65 percent are newcomers. We are convinced, however, that every student who attends learns something and benefits in some way. There is always a gain, never a loss. It takes a good deal of cultivation before identifying serious students. As a result, no students are ever refused admittance to the program if they are within the following qualifications:

1. They must be Hispanic.

2. They must be attending high school or must have just graduated.

3. They must indicate a desire to improve the competencies they already have.

In January 1988, 117 students applied for the mathematics workshops. A letter of acceptance was sent to each qualified student. Of these, 73 students came to the first workshop and were tested for placement. Three months later, 52 students received certificates, of whom 25 received Madonna College sweatshirts for perfect attendance. Table 2 compares the overall participation of students in the program from 1985 to 1988.

Flexibility is the key to success since a frequent turnover of participants occurs.

Another very essential element is *parental involvement* in the program. Parents are contacted by mail, telephone, and home visits. Many students are recruited through their parents, who hear about the program at church, at a meeting, at school, or from a compadre. Good rapport and open communication channels with school personnel have enhanced public relations and contribute greatly to the recruitment of students to the Educational Access Program for Hispanic Youth.

Communicating with schools is essential, too. Each participating school receives a roster of students with their pretest and posttest results, level of learning, and attendance record. Generally, the schools share the information with counselors and/or include the classes as enrichment on the students' permanent records, thus enhancing the status of the student through reinforcement.

Before initiating the Educational Access Program, Madonna College established an Advisory Committee composed of parents, educators, and community leaders. The committee serves to monitor the program and to give input to enhance its quality. The members of the committee are continually informed with updates and act as liaison volunteers between the college and the Hispanic community. There is no doubt that they have been instrumental in securing funds, promoting the credibility of the program, and establishing a link of commitment between Madonna College and the Hispanic community. This liaison results in community support, a necessity when an essentially Anglo, suburban middle-class college is attempting to implement an educational access program.

**TABLE II**

**Overall Student Participation**

| Year | Applications Received | Actual Number of Participants | Workshops Involved |
|---|---|---|---|
| 1985-86 | 175 | 140 | 6 |
| 1986-87 | 226 | 187 | 3 |
| 1987-88 | 393 | 235 | 4 |
| 1988-89 | 76 | 45 | 1* |

*This number represents only Phase One Mathematics Workshops.

Another key element is *adequate funding.* Madonna College has been totally cooperative and financially supportive of the Educational Access Program for Hispanic Youth, not only inconcept but also in commitment. Besides contributing a substantial amount of money to the program directly, the college development office has made every effort to secure additional funding from private foundations, business, and industry.

*The faculty* also plays a major role in ensuring the program's success. It is no easy task to place the right teacher with a group of Hispanic youth. The selections have not all been the best, but most of them have been excellent. The educator needs to develop good rapport with the students, understand them, appeal to their thinking patterns, and respond to their emotional and cultural needs. The instructors are urged to treat the students as precollege students, and to date, they have responded to that designation.

The classroom atmosphere is nontraditional and casual. Pressure is absent and replaced with a willingness to learn with an instructor who is patient and eager to teach, and to provide hands-on activities to clarify and reinforce physical principles or computer science formulae.

To ensure that all instructors are on the same track, they are required to come an hour before the actual Saturday classes. Content is discussed along with successful methods and student behavior, and announcements are made. A part of this hour is also devoted to class preparation, so that students have the full benefit of two hours of solid learning carefully designed and executed without interruption. These meetings serve to unify the teachers, to better prepare them for their instruction, and to inform them of noteworthy news relevant to the program of the students.

## PROGRAM EVALUATIONS

The results to date can be expressed best by the triple evaluation system that is being used. Evaluations are secured from an outside competent evaluator, the staff, and the students themselves.

Gumecindo Salas, the outside evaluator from Michigan State University, stated in his written report:

> After one year, the Madonna College Educational Access Program for Hispanic Youth can be judged successful. Without exception, every one of the stated objectives was achieved and in most instances significantly surpassed. All of the students who participated found their postsecondary education aspirations and horizons expanded.
>
> As a result of sound program direction and outstanding cooperation between Madonna College and the Hispanic community, and the various high schools, the project was able to meet all of the objectives and to achieve the projected outcomes.

Enthusiasm, motivation, and the rapport between the faculty and students resulted in a program that was able to achieve the expected outcomes as follows:

- 75 percent of the Hispanic youth enrolled changed their attitudes toward learning and increased their education expectation level.
- 100 percent of the seniors identified a college or university that they would be attending in the Fall. The initial projection stated in the proposal was 65 percent.
- 70 percent of the students enrolled increased their mathematics understanding and skill level.
- 70 percent of the students working closely with the faculty improved their ability to comprehend and analyze reading material and to compose assignments effectively.
- 100 percent of the participants demonstrated an increase of knowledge in science-related careers. This came about in the classroom through Hispanic guest speakers currently employed in the scientific field, and through the assistance of a group of Hispanic professionals with Saturday classes. These role models were members of the Hispanic Advisory Panel of Michigan Bell Telephone Company and the Society of Hispanic Professional Engineers.
- 65 percent of the participating youth indicated an increase in their ability to identify their aptitudes, abilities, interests, and values and to relate these characteristics to career plans and choices.
- 80 percent of the participants showed an increase in their awareness of career opportunities and their relationship to self-assessment.

Most of the students expressed an interest and competence to learn about careers in the science areas. It is gratifying to find students who previously had never considered a science-oriented career now talking about becoming a civil engineer, a doctor, or a health professional.

*"The Educational Access Program for Hispanic Youth has also made a significant impact on the parents, helping them to realize that education does make a difference in attitudes, employment , and life."*

In evaluations of special or supplemental academic programs in which the subject matter is directly related to course content being taught in regular academic programs, it is difficult to record a true and an accurate assessment of the material learned and the corresponding academic growth of the students. So much of what is learned in one setting enhances the opportunity for achievement in a complementary educational setting. Supplementary and complementary academic support programs help students to compete more effectively in regular classes.

As a result, evaluation accuracy becomes more difficult with attempts to separate and evaluate what is learned specifically in an access program or to compare the new learning with what is learned in a regular classroom. However, by combining both experiences, students are able to perform more confidently in a regularly enrolled course in high school.

In any learning experience, the affective domain is perhaps the most difficult area to evaluate. Yet it is the major and dominant factor that influences learning. Therefore, it is important to assess a program for its affective as well as its cognitive learning aspects. In the case of the Educational Access Program for Hispanic Youth, consideration has been given to both aspects by the evaluator as critical and important in reviewing the impact of the program on the students.

The staff evaluated the program in relation to student progress, classroom enthusiasm, and attendance. The overall response was positive and one of endorsement of the pedagogical principles of the program. Generally, the teachers lamented the irregular attendance on the part of some participants because it hampered learning considerably. Every teacher dreams of every student's learning to maximum capacity. This ideal is never realized for all students because of social and family responsibilities. The attendance is voluntary, and the student's presence there is based on his or her determination to improve the skills already possessed. A student is urged to continuously attend. If regular attendance does not occur as it should, the director concludes that the student still gains from each class attended.

The students themselves completed questionnaires and candidly rated the program and their instructors excellent on a 5-point scale. The respondents suggested the incorporation of Spanish language study and science classes other than physics.

The Educational Access Program is in progress for the fourth year in 1989 through funding from the AIP. The curriculum includes mathematics and physics, and the general format is used as previously. Minor adjustments are made to improve the quality of instruction and enhance learning.

To date, the program has been instrumental in placing 81 seniors in college. The following table (Table 3) cites the numbers of senior high school students participating in the program. Further, more than 257 high school students in grades 9 to 11 have increased their knowledge and gained skills to have them become better performers in their regular mathematics, English, science, and computer classes.

The Educational Access Program for Hispanic Youth has also made a significant impact on the parents, helping them to realize that education does make a difference in attitudes, employment, and life. It does influence future financial stability.

**TABLE III**

**Participation of Senior High School Students**

| Year | Total Participants | Seniors | College-Bound Seniors |
|---|---|---|---|
| 1986 | 50 | 22 | 20 |
| 1987 | 50 | 28 | 26 |
| 1988 | 50 | 40 | 35 |
| 1989 | 25 | 0 | 0* |

*The AIP program wants minority participants in grades 9-11.

The program has assisted in shattering a few myths about Hispanics believed by secondary school educators. Yes, there are capable Hispanics who can and do learn. Yes, there are determined Hispanics who are willing to give up a good portion of their Saturday to improve themselves. Yes, there are Hispanics who are ready to ride a bus to a suburban college for six Weeks to become better educated.

Yes, the time is now! In the four years of its existence, the Educational Access Program has made tremendous strides toward educating Hispanic youth. In terms of the need, it is a minuscule effort that calls out to be replicated by institutions throughout the nation.

★

# THE CRISIS IN MEDICINE:
## Lack of Minority Involvement

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To those of you who were not yet around, professionally, in the 1970s, the things happening today with our discussions about getting minorities into higher education is a repeat of those times. In the early seventies, there was a move to bring minorities into many different professions. At that time, I was a young assistant professor at the University of Minnesota School of Medicine, and I was involved in evaluating and putting together programs at the national level at the National Institutes of Health and also within what was known as HCOP, Health Career Opportunity Programs.

Basically, ladies and gentlemen, what is happening nationwide now is the same thing that happened in the early 1970s. A real sensitivity and commitment toward education of minorities is appearing again, and I feel some of the same models that were used in the seventies will be used and repeated here. The motivation now is different; it is more political. In the seventies, it was more a "bleeding heart" liberal commitment to get minorities into health care delivery fields and into higher education. Today, it is more of a political reality. As you have heard over and over again, we - minorities - are increasing in number, and all of a sudden the politicians are scared. Those of us who are getting up in age want to make sure somebody is

there to support our Social Security when we get there - you have to be practical about these things.

You have heard two speakers this morning. You heard one speaker talk about what is happening in terms of parental support of students, even before they enter school. You have heard the other speaker talk about what is going on in college. Our first speaker talked about organizational programs. I come from the School of Medicine, and so where I am coming from is, depending on your perspective, either the beginning or the end of an educational process. I think that the salary levels for faculty are arranged in the wrong order. We at the medical school level are paid the most, and those who teach kindergarten, first, second, and third grades are paid the least - and it should be the reverse.

*"You have to train the young students of today to become part of the infrastructure, which means that they have to become part of the research scientific community."*

We have taken the students who are usually highly motivated, articulate, and very aggressive. Basically, we really just have to hand them a book and say, "Here is the material. We will give you a test at the end of a week." On the other hand, you have grammar school, first-, second-, and third-grade teachers who have to work very hard with students, their minds and mentalities. It is very important for people to realize is that those of us in higher education are motivated by research inquiry. We are not motivated to be good teachers. Some think that, when students get into college or go on to medical school or graduate school, there will be supporting networks in place. But they are not there, because we, as faculty, think that students are motivated, articulate, and willing to learn. If not, then we will flunk them.

We are not rewarded for teaching excellence in most universities. There are some great universities in this country - but why are they acknowledged as great? Is it their teaching expertise, or their research? It is their research. My policy has always been, instead of fighting this point, to realize right off the bat that that is the way things are. You are not going to change the academic institutions of this country. You have to train the young students of today to become part of the infrastructure, which means that they have to become part of the research scientific community.

This is very foreign to many minority students. My father was a welder. Both of my parents, I think, finished fifth or sixth grade. Both came from Mexico, and neither one knew anything about college. To go to any minority group and say, we are going have you get involved in research, they do not know what that means. Parents do not know what that means. One of the speakers was talking about dehydration and diarrhea. People can relate to that easier than they can eventually to something called research. But what motivates us as faculty is research, and it has nothing to do with teaching students.

You are talking to a medical school faculty person who actually is a Chicano who knows the system at both ends. Those of you who go to scientific meetings - we do this all the time, right?

One of the points I would like to make here is that the medical schools in the United States are facing a problem. The problem is twofold: the total number of students enrolled in medical schools throughout the United States and Puerto Rico, and the total number of minorities involved - in this case, Hispanics. Only 1.7 percent of the total number of medical students in the country are Hispanic. This is a point those of you working with minority students should be aware of.

In medical schools we are facing another crisis. The crisis now is that there are not enough students applying for medical school. The number of students applying for medical

school is down, and the number of minority students applying to medical schools is even further down. Many of the sharp students in this country now go into other careers, and medicine is facing some real problems. So I am telling all the Hispanics, American Indian, Black, and Asian American students that if you are interested in going into medicine, now is the time. The credentials that you need are not as great as they were four or five years ago, and there is a good chance of getting in.

But there are a couple of real problems here in the number of faculty in the medical schools throughout the United States who are minorities. If you have a pie diagram showing all the medical school faculty in the United States, this little part represents all the minority faculty in the United States. And most of that sliver comes from Morehouse, Howard University, and the University of Puerto Rico. Most of them are not at the major medical schools in this country. There is a tremendous need for minority faculty to be in the schools of medicine throughout the United States, whether M.D.s or Ph.D.s. This just breaks it up for you in terms of showing you the kinds of inequities that we faced in 1970 when we first got involved in the programs. The inequities exist to this day. After 18 years of support by the federal government in trying to get minority faculty and minority students into health care delivery professions, we are no better off than this.

Now I want to bring out a couple of points that are very important. My area of research deals with temperature regulation. I do a lot of research up in Minnesota dealing with what happens to people when they get cold. We bring in a lot of monies from the Department of Defense dealing with hypothermia. The point I want to make is that what we have done over the years is to take every minority student we can and introduce them to scientific inquiry at a very early age. We, as medical school faculty, are driven by a research question, and we want the students to get turned on to life-long learning. Everybody talks about life-long learning, but if you talk to any young Hispanic kid he will not know what that means, until he sees you actually working in a laboratory.

*"So I am telling all the Hispanic, American Indian, Black, and Asian American students that if you are interested in going into medicine, now is the time. There is a good chance of getting in."*

In 1976, the first Western Regional Working Conference on Ethnic Minorities and Health Professions was held, in which the basic concern of Blacks and Hispanics at the time was to determine how we were going to get minority students into graduate careers. The point I made at that time in an article motivating faculty in administration to meet minority student needs was that one has to get the minority student into the laboratory with the faculty - to get them involved in research and scientific inquiry. It is not enough to have a student become conversant in calculus, biology, physics. We do not stand a chance, otherwise - that has been my thesis for years. If you take a look at the total student population at the University, there is the Anglo population, the Black, Asian American, American Indian, and Hispanic populations. This is typical for the entire United States, and it has not changed much in at least the last 15 to 20 years that we have been monitoring it. We have been unsuccessful in really addressing this problem.

I welcome those of you who are just now getting into the area, and I want to tell you that there will be a lot of highs and a lot of frustrations. Minority programs at an academic institution are very controversial because there are many things that go into what are considered minority programs, and because there is not a quick fix. You have a multifactorial kind of problem with minority programs. You can have the community involved, if it is a community that is very concerned about programs involving their children. Then the president gets

concerned and then the vice-president gets concerned and then the deans get concerned - but the department chairman says, "We are interested in research. Take care of the community some other way." The faculty are concerned because many times they feel that minority programs tend to diminish what they want to accomplish, and this concern is very real. Faculty members really want good students, and it is an exceptional faculty person who is going to put in the additional time to work with minority students. There is a need for financial support for these minority programs, and the programs that we have in place in Minnesota - I am sure that this applies to the ones most of you have in place - are dependent on soft funds. Those of us who have been running minority programs for years have had to go after money year after year, and we have no sense of continuity. Politically, minority programs are obviously very high priorities; they have been, and they are going to continue to get hotter. Political support might be one of the greatest things we have to keep minority programs alive.

***"It is imperative to realize that if a program is going to survive in an educational institution, it must have the support of the faculty. You cannot legislate faculty to get involved with minority programs. They have to really want to do it ....."***

Some faculty members really support minority programs on the basis of an educational-philosophical approach. They feel it is very important to get all the way down to the third and fourth grades. Then there are others who feel that universities do not have much to do with minority programs - that they should just "take the best students and thank you very much." It is hard to quantify the effectiveness of minority programs in terms of making them respectable to the faculty. It is very hard, and that is why I have been asking the speakers about their control groups because we ourselves have difficulty in quantifying how effective we are. Minority programs are difficult to integrate and coordinate if you are working with *one* minority group, Hispanics, Blacks, or whomever. If you want to get involved with several minority groups, then it becomes a little bit more difficult.

I think that for minority programs, for those of us in this room, there is no easy answer, nor will there be one. A point made by an earlier speaker is that it takes a commitment of all of us with the understanding that it will be a long time before we see some fantastic results. Our minority program centers on short-term and long-term goals, the short-term goals from when we initiated these programs. Eighteen years ago, it was imperative to track faculty and students who were going to succeed within the first five years. We gave ourselves five years. Second, we wanted to promote a tradition of success and we wanted to have scientific seminars dealing with educational aspects, and dealing with our programs. We also wanted to attract additional financial support. So when we set this up, we wanted to find the faculty who were interested in working with minority students and find the students who wanted to come into the University of Minnesota and eventually go on to medical school. We wanted to have a tradition of success, and that success meant we wanted to have minority students presenting scientific papers, minority students going out and recruiting other minority students, and we wanted to be in a position to attract additional financial support. Our long-term goal was to establish a positive national and international image concerning minority programs and increase the number of minority faculty and students at the University of Minnesota, specifically at Duluth.

Our system centers on this paradigm. First, we made a commitment very early on, especially up in northern Minnesota, to work with the communities. It meant that we would have to always work with the community, and that carried with it a mixed blessing. The mixed blessing was in terms of political support. The community was always there if we ran into financial trouble. The negative side was that at times, they wanted to institute their own

programs because they felt that the faculty were too heavy-handed in the kinds of standards that we wanted. That led to what I used to call, "some very positive creative tension" among the faculty, the American Indian community, and the Hispanic community in Minnesota.

There is not an easy answer. This model involves working with faculty, staff, and students. It is imperative to realize that if a program is going to survive in an educational institution, it must have the support of the faculty. You cannot legislate faculty to get involved with minority programs. They have to really want to do it - without faculty support, I will not even try it because the students will get lost.

***"..... everybody goes after the same students."***

We at Minnesota involved a number of campuses: the Duluth campus, a state college called the Bemidji State, the University of Minnesota Morris campus, the Minneapolis campus, the College of Saint Benedict (a private college), and the University of North Dakota. The University of North Dakota had a very interesting program 15 years ago, in which they brought in American Indian students and their families. After a three-year period, full support of the federal program fell through, but they had the same idea of a previous speaker of bringing the family actually into the University of North Dakota to support the student.

Recruitment has always been and will continue to be a major part of these programs - and I have heard that said over and over again. There are a couple of points about recruitment that I think need to be addressed. One, many times there is no coordinated effort, and everybody goes after the same students. Two, there is no database that I am aware of for minority students, in any state. There are numbers here and there, but how many are going to the various colleges and campuses in and around a particular area? We attempted to actually track that with our model. We wanted to coordinate all campuses and have a database of all minority students. We wanted to coordinate the effort with the state universities and community colleges, recruit students from high schools and colleges, and establish a stable financial base.

We have been singularly unsuccessful in establishing a financial base. All the programs I am going to show you have been on the basis of soft money. The University of Minnesota this year made a commitment to support some of these programs, but again that is dependent upon political whims across the state.

We have a number of programs that we put into place that I consider in some ways successful. I will give you their strong points and their weak points. Our first program, which was supported by HCOP, Health Career Opportunities Program, has been in existence 18 years, and so has the Native Americans Into Medicine program. We use that acronym so that we can get funds allocated for American Indians. In this program, we have had Hispanics, Blacks, and Asian Americans involved in terms of getting them into health care delivery areas. It was started in 1973, and it started at the high school level and went to the college level. These summer courses were taught by medical school faculty. Since then, 344 students have attended summer courses. The course was a six- to eight-week program that involved anatomy, the favorite course of the minority kids. They loved to do the dissection of cadavers. That course was always a turn-on - gross anatomy for minority students. Their next favorite was exercise or sports physiology. A lot of minority kids loved to get involved in sports, and that became one of their favorite areas.

The course the students did not like was biochemistry. Medical students to date do not like biochemistry, and minority kids are no different. Of the 344 students who have attended these summer courses, 45 are now physicians.

That is a tremendous record, I thought, until we ran our controls - I have been asking the question about controls. We had another group of students we did not accept into our summer courses, and analyzed the data for them, and approximately 20 of them went onto health care delivery professions - not all as physicians, but nevertheless a significant number. If you do statistical analysis, there is not a significant difference between this control population and the students we did accept. I argue, "Well, we got more in our group that were physicians." But somebody said, "Yes, but the others went to nursing, pharmacy, and other areas, and those students went on by themselves." I do not know whether we really had a direct impact or not.

Question from the floor:

Does that mean that they were going to make it anyway?

There you go - I don't know. I want to tell you one thing that is very important about the community. There are times when we as medical school faculty are very hard-nosed, and if the student does not do well after one or two sessions in our summer program, we bring them back every summer for a couple of years. The summer is meant to expose them to medical school and then to give them some idea about research inquiry.

We had one student, a very beautiful woman who was beaten up by her husband. She left that husband, had another relationship, and that person also beat her up. Nevertheless, that woman, for three years in a row, kept coming back and taking her summer courses, had a child, and went away to the University of Minnesota at Morris. My community said, "This student is going to make it," and I kept saying, "There is no way this student is going to make it. She has been beaten up by three different husbands, she has a child, and she is on some type of support." She came by one day with a black eye and said, "Dr. Pozos, I'm going to make it. You just got to trust me." Today, she is an intern and practices internal medicine in Minneapolis. To me that is a success.

I think we helped her, but did we help all these other students? I think that really urges all kinds of controls in any studies we do, to demonstrate what is really happening. But whether or not we do controls, these programs are important. We have to help these people - I agree about that.

Minority Access to Research Careers (MARC) is the program that has the greatest potential. It is funded by the National Institute of Health. It takes minority students and puts them in the research laboratory and funds their tuition, and their board and room for two-and-a-half years, and if they do well, it will fund them in graduate school or in medical school.

We have this program at the University of Minnesota in Minneapolis, at UM-Duluth, and at the College of Saint Scholastica. It started in 1978. We have had 40 American Indian students involved in various biomedical research careers, and right now, we have three American Indian Ph.D.s, all in biomedical sciences. It is a tremendous model and a very positive kind of program. It funds the faculty who do the research, it funds the students, and it has been funded to approximately $1.75 million.

Question from the floor:

Is that only for students going into medical school or medical careers?

That is right; however, you can define that in many creative ways. If a student is going into psychology, we fund that student - it does not just have to be biomedical careers.

It can be biochemistry, physiology, it can be psychology. A lot of our minority kids like psychology. They do not like physiology as much as they like psychology. So psychology is one of the areas that the MARC program will fund. We call it psychology, we get students all the way through. This program has the greatest hope and has the greatest amount of flexibility. It was funded by the Rockefeller Foundation, which gave money to Howard University. Howard University contacted us in 1979, stating that we could fund students from grades 8 to 12 to do biomedical research. We have had seventh- and eighth-grade kids involved in the medical schools doing biomedical research.

Now some of you might say, "Well, what do these students do?" First, we usually team them up with older American Indian students or older students that are around. Second, that student gets involved in reading and writing skills and understanding the basics, the logical approach of the research we are doing. They get a feel that the medical school at the university is not that foreign of a place. We initially started looking at eleventh- and twelfth-graders, and we are now looking at eighth- and ninth- graders. The eighth- and ninth-graders are the most exciting group of kids you can work with. They are excited - they are there every day. In fact, we have a number of students working in my laboratory. After the program ended this year, a student said, "I just want to stay here." He has a stable family life; he just likes what goes on there, and so he is continuing to work in my laboratory today. This is a program that funds the students and pays them $100 a week. We have them there for eight weeks. They have to write a paper, they have to present the paper to the medical school faculty, and they are all scared, but they all do a beautiful job.

***"Any time one of these grants runs out, we lose our continuity... because the universities will not support these kinds of programs."***

We now have a commitment to go there from high school (which is this program) into college (called the MARC program) and the HCOP program so that we can get them into professional school. The reason this is a fragile program is that it is funded by the Rockefeller Foundation to Howard University, and this is the last year of its funding. We do not know where to get the monies to continue this part of the program. If you think about it, how we started and where the monies were are just the opposite of what some of the other speakers have done. Everybody says start from the bottom, and, you can't start too young. I agree with you, but the funding sources for us to do what we did started at which level? The sources started first at the medical school level, then at the college level, and finally at the grammar school level - but that money dries up this year.

Not only are marine science and biomedical health care delivery important, but we took that same model and went to another agency called Seagrant. We had, basically, the same idea of having American Indian students doing research involved in some aspect of marine science. No longer are we into only biomedical careers, but we are also into marine science. A lot of the American Indians have reservations that have problems dealing with toxic pollution with their lakes, seafarming, fish raising, etc. At the start, in 1980 at the university, we have had at least 15 students involved, again in various aspects of research. We have had six graduates, three who are now working on reservations and two who have gone on to earn Ph.D.s.

The MBRS program is something that we cannot really do. We do not have the ability to do it. There is a reservation close by the medical school which actually gets money from the NIH. We now take students from the twelfth grade through college and have them do biomedical research. But the monies come from the reservation, then they go to medical school faculties and to the students.

As you can see, what we have done creatively over the years is put together pieces here for whole continuum. The point is that any time one of these grants runs out, we lose the continuity that some of the speakers have all talked about because the universities will not support these kinds of programs. So here is the model.

I think this is the point I was trying to make earlier. You can take a student at least at the high school level - I believe at the grammar school level - and bring them in so that they can end up doing research either in biology, like at the College of Science and Engineering, or then they can actually ducktail into the Medical School in physiology. The point is to try to get those students to realize as early as you can that the university and the medical school are not foreign environments.

I applaud the efforts of the speakers here talking about getting students out and seeing what is out there. I really did not know what the university was all about. My father said, "You've got to get an education," but he did not know what that meant either. I am sure you have all heard that. My mother said, "Go get an education," but she did not know what it meant either. It really works for some students if you can show them a continuation from grammar school to high school all the way through to medical school.

The models we use a lot are effective in dealing with alcoholism, obesity, nutrition, and AIDS. We bring in speakers to talk about these different diseases that affect the minority population. We have brought in sociologists and other people. The whole idea is to show students that education and research are not static kinds of entities. Many of the counselors we talk to, whether it is in engineering or physiology, have no concept of life-long learning. At the high school level, I feel that is disastrous for many kids, because the counselor does not see this continuation - that higher education does not mean sitting down and reading a book but, rather, active involvement in scientific inquiry. A student can go back and help the minority community if they want. It can be a very exciting challenge.

This is the model that we have put together over the years. We have an elementary school program and a high school program that are funded by the Howard Rockefeller Program, and we have the Native American Medicine Program that bridges the high school college program. We have part of the college program being funded here by the reservation through NIH monies, then from the college to the graduate career, then from college to the medical school. This whole thing has been precariously put together, involving minority community support. Something someone else has mentioned - business community support - has been very positive. Businesspeople like to support these ideas, but this support is also very fragile. All you need to do is have one part of the package fall apart, and you will lose students.

This does not have to be about just medical research. This whole idea of scientific inquiry can involve any issue. An example from the Minneapolis campus is two minority students who are interested in racism. This is turning on the students to life-long learning, by having them work on a question that they, themselves, are interested in. It does not have to be AIDS, say, but something that they want to study. This is a letter from a seventh grader who worked in my laboratory who said she enjoyed herself a lot and wants to come back next year to do some research. This was in 1986. She did not come back in 1987 - she had some parental problems, with her father leaving - but she is back this year. I think if you can get them early enough and turn them on, and they see medical school faculty and university faculty are friendly people, then we can hold some of the students. I do not say all of them - I say some of them.

Two years ago, we had a conference in Duluth. We are having one in a week in the scientific community. It is very important for us involved in minority programs to let the academic community know that what we are doing has a certain amount of scientific credibility - I don't know if that is the term to use - but it is good to have these conferences. This one was sponsored by the NIH. I would like to see conferences like this for Hispanics. I would like to see conferences like this for Blacks and Asians - we don't see this enough. All you do is hear about programs, and then some national publicity about one program or another. This kind of business is very much needed to bring together scholars and have the proceedings

published. I am very happy to hear that the proceedings of this [CASET] symposium will be published as well. We do not see enough of that out there in the field. I think this is the way many of us feel.

To recapitulate a couple of points, programs such as these are very much tied to the commitment of certain people. Certain people drive these programs. Those people, whether they are at the university level or at the community level, are involved for reasons other than money or social acknowledgment. They are motivated to be involved. We do not have enough of those people around in the present generation, our generation - and if you take a look at the next generation, there are fewer. Somehow, we have to work together. I do not know how that is ever going to be done. I have been harping on this for years because once these programs fall apart, whether it is at the university level or community level - it takes another five years before the momentum gets going again.

That is not a positive note to end on, but thank you very much.

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# MATH ENRICHMENT PROGRAM AT GARFIELD HIGH SCHOOL

**George Madrid**

**Coordinator, Transition Program**
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Mr. George Madrid, Project Coordinator for East Los Angeles College, handles administrative matters related to the Escalante Program. In addition, he works alongside Mr. Escalante, counseling students and providing a helping hand where needed.

On behalf of Jaime Escalante, PACE, and East Los Angeles College, I would like to congratulate CASET for an excellent conference being presented here.

How many of you have seen the movie, *Stand and Deliver* once? How many of you have seen it twice? Those of you who have seen it twice - it shows *ganas*. Behind the story, it is ganas.

At any time during my presentation, I welcome questions. I feel I have a lot of information that needs to be shared with you.

## THE ESCALANTE PROGRAM: THE FORMATIVE YEARS

East Los Angeles College started working with Mr. Escalante in 1980, just before the controversial year when funding was not available and Escalante was looking for funds to expand a program motivating high school kids to go beyond a high school education. At that time, I was working for East Los Angeles College as a tutor with Upward Bound programs. A lot of the kids would come to me on Saturday mornings and say, "Gee, Mr. Madrid, I have got a teacher - he is wonderful. You have got to meet this guy. He really makes me study. He gives me a lot of desire to continue my education. He comes to my home, he talks to my parents. Now my parents let me stay after school. Now my parents want me to go to college." Now, these were the Latinas whose parents wanted them to stay home, take care of the children while they were working, single parents who did not even have dreams of going to four-year colleges. Parents did not know that kids could get financial aid. Then Mr. Escalante entered the home environment and broke the ice and showed them that there was a pathway to four-year education, a pathway on which he would help them. So 1982 came around - that was a controversial year, as you have all seen. That type of program grew from 12 students to 600 during the academic year.

When I first met Jaime Escalante, he was working for an Upward Bound program. He felt that the Upward Bound programs were not doing all they could to get kids into colleges, to get kids to study, because of the way they were structured the way they were being run. So he checked me out, by asking the students, "Who is this guy?" The students were his pipeline to determine whether I was a reputable

program director. He asked a lot of the kids I knew, and he gave me an opportunity to work with him, but I had to deliver everything that I said I was going to do - that is what he demands - if you say something, you had better be there because otherwise your head will be on a platter.

At that time in 1980, I was barely a tutor working on my undergraduate year at the University of Southern California. I went to the college president and said, "I have a fish by the tail that will make Los Angeles College shine like a diamond." The president did not even know who I was. I was just an employee. That summer when I brought Mr. Escalante into the program, our first grant was for $60,000.

Two years later, he started to get a lot of notoriety. Articles were being written on education and on Escalante. The second year that I worked with Mr. Escalante, our funding had been cut - no more money. The Department of Education, Health and Human Services, was cutting our grants that summer. Two weeks before the program was going to end, Mr. Escalante received an award, the Master Teacher of the Year, from Ronald Reagan in California. Being at that time a project coordinator, I wrote a letter to Ronald Reagan, and I signed Jaime's name to it. I complained to the Reagan administration that:

- Hispanics were being discriminated against;

- Other four-year institutions were getting all this money but that the community college system was being overlooked - the community college system that was helping students transfer from a two-year college to a four-year college; and that

- These kids really needed that opportunity to try a two-year education because not a lot of our kids in the east side community are able to go into a four-year college at that time.

So I sent the letter to Reagan and gave him all the statistics. I do not know if he read it or not.

The day before Jaime met with Reagan, I told him, "Jaime, I have to tell you something. I wrote a letter to Reagan, and I signed your name to it."

He said, "So what?"

I said, "Jaime, I said this, this, and this."

"So what?" he said. "Don't worry about it, I'll back you up."

"Yeah, but Jaime, you don't know what I'm saying."

"Don't worry about it."

With that, Jaime met with Reagan. Two days later, at that time, the Secretary of Education, Margaret Heckler, contacted the president of the college and indicated that we had been awarded $250,000 for that year. As of that time, with $250,000, we have been able to serve 600 kids and more. So we have been gradually building up the funding, and funding has not come easy. It has not come easy - you all know that.

I would like to show the movie. Then, after the movie, if you have any questions, I can talk about the program, how we are set up in terms of tutors, where we select our tutors (our tutors are our kids).

[*Film Stand and Deliver shown.*]

## SET-UP OF THE ESCALANTE PROGRAM

In May of this year [1988], we had 160 people attempting calculus, 260 overall in Advanced Placement Examinations, English, Spanish, or other areas. Again, during the summer session, we had 350 students, and all 350 worked after school or before school. Summer programs start at 6:00 in the morning. Between 6:00 and 6:30 a.m. the students have breakfast. Between 6:30 and 7:00, they are getting ready for class - that is pretty early in the morning. Escalante demands a lot of them. He drives them.

I was just reflecting as you guys were watching the movie, and I was looking at you guys. There are a lot of diamonds like Escalante in here, whether you have been recognized or not.

Students always come to me, and they talk about professors who go beyond what is required. I would like to say that Dr. Eloy Rodriguez, back here from the University of California at Irvine, has been an inspiration in my life. I met him about ten years ago, and he did not recognize me. I guess I have grown a little older, a little wiser. But there are professors throughout the United States who our students encounter, who are like diamonds in the rough, who have not been recognized, and Escalante knows it. You know it, and I know it. The fact is that we have to keep working with our students, working with our community.

***"Escalante demands a lot of them. He drives them."***

During the summer, we work in five areas: algebra, trigonometry, math, calculus, and SAT English (this is our first year working with English). Our data show that our kids are going to four-year colleges, excelling in math and science, but when it comes to communication skills, they are suffering badly. They would come back, and they would say, "I can't hang in there. I can't make it." And Escalante would say, "Hey, we've got to do something." I said, "Why don't we hire an SAT specialist, the best SAT specialist we can come across, someone who can work with them in English?" So this year, we worked with an SAT specialist, and she works with kids after and during school. This summer she worked from noon to 5:00 daily, getting them ready for the composition, their personal essays on why they want to go to the four-year colleges.

Question from the floor:

Where does the funding come from for the summer program?

Atlantic Richfield Foundation basically pays 60 percent of it; the rest is paid by the Ford Foundation. I am telling you where the money is - it is there. The money is really there. You go after it, and you demonstrate in your proposals what you are going to do and how it is going to be spent.

The community college played an important role in getting this program started, at a time when funding was hurting. The college stuck its neck out and said, "All right, we'll finance it 100 percent." They borrowed from Peter to pay Paul, and that is the whole story there. During the academic year, we meet every Saturday and after school at East Los Angeles College, and the money is paid by the community colleges to pay the teachers for one hour per day and four hours on Saturdays.

There are other teachers, three in mathematics and the English teacher. Escalante has hand-chosen these teachers to work with him. He went around to the different schools and selected teachers that he felt were going to carry on the same kind of teaching at Roosevelt High School and at Garfield High School. We have just applied for a grant with the National Science Foundation to go to five other high schools and bring in 40 teachers next summer from throughout the United States to work with Escalante. So if you feel that you ought to be one of the 40 teachers, or if you feel as a project coordinator that you have a teacher that you would like to work with us for one year next year, send us a letter because we will get funded. It is re-election time, so money is going to be out there too. You know that, and I know that - now is the time to hit the people for the money. If you would like to be part of that team-teaching approach, I would like for you to write us a letter, give it to Jaime, and he will make the decisions - he has never said "no."

Question from the floor:

Is this a summer program or a yearly one?

It will be a yearly program. The teachers will come after school and on Saturdays during the academic year. During the summer program, they will stay with us for 10 weeks. Housing and a stipend will be provided for the teachers as well as for the students. Objectives of the program are to develop skills in mathematics, motivation, and desire to continue their education. It is all in what he says is *ganas*. Again, each kid makes $700 for the summer, $700 that the faculty really needs. It is an incentive to go to summer school. Every Friday, we take the kids to the University of California at Irvine and the University of Southern California and introduce them to students who have left the program, who are in professional areas, and can motivate them to continue their studies. Any questions at this time?

***"The money is really there. You go after it, and you demonstrate in your proposals what you are going to do and how it is going to be spent."***

Question from the floor:

What is the teaching load on Mr. Escalante?

He has about 150 kids the first hour.

Question from the floor:

What is the number of classes on a daily basis?

He has two classes, trig/math analysis and calculus. In the trig/math analysis class, he has 150 kids in the morning. From 11:00 to 1:00, he has the calculus team.

Question from the floor:

Do other teachers in this high school try to follow his example, not only in mathematics but also in biology, chemistry, physics?

A lot of them do, especially now that the movie is out. They are cleaning their *laganas*, and they are saying, "I'm being watched."

Question from the floor:

I can also sense some feeling of jealousy from some faculty members in that school.

There is a lot of it, especially from the PE Department. They want the kids to be jocks. Escalante started getting the jocks to stay after school instead of going to practice, and carrying books.

Comment from the floor:

But that would not be jealousy, necessarily. I am talking about jealousy in the sense from other faculty members in the same disciplines.

Oh, yes, because they have not been recognized.

Question from the floor:

But do they deserve to be recognized?

I can't say that. My gut feeling is "no," because they have ripped off the system. They have ripped off the kids, and it reflects.

Question from the floor:

How many sections of calculus do you have? Is it only one section? Is it a fact that everybody in school wants to take calculus with Mr. Escalante? If you have two or three different names but everybody wants to take Mr. Escalante, it must generate bad feelings from other teachers.

The kids know that in order to take Jaime at Garfield, they need to take Ben Jimenez. It is a ladder. To get up to here, you have to go here first. Before you get to Ben, you have to take Mr. [Angelo] Villavincencio.

Question from the floor:

So in essence, what you are saying is that it is only one section that Mr. Escalante teaches, in terms of trigonometry, and another one in calculus.

Right. There is not two or three sections of the same course with different instructors.

So what he has done is that he has taught these teachers to motivate the kids. When he first started, it was just him, down here in the trenches, after school by himself. That was when he got sick and had his heart attack.

Question from the floor:

What is his educational approach? It is really nice to see this motivational part, but when Jaime has his next heart attack or whatever, what message is he really leaving for the next generation of educators? Is there something unique about his educational approach?

It is unique - his staying after school, cracking the books late, getting down to their level, coming home with the kids, eating at the dinner table, doing homework at the dinner table, going back to the school (he does not go home until 11:00 at night). While I am taking a shower, I feel guilty because Jaime's back at East LA College or Garfield, staying late. Now there are adults who have approached him. He is teaching also at the Community College level with adults, and these people are trying to get into his classes. But again, to get back to your question, it is really getting to their level, understanding the problems that are existing in the family, and getting involved with those kids during lunch time, after school, Saturdays, and Sundays. A lot of the teachers who are now in the program are experiencing such thoughts as, "Gee, these classes are taking a lot out of my personal life, my family life," and Jaime says, "Look, you have a job to do."

Question from the floor:

Would you say that the parent part is quite unique?

It is. I mentioned that last night.

Comment from the floor:

Bringing the parent involvement into the whole process is unique, at the high school level. In elementary school, it is a given.

We start at the junior high school with the ninth graders who are going to go to Garfield High School and Roosevelt. We recruit them to come as they are leaving ninth and tenth grade to stay after school and to come to the summer program. We meet with their parents at least four times a year. Jaime calls the parents at least twice a month and talks about any problems arising. If he sees that the kid needs a pair of shoes, he will call one of the graduates who has left the program who is now either a surgeon or an engineer and says, "I need some money for a pair of shoes for a kid." Our friend will send the kid to this store, and the kid will leave with a wardrobe of clothes. There are a lot of poor kids in our program that he really helps personally. He calls the parents and reminds them, "I have a contract with you; Maria has not stayed after school. What is the problem?" "Well, she needs to really help me. I have been sick, or one of the kids has been sick." Jaime will say, "Tomorrow, I expect her to be here."

He follows through with phone calls and personal home visits. Also, he makes the principals from each of the high schools get involved and commit themselves. The high schools we worked with did not have books. We had car washes and fundraisers to get books, books that would cost $35 to $50 apiece. He got so popular that publishing companies were offering to give us free books. So we are now getting free books, but only because he reads them, evaluates them, and sends them back.

Comment from the floor:

I am sure that after the movie was released, there were a lot of people in the educational area who were ready to follow his example, nationwide, not only at the high school level but also at the college level.

There are, but it arose a while ago. A lot of people are jealous and angry. It is human nature.

Comment from the floor:

Let's not necessarily look at the negative side, but something that concerns me is there is no question that Escalante is an extraordinary individual, highly motivated, highly involved. He is really extraordinary. I am a little concerned that a lot of the teachers - and I would say that 80 percent of the teachers, certainly in Texas - are already underpaid, and over-committed, just in the classroom. Classrooms are very, very crowded. The public sees this kind of a film, and they say, "Why can't you be like that? Why can't you go out and do car washes? Why can't you take the responsibility?"

I would like to see some of that individualism coming out. Teachers should be able to obtain some of their own money - why should they depend on the support of the Federal Government? It might also have the impact of demanding too much from teachers who are themselves under siege. And I just wonder how one overcomes the vision that the public might be getting. I think that teachers may be doing enough, but some of them are very restricted in resources and lack of government support.

Comment from the floor:

Part of the problem there may be the teaching load that they have. How does somebody do a job like that if you are going to have a teaching load of five classes a day? It is impossible. A person is human, and you can just go so far.

It is ignorance for one to think that it does not take money to run an educational institution. Escalante uses every resource possible to run a program at that level. We look for every dime possible.

***"Our statistics show that 95% of our kids going on to four-year colleges go to graduate school. The rest are just staying at the undergraduate level. 95% are graduating from the transition mathematics program."***

Question from the floor:

I guess one of the questions that I am asking goes back to Robert's [Dr. Robert Pozos] question, "How does this make it possible to have more Escalantes?" Does Escalante get any feedback or anything that indicates that this is a model that can be put together? How do you put it together in such a way that teachers will be motivated, believe that they are going to get better pay, and have their attitudes changed on how they perceive their students? It is clear to me that Escalante is very popular among the students. He has proven them to themselves continually, which is something that I think a lot of the minority students rarely ever get. It is almost something like a Catholic school. But it is certainly being exposed to being "stroked" a lot. I just wondered how that can be translated.

When Bush visited Garfield High school, his [Escalante's] comment before Bush got there and when Bush got there was, "You are wasting my time, you are bringing politics into my classroom, and there is no room for politics. But there is room for money from the Department of Education, which is shy now on all of our educational institutions." Escalante mentioned that money needs to come to education hundreds of times. Teachers' unions - he has written letters to teachers' unions, to the Department of Education, William Bennett. Yet, the politicians come around.

Question from the floor:

Have you done an analysis of all the graduates that have left the program? We have seen some outstanding successful and commendable examples. What happened to all the students?

Our data have just come back and will be published by January of next year, and it will be out to the public. Our statistics show that 95 percent of our kids going on to four-year colleges go to graduate school. The rest are just staying at the undergraduate level. 95 percent are graduating from the transition mathematics program.

Question from the floor:

How about the other kids?

They are staying at the undergraduate level and not going on to the graduate level programs.

Question from the floor:

You are saying that 95 percent of the students are studying at the master's or Ph.D. level, and 100 percent are graduating from college?

Not only are they going to the four-year colleges, but they are also going to the Air Force Academy and the Naval Academy.

Question from the floor:

And the others who were not in the program, what are their statistics?

From Garfield High School?

Question from the floor:

What about those that were not in the program, that come from the same high school?

That has not been done. We have not compared those graduating from high school and not going out to college or just trying to get into college. Of those who have entered our program and been in it for four years, 95 percent have gone on to graduate school.

Comment from the floor:

I am sure it has been a tremendous, positive influence, but it still would be interesting to see what would happen to the other students who did not have the benefit of this kind of motivational approach. I would like to see what happens to those kids.

Well, Garfield does have a lot of kids who apply to the four-year colleges and do not finish because they lack financial aid or because they can't cut it academically.

Question from the floor:

What is the drop-out rate of Hispanics in the Los Angeles area?

At least 33 percent.

Question from the floor:

Well, that is pretty low. In Texas, it is around 45 percent; in Chicago, it is around 55 percent.

Well, again, there have been some good changes; 33 percent, I would say, for the drop-out rate. That is about the national average. The point I am trying to make is that to keep what Jaime brought alive, there has to be some documentation as to what really specifically here is a personality cult. You have a tremendous individual here who can train other individuals, and he now has a ladder. So he can now benefit from his years of hard work. The problem is that he is not going to be around that much longer. And if there is something to be gleaned from this, that is to re-document. That is why we are asking these kinds of questions. How many kids really benefit? For once, we see an inspired high school teacher - and that is what we are looking at. Is it just an inspired teacher or what? I would like to see the specifics of the quantification that you guys are going to do that would give us something to say about whether it is really more than personality, or not.

Question from the floor:

Does his personality have a lot to do with it?

This gentleman [Mr. Ben Jimenez] was scared to teach at Garfield High School until Jaime inspired him. Why? He was afraid of the environment because kids were carrying guns and they

were not motivated. Kids were falling on the floor from drugs. It was bad - it was terrible. What he told us, the teacher, was that he did not want anything to do with education. This year, because of this instructor, Ben [Jimenez], more of his kids came out with 5s than in Jaime's class. This year, 160 kids took the calculus examination. Only 55 percent passed. The reason that only 55 percent made a passing score was that the media were coming around wanting to know more about how Jaime was doing it. Interviews, the movie - it was terrible. At least 45 percent of Escalante's time was distracted this year, and it had an effect on him personally and on the kids. I saw it coming, and I knew this was going to happen.

Question from the floor:

How old is Mr. Escalante?

How old is he? I really do not know, to be honest with you.

Question from the floor:

With regard to the question, how indispensable is Jaime to this program? Can you duplicate this program in another part of the United States?

Yes, yes.

Question from the floor:

Has it been done already?

Again, remember Jaime has been highlighted because of Hollywood, but the kids highlighted it because of the number of people passing the examinations with scores of 5s. The program can be duplicated if you choose quality instructors who have the desire to work with these kids. You start off with 12 or 15, maybe not a large number, and you carry on and carry on. You bring in those 15 that leave your program to motivate another 10 or another five, but there has to be camaraderie. And it keeps growing and growing and growing. It becomes a tightly knit group. Like at the University of California at Irvine, in creative medicine; that is a tightly knit group, and it cannot fall apart. It does fall apart if you do not have an individual like Escalante back there knitting the team. But Escalante has other people backing him up because he is only human and he needs an administrator to get the money and to make sure it is there to make things happen.

Question from the floor:

Who is that?

Me, I have got to say. It has been difficult for me because I was a novice, and I could never have done it if there had not been a woman in my life, my wife. It was hard. I grew gray hair overnight.

Question from the floor:

So now really, Jaime's obviously proven what he can do with the students, and now he is trying to teach the teachers his method, so that they can go out and impact more students. Is that right?

That is what he wants to do with the National Science Foundation Grant.

Question from the floor:

So he is going to bring them in, and they then observe him and develop, of course, their own style.

Exactly. He wants the teachers to bring in at least 40 students each.

Question from the floor:

But they are not coming to California, are they? They are bringing the students with them? That is a lot of money!

Yes, they are coming with them. Yes - a million dollars. The National Science Foundation wants to bring in the tutors, the instructors, and the students with whom these instructors will be going back to the schools with, to implement the same kind of program, to keep it going, to keep it alive. It is going to be a challenge, but it is one that we want to confront and give it 100 percent of our best.

Question from the floor:

Will it be for the summer of 1989?

Yes.

Question from the floor:

Only California teachers?

Throughout the United States.

Question from the floor:

Forty teachers and 40 students?

Forty teachers, and each teacher will bring 40 students and be housed at USC, Cal State, LA.

Comment from the floor:

So, at the same time the teachers are learning how to do it, the students are watching them learn. That is interesting.

Exactly.

Question from the floor:

What type of selection criteria are they going to have to choose the one teacher and the state?

Jaime is going to review and talk to all the teachers that apply. Applications will be sent out.

Question from the floor:

Is that one teacher per state?

No, only 40 teachers, and each teacher will bring in 40 students from his or her neighboring high school. Let's say Texas has one teacher and 40 students go to East LA College that summer or a dorm at USC.

Question from the floor:

I thought you said it was for a year?

It is for a year, but it is going to start off in the summer of 1989, and the kids will be given high school credit or college credit.

***"He does not let them fade away after four years. The kids who graduate and continue their four-year education in the institution and get their degree will be asked to come back as guest speakers and role models or team-teachers."***

Question from the floor:

The kids will be there for the summer, the rest of the year, and so will the teachers. What will the teacher be getting?

His regular stipend paid by the National Science Foundation.

Question from the floor:

Will the teachers be expected to implement this program in the location they are coming from and go back to start a similar program?

Yes, and they do not have to be at an advanced placement level. It can be in Algebra 1A, in Algebra 2A, or Geometry. It does not have to be in an Advanced Placement Calculus level or AP-level class.

Question from the floor:

Have you sensed that there is a type of fantastic pressure being put on the student?

I don't understand.

Question from the floor:

At the beginning, it seems as if he was a very strict disciplinarian. Has that lessened? You don't have to deal with that continuously, if you already have proved that you have tremendous success. Do you continue with every new batch to run at full speed?

He does - he does re-motivate every new batch of cookie that is coming out. Every batch is being re-motivated, and at first, he was doing a lot more. Now that we are bringing in students that have left the program and are now at Jet Propulsion Laboratory, a lot of that is carried out by our former kids.

Question from the floor:

Will they have Jaime during their senior year only, or will they have him in their junior year?

We have him in the tenth, eleventh, and twelfth grades.

Question from the floor:

Then they will have an opportunity to have Jaime Escalante? So Jaime initially can be with them three years?

Right, yes, they can, and in their senior year, he will ask them if they want to stay as tutors. Or they will leave for the four-year university, and he will stay in contact with them. He does not let them fade away after four years. The kids who graduate and continue their four-year education in the institution and get their degree will be asked to come back as guest speakers and role models or team-teachers. Those who have their teaching credentials will be asked to team-teach with him.

Thank you very much.

★

# CAREER PLANNING FOR TODAY AND TOMORROW ($CPT^2$): Success In Mathematics and Science For Grammar School Children

**Elsie Rivera**

**Society of Hispanic Professional Engineers (SHPE)**
**Midwest Regional Chicago Chapter**
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For quite some time now, the Society of Hispanic Professional Engineers (SHPE), Midwest Regional Chicago Chapter (MRCC), has been wanting to develop a structured program of career orientation and educational motivation for children at the grammar school level. In late 1987, after five years of involvement with students at the university and high school levels, SHPE began organizing Career Planning for Today and Tomorrow ($CPT^2$).

Since its birth in 1982, SHPE has made the recruitment and retention of Hispanic students in college mathematics and science curricula a top priority. It has always maintained strong ties with its university-level chapters, supporting student chapter activities, participating in engineering panels, and sponsoring social activities to create a sense of camaraderie and accessibility between students and professional Hispanics. Then, sensing the desperate needs of our Hispanic students at the high school level, SHPE has effectively launched the mentorship arm of the Students, Teachers, Educators, and Parents (STEP) program. The organization STEP is sponsored by the Joyce Foundation and DePaul University. Its main objective is the preparation of students from Benito Juarez High School for college by providing them with academic support, developing their leadership skills, and exposing them to the wide variety of career opportunities available to college graduates. An attachment on the STEP program is provided in Appendix A.

In 1983, SHPE decided to start reaching out to even younger Hispanics. With help from the American Association for the Advancement of Science (AAAS) Office of Opportunities in Science (OOS) and funding from the Pew Charitable Trusts, SHPE-MRCC was able to plan and host $CPT^2$ at the University of Illinois at Chicago on Saturday, March 19, 1988. More than 150 students from grades 6 through 9 attended, along with more than 50 parents and a few teachers. The basic outline and content of the $CPT^2$ was laid out by AAAS/OOS in its project *Linkages Resource Guide* (see Appendix B).

**FIGURE 1**

**Opportunities in Science:**
***C*areer *P*lanning for *T*oday and *T*omorrow**

**$CPT^2$**

***AGENDA***

| | |
|---|---|
| 9:00 a.m. | Pick up attendees |
| 9:30 a.m.- 10:10 a.m. | Registration and arrival |
| 10:00 a.m.- 10:05 a.m. | Welcome, introductions, housekeeping<br>Elsie Rivera-Amoco Oil Company |
| 10:05 a.m.- 10:15 a.m. | State Senator Miguel del Valle |
| 10:15 a.m.- 10:30 a.m. | Status of Minorities in the Science, Engineering and Health Work Force<br>Manuel Figueroa-AT&T |
| 10:30 a.m.- 11:30 a.m. | Minority Role Model Speakers<br>Osvaldo Arce-Computer Scientist<br>Grace Pinzon-Civil Engineer<br>Wesly Yapor M.D.-Chief Surgeon<br>Omar Santos-Geologist |
| 11:30 a.m.- 12:45 p.m. | *Workshops*<br><br>*Parent Workshops*<br>Carmen Suarez, Counselor, IIT<br>Andrew Cordero, Counselor, Purdue<br><br>*Teacher Workshop*<br>Leticia Gonzalez, Teacher, Saucedo Magnet<br>Ivan Gonzalez, Coordinator, S.O.Y.<br><br>*Student Workshops*<br>Demetrio Garcia-AT&T<br>Elsie Rivera-Amoco Oil Company<br>Susan Carmona-UIC MERRP<br>Andres Garza-UIC LARES |
| 12:45 p.m. - 1:15 p.m. | Lunch Break |
| 1:15 p.m. - 1:30 p.m. | UIC Saturday Program-Jose Rodriguez |
| 1:30 p.m. - 1:45 p.m. | Closing<br>Lupe Aguilar-SHPE-RCC, President |

**FIGURE 2**

## STARTLING STATEMENTS EXERCISE

(adapted from the Equals Program,
University of California)

1. There are nearly 4 million people in the science and engineering work force. How many Blacks are in the science and engineering work force?
   a. 9,500
   b. 90,500
   c. 900,500

2. How many Hispanics are in the science and engineering work force?
   a. 8,600
   b. 86,600
   c. 860,600

3. How many women are in the science and engineering work force?
   a. 5,260
   b. 51,260
   c. 512,600

4. There were 369,300 employed doctoral scientists and engineers in 1983. How many of these were Black?
   a. 490
   b. 4,900
   c. 49,900

5. The overall unemployment rate for Blacks (ages 25-44) in 1983 was 14.8 percent. What was the unemployment rate for Black scientists and engineers in 1984?
   a. 2.5%
   b. 5.0%
   c. 15.0%

6. The median family income for Blacks in 1982 was $13,598. What was the annual salary for Black scientists and engineers in 1984?
   a. $20,000
   b. $32,000
   c. $40,000

7. Which racial group had the lowest verbal and mathematics SAT scores in 1984?
   a. Asians
   b. Blacks
   c. Hispanics
   d. Native Americans

## WHY

SHPE believes that these younger children have an innate curiosity about how things they see around them work as units and together as systems. There is a yearning to understand the unknown, a less-inhibited tendency to ask questions. AAAS informed us that many researchers also feel that it is this natural curiosity in children that explains the fact that peak interest in mathematics and science occurs at about the fourth and fifth grades. That, then, is the ideal time to introduce the wide variety of careers available in the mathematics and science fields, and to begin the academic coaching required to build those careers. This time is especially crucial to underprivileged children who may have no role models and no knowledge of the career opportunities available to them, or the academic preparation required for college entrance.

*"Peak interest in mathematics and science occurs at about the fourth and fifth grades. That, then, is the ideal time to introduce the wide variety of careers available in the mathematics and science fields."*

## NATURE OF THE PROGRAM

The $CPT^2$ program consists of a one-day technical career orientation and planning symposium for children in grades 6 to 9, their parents, and counselors. (Figure 1 shows the agenda for the March 19, 1988 program.) The symposium emphasizes encouragement of enthusiasm and success in mathematics and science.

## OBJECTIVES

The objectives of the $CPT^2$ program are as follows:

1. To evaluate and select a high school academic track that stresses mathematics and science classes such as algebra, geometry, trigonometry, calculus, biology, chemistry, and physics.

2. To explore career opportunities in science, engineering, and health care fields by utilizing Hispanic professionals as role models.

3. To explain the preparation required for college entrance examinations such as the Preliminary Scholastic Aptitude Test (PSAT), the Scholastic Aptitude Test (SAT), and the American College Testing (ACT) program.

4. To help students identify and participate in out-of-school programs offered by universities, science and health museums, business, government agencies, and hospitals.

5. To encourage participation in activities that support success in science and mathematics, such as watching science television shows, reading science magazines, and visiting science museums.

6. To instill in parents the importance of an education and of success in mathematics and science, no matter what career choice their child makes, and to emphasize the realistic accessibility of a quality education.

7. To give tips to teachers and counselors on teaching science equitably, and encouraging student interest in mathematics and science.

## AUDIENCE

The audience consisted of 100 Hispanic sixth-, seventh-, eighth-, and ninth-grade students from 10 predominantly Hispanic grammar and junior high schools, 50 teachers, and 50 counselors.

## INTRODUCTORY SPEECHES

To set the atmosphere for the rest of the program, SHPE had the first Hispanic Illinois state senator, Miguel Del Valle, give a fiery motivational speech on the importance of an education and the attainability of a great career for anyone with drive and motivation regardless of their ethnic or financial background.

With the "I can do anything I set my mind to" attitude in place, AT&T engineer Manuel Figueroa talked about the shocking status of Hispanics in the science, engineering, and health care fields. He utilized the Startling Statements Exercise prepared by the AAAS as well as some of his own findings (see Figure 2). His purpose was to stress the gravity of the underrepresentation problem to describe its possible consequences on American technological superiority, national security, and economic stability.

## ROLE MODELS

Hispanic role models were used to introduce the students and parents to science professionals with whom they could easily identify. Role models described their careers and the struggles they had to face in order to attain them. They stressed the rewards of a professional career, financial comfort, an improved lifestyle, and respect. They also gave detailed accounts of how they chose their careers and how to relate interests to possible career options. Possibly for the first time, many of these children and their parents were seeing one of their own ethnic group in a position of prestige, with a highly respectable job, and a very comfortable lifestyle.

## WORKSHOPS

Handouts at the workshops included:

- *Career Opportunities in the Sciences*, a list of sources on occupations and training requirements compiled by the AAAS/OOS.

- "The Engineering Professional," an article published by the National Action Council for Minorities in Engineering (NACME).

- A fact sheet on Project Upward Bound.

- *Are You Interested in a Health or Medical Career?* issued by the Illinois Institute of Technology.
- *Footsteps to the Future: On the Trail of the Technocats*, a brochure funded the Ohio Department of Education (see Appendix C).

## FUNDING

The Pew Charitable Trusts and private donations were the primary sources of funding for the $CPT^2$. AT&T provided equipment and personnel for a hands-on electronics workshop.

## SITE FOR THE $CPT^2$ PROGRAM

The University of Illinois at Chicago (UIC) was chosen as the site for the program. The Museum of Science and Industry was considered but was ruled out because of its complicated accessibility and possible distractions to the workshops. Seven rooms at the UIC were reserved for $CPT^2$ with help from the UIC Minority Recruitment and Retention Program. The main lecture auditorium holds 300 people. It served as the site for the introductory speeches and role model segments of $CPT^2$. The expected 100 students were divided into four groups for the small-group workshops. Two large rooms were reserved for the parent workshops. The teachers and the counselors stayed in the auditorium for their activities.

## RECRUITING

Five schools from Chicago School District 5 and five schools from Chicago School District 8 were targeted for special publicity. The principals of each school were asked to select 10 students for participation in the program. Permission for participating was obtained first from the district superintendents.

## COMMITTEE MEETINGS

Committee meetings were held every first and second Wednesday from November until the program date on March 19. The committee consisted of four SHPE members, one SHPE student member, one teacher, and the director of another grammar school educational program. (see Figure 3 for the job description of the planning committee members.)

## MARCH 19 HELPERS

About 15 members of the UIC SHPE student chapter came on the day of the program (March 19) to lend a helping hand for sign making and posting, serving, and cleaning up. Several organizers from other programs for grammar school children also helped in ushering children and giving presentations.

## SPECIAL PROBLEMS

The $CPT^2$ program had to cope with some special problems:

- Language: All program handouts had to be translated, and all speakers had to be fluently bilingual.
- Program length: The SHPE program was longer and included more activities than that suggested by the AAAS/OOS.
- Transportation: Buses, which were not allotted for in the AAAS budget, were used to take children from their schools to the university.
- Meals: Since the program was longer than what the AAAS/OOS had specified, lunches (for which no money was allotted), rather than snacks, had to be provided for the students.
- Teacher enthusiasm: Program leaders had to find a way to increase teacher enthusiasm about the program.
- Lack of counselor participation: No counselors showed up for the program.

## RECOMMENDATIONS FOR FURTHER EFFORTS

For programs such as the $CPT^2$ to be more successful and attain better results, program leaders must:

- Expand the pool of volunteers.
- Establish a stable funding base with multiple funding sources.
- Increase the involvement of major universities, schools, businesses, and other community organizations.
- Develop a stronger parental and community support system.
- Develop a peer support system.
- Improve follow-up procedures and data collection methods.

**APPENDIX A:**
**Mentorship Program for STEP**

## Opportunities in Science: Career Planning for Today and Tomorrow ($CPT^2$) Workshop

*Planning Committee Members*
*Job Description*

Planning Committee members should have experience in one or more of the following areas—teaching math and/or science using hands-on materials or manipulatives, recruiting participants and/or speakers for conferences, developing publicity materials, catering meal functions, conference registration, public speaking, leading discussions, fundraising, and evaluation. Committee members should know the community and gave good contacts with potential participants, sponsors, and others that can help advance the goals of the conference.

Planning Committee members must be willing to:

- carry out one or more of the tasks outlined in the weekly schedule.
- volunteer one (1) night a week, two (2) hours a night, for four months to attend committee meetings; meetings can be held during the weekdays or on weekends.
- attend and help out on day of workshop.
- attend the workshop evaluation meeting.

**APPENDIX A, Continued:**
**Mentorship Program for Step**

## MENTORSHIP PROGRAM FOR STEP
**(Students, Teacher, Educators, and Parents)**

### Introduction

The Society of Hispanic Professional Engineers Midwest Regional Chicago Chapter (SHPE-MRCC) is launching an effective and productive "mentorship program" in 1986. The officers as well as the membership believe that the wide range of disciplines, degrees, and job experiences embodied in the organization will prove fruitful for the students of Benito Juarez High School and future participants.

### STEP History

STEP is an organization that was founded by the Joyce Foundation and DePaul University in 1982. Its objective is to prepare high school students for college and to develop their leadership skills. STEP's philosophy advocates that parental involvement is a must for developing a support system for students. The project started with 25 students and it presently sponsors 69 students. To participate, students have to pass the California Student Test and their progress is monitored at the end of each academic year. The program consists of 6 hours of instruction per week and the classes are held mostly on Saturdays. Some of the subjects are mathematics (up to pre-calculus), communication skills, reading, writing, and science. Currently, there are 9 instructors of which 3 are engineers.

### Purpose

The purpose of forming the "mentorship program" is to provide a vehicle whereby Hispanic professional engineers can actively enlighten future generations of our community by providing first hand experience of the work environment and exposures to various segments of our society. Our goal is to encourage students to remain in school and to motivate them to consider engineering as a viable career option. The role the mentor plays in the mentorship program is critical to its participants. Thus, the exposure the mentor offers to the high schooler will impact the student for the rest of his life.

### Implementation

Throughout the fiscal year various group activities are coordinated to unite all the mentors and students. The group functions are provided by the organization in addition to the individual student/mentor activities.

The group excursions serve four functions:

- These events initially break the ice between the mentor and the student.
- Time is allocated for the students to enjoy recreational activities with peers.
- Mentors can take advantage of these group outings to compare notes and discuss possible joint excursions.

**APPENDIX A, Continued:**
**Mentorship Program for Step**

Qualifications

The requirements for becoming an active mentor are as follows:

- The chairperson must be notified of the member's desire to participate in the program.
- The mentor must make a sincere commitment to fulfilling the goals of the program.
- The mentor will be asked to share his or her personal experiences and difficulties encountered in obtaining his education. His work experiences and accomplishments are also of great benefit to the students.
- The individual student/mentor activities are very important and cannot be substituted with group activities. The purpose of our program is to interface at the personal level on a one-to-one basis.
- If the mentor cannot continue with the program, he or she should notify the chairperson so that the mentorship committee can locate a suitable substitute. Thus, the project's credibility would remain intact and the student's learning through exposure would not be hindered.

**APPENDIX B: Linkages Resource Guide**

## FACTS THAT BLACK, HISPANICS AND NATIVE AMERICAN PERSONS SHOULD KNOW ABOUT FINANCIAL AID FOR COLLEGE

prepared by the

American Association for the Advancement of Science
Office of Opportunities in Science
1333 H Street, N.W.
Washington, D.C. 20005
(202) 326-6670

FACT: A new study by the Census Bureau called *What's it Worth* looks at the relationship between monthly income and education. This study reports that on the average:

- a high school graduate earns $1,045 a month.
- a college graduate with a bachelor's degree earns $1,841 a month.
- a person with a doctorate degree earns $3,265 a month.

FACT: Today, one year of college could cost as little as $500 or as much as $20,000. Many colleges expect parents to contribute to their child's education. Parents should start saving for college as early as possible. The chart on page 2 will help you determine how much you can save for your child's college education. Any amount of money is better than nothing. Financial aid is also available from other sources, including:

- colleges themselves;
- federal, state, and local sources, such as the state department of education, Social Security Administration for dependents or retired or disabled persons, and the Bureau of Indian Affairs;
- community-based organizations, such as Urban Leagues, sororities and fraternities, Y's, Boys and Girls Clubs, service clubs, organizations of and for people with disabilities;
- professional associations such as Society for Hispanic Professional Engineers, American Indian Science and Engineering Society, and National Society of Black Engineers; and
- businesses and corporations.

Federal financial aid programs include Pell Grant Program, College Work-Study, National Direct Student Loan Program, and Guaranteed Student Loan Program. States may offer scholarships or loans to attend state colleges and universities.

Loans can also be obtained from banks and credit unions and government sources. Students can save monies earned from summer or part-time jobs.

**APPENDIX B, Continued:**
**Linkages Resource Guide**

**CHART TO ESTIMATE HOW MUCH YOU CAN SAVE FOR YOUR CHILD'S COLLEGE EDUCATION IN A BANK OR CREDIT UNION ACCOUNT**

| Number of Years Before Your Child Goes to College | Months of Savings | Multiply this Number by the Amount of Money You Save Each Month |
|---|---|---|
| | 0 | 0 |
| 1 | 12 | 12.336 |
| 2 | 24 | 25.432 |
| 3 | 36 | 39.336 |
| 4 | 48 | 54.098 |
| 5 | 60 | 69.770 |
| 6 | 72 | 86.410 |
| 7 | 84 | 104.074 |
| 8 | 96 | 122.829 |

*Example:*

Step 1: Determine how many years it will be before your child goes to college. For example, if your child is in the 8th grade, it will be 5 more years before he/she goes to college.

Step 2: Look at the part of the chart that says *Number of Years Before Child Goes to College* and find the number 5.

Step 3: When you find the number 5, write down the number that is on the same row as the number 5 in the part of the chart that says *Multiply this Number by the Amount of Money You Save Each Month*. This number is 69.770.

Step 4: Decide how much you can save each month for your child's education. Let's say you decide to save $50 per month.

Step 5: To determine the amount of money that you can save for your child's college education, multiply the number you found in Step 3 and the amount of money you decided to save in Step 4 (69*.770 x $50 = $3448.50).

Answer: The amount you can save for your child's education is $3,448.

Work Space to Figure Out What You Can Save For Your Child's Education

**APPENDIX B, Continued:**
**Linkages Resource Guide**

## CHECKLIST FOR APPLYING FOR COLLEGE AND FINANCIAL AID

The application forms that your child will need to apply for college and financial aid are available in the office of the high school guidance counselor. Listed below is a calendar of when to ask for application forms for college entrance tests and college admissions and financial aid forms. Remember to allow plenty of thinking and writing time for your family to sit down together and fill out forms.

| When To Ask | WHAT TO ASK FOR |
|---|---|
| September of Junior Year | Ask Guidance counselor about the PSAT test. To be eligible for a National merit Scholarship, students should take the Preliminary Scholastic Aptitude Test/National Merit Scholarship Qualifying Test (PSAT/NMSQT) in October of their junior year in high school. There are additional scholarships for Black and Hispanic youth that are determined by using PSAT scores. |
| Summer between Junior and Senior Years | Write for college catalogs and college and financial aid applications forms. According to a publication of The College Board, most colleges charge an application fee; if you cannot pay this fee, write to the college admission officer and ask for a fee waiver. If you need help writing a fee waiver letter, ask a teacher or a counselor. Most catalogs and forms are not mailed out until August or September. |
| September of Senior Year | Ask guidance counselor about SAT or ACT college entrance examinations. College entrance tests include the Scholastic Aptitude Test (SAT) and American College Testing (ACT) Program Assessment. Students should take one of these college entrance examinations during the Fall of their senior year of high school. Some colleges also require one to three achievement tests in specific subjects. Check the catalog of each college that you apply to since requirements may be slightly different. Fee waivers are available for these tests. |
| November 1 of Senior Year to February 15 | College and financial aid applications are available from guidance counselors. Be sure to ask for financial aid forms from The College Board's Financial Aid Form (FAF) or the American College Testing Program Family Financial Statement (FFS) and the state financial aid office.<br>• In order to be eligible for financial aid from most colleges, the amount of family contribution must be determined by The College Board or American College Testing Program. In deciding family contributions, both annual family income and expenses are considered; large debts, the number of dependents and other factors are considered. Since federal income tax forms are required, completed financial aid forms cannot be mailed until February.<br>• The College Board or American College Testing Program sends the amount of expected family contribution to applicant and colleges listed on the application form. Be sure to list the names and addresses of the colleges that you are applying to on the application form.<br>• The expected family contributions can come from savings, bank loans, and/or part-time student jobs.<br>• Your child should give the guidance counselors the names of the colleges where he/she wants high school grades sent.<br>Usually, colleges send an admission letter before a financial aid letter. |

FACT: You can find out more about financial aid opportunities from school guidance counselors; libraries; community-based organizations; and the college that your child applies to. Keep all materials in one box, file or drawer.

FACT: Read, very carefully, all catalogs, application forms, and letters that come in the mail from colleges and college services.

**APPENDIX B, Continued:**
**Linkages Resource Guide**

## RESOURCES

### Where to Write to For Financial Aid Information

American Association for the Advancement of Science, Office of Opportunity in Science. 1333 H Street, N.W., Washington, D.C. 20005.

National Action Council for Minorities in Engineering. 3 West 35th Street, New York, NY 10001.

American Indian Science and Engineering Society (AISES), 1310 College Avenue, Suite 1220, Boulder, CO 80302

National Urban League, 500 East 62nd Street, New York, NY 10021.

The American Legion Education Program, *Need a Lift*, National Emblem Sales, P.O. Box 1050. Indianapolis, IN 46203 ($1.00 charge).

U.S. Department of Interior, Bureau of Indian Affairs, Washington, D.C. 20245.

### Where to Write For Information on College Entrance Examinations

*Taking the SAT*, College Board ATP,CN 6200, Princeton, NJ 08541.

ACT Registration, Box 414, Iowa City, IA 52234.

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Resources for this guide include *What's it Worth*, U.S. Census Bureau, Series P-70, No. 11, Washington, D.C., and *Need a Lift*, The American Legion Education Program, Indianapolis, IN., *Going Right On (GRO)*, The College Board, 45 Columbus Avenue, New York, NY 10023-6917.

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**APPENDIX B, Continued:**
**Linkages Resource Guide**

## FACTS THAT BLACK, HISPANIC, AND NATIVE AMERICAN PERSONS SHOULD KNOW ABOUT JOBS IN SCIENCE, ENGINEERING, AND HEALTH FIELDS

FACT: **TECHNICAL JOBS REQUIRE MATHEMATICS, SCIENTIFIC AND COMPUTER SKILLS.** The U.S. Labor Department reports that half of the 20 fastest growing careers are in computer technology and health care. Computer automation will continue to change the workplace and influence clerical jobs, the "sweat labor" jobs, and professional science, engineering, and health care jobs.

FACT: **MANY TECHNICAL JOBS IMPROVE THE WAY WE LIVE.** Many people do not realize that scientists and engineers developed VCRs, microwave ovens, cordless telephones, and video disc recorders. In 20 years, the World Future Society predicts that baby-sitting robots and voice activated wristband alert systems to call for medical help will be available.

FACT: **TECHNICAL WORKERS ARE INVOLVED IN A VARIETY OF ACTIVITIES IN BUSINESS/INDUSTRY, COLLEGE/UNIVERSITIES, GOVERNMENT AGENCIES, AND HOSPITALS/CLINICS.** For example, in health care fields:

- Perfusionists operate heart-lung machines during surgery.
- Nuclear medicine technologists use radioactive materials to make diagnostic tests.
- Cytotechnologists use microscopes to detect changes in cells caused by diseases.
- Medical sonographers operate ultrasound machines which create pictures of the body.

In science and engineering fields:

- Zoologists and biochemists are involved in the preservation of animals like the black rhinos.
- Physicists and mathematicians use laser telescopes to find out how the solar system works.
- Chemists and engineers are exploring ways to control air and water pollution.
- Engineers and medical specialists develop implants and other devices that help blind people to see, deaf people to hear, and paralyzed people to walk.

FACT: **OTHER SKILLS NEEDED BY TECHNICAL WORKERS INCLUDE WRITING, MAKING SPEECHES, AND TEACHING.** All technical workers are expected to write memos, record data, and consult with other professionals. Many technical workers write papers to explain their work to other technical people and to people who give them money for their projects; make speeches about their work; and teach in schools, colleges and universities, and hospitals.

FACT: **TECHNICAL WORKERS HAVE EXCELLENT SALARY POTENTIALS.** Average starting salaries by degree level are listed in Figure 4.

**APPENDIX B, Continued:**
**Linkages Resource Guide**

FACT: **SCIENTISTS AND ENGINEERS HAVE LOW UNEMPLOYMENT RATES.** The general U.S. unemployment rate is 7-9 percent; the unemployment rate for scientists and engineers is 1.6 percent.

FACT: **HIGH SCHOOL COURSES NEEDED TO GO INTO TECHNICAL CAREERS AFTER HIGH SCHOOL OR TO MAJOR IN A TECHNICAL AREA IN COLLEGE INCLUDE:**

- Algebra
- Geometry
- Trigonometry
- Calculus
- Biology
- Chemistry
- Physics

**DOCTORAL OR MEDICAL DEGREES**

| | |
|---|---|
| Biology | $36,900 |
| Computer Technology | 40,300 |
| Engineering | 46,300 |
| Mathematics | 37,900 |
| Medicine/Dentistry | 50,808 |
| Physical Sciences | 41,700 |
| Psychology | 36,600 |
| Social Sciences | 34,400 |

**BACHELOR DEGREES**

| | |
|---|---|
| Biology | $18,708 |
| Business | 28,512 |
| Engineering | 33,996 |
| Mathematics | 25,392 |
| Pharmacy | 31,564 |
| Physical Science | 30,348 |
| Psychology | 15,021 |
| Social Science | 19,321 |
| Registered Nursing | 23,920 |
| Physical Therapy | 21,008 |

**TWO YEAR DEGREE OR TRAINING**

| | |
|---|---|
| Computer Technology | $16,536 |
| Electrical Technology | 24,804 |
| Engineering Technology | 23,244 |
| Health Technology | 17,056 |
| Licensed Nursing | 15,600 |
| Radiology | 19,916 |

**FIGURE 4**
Ladder of average salaries for technical jobs by degree level

**APPENDIX B, Continued:**
**Linkages Resource Guide**

## FOR INFORMATION ON THE FOLLOWING TECHNICAL CAREERS, WRITE TO:

Aerospace: *Careers in Aerospace With In Your Lifetime.* Student Programs, American Institute of Aeronautics and Astronautics, 1290 Avenue of Americas, New York, NY 10104.

Biology: *Careers in Animal Biology.* American Society for Zoologist, Box 2739, California Lutheran College, Thousand Oaks, CA 91360.

Chemistry: *Careers in Chemistry: Questions and Answers and A Career as a Chemical Technician.* American Chemical Society, 1155 16th Street, N.W., Washington, D.C. 20036.

Dentistry: *Dentistry: Is it For You?* Council of Dental Education, American Dental Association, 211 East Chicago Avenue, Chicago, IL 60611.

Engineering: *Take It From Us ... You Can Be An Engineer.* General Electric Company, Educational Communication

Pharmacy: *Shall I Study Pharmacy?* American Association of Colleges of Pharmacy, 4630 Montgomery Avenue, Bethesda, MD 20014.

Physics: *Physics: A Career For You.* American Institute of Physics, 335 East 45th Street, New York, NY 10017.

Physical Therapy: *Physical Therapy Career.* American Physical Therapy Association, 1111 North Fairfax Street, Alexandria, VA 22314.

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Resources for FACTS include *Careers in Health Care*, The Pittsburgh Press, October 28, 1986; *Minorities and Women in Science and Engineering*, National Science foundation, 1987; *What's it Worth*, U.S. Department of Commerce, Series P-70, No. 11, Washington, D.C., 1897; and *A Summary of Salary Surveys*, Commission on Professional Science and Technology, Washington, D.C., 1987.

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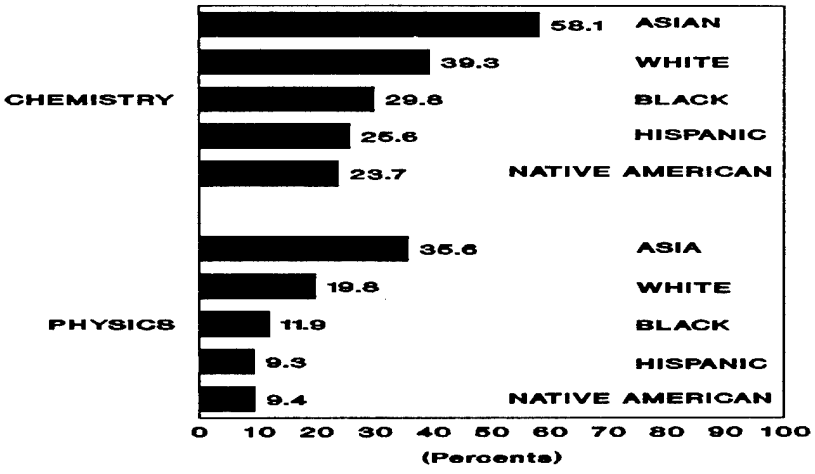
This resource guide was developed by Yolanda S. George, AAAS, and Tricia Zainal, consultant with a grant from The Pew Charitable Trusts. AAAS Office of Opportunities in Science, 1333 H Street, N.W., Washington, D.C. (202) 326-6670.

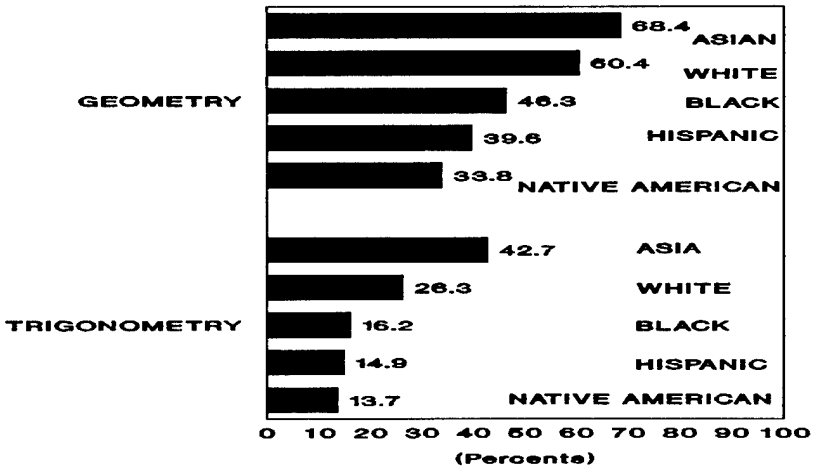
**APPENDIX B, Continued:**
**Linkages Resource Guide**

## MATHEMATICS AND SCIENCE CLASSES NEEDED FOR TECHNICAL CAREERS

Black, Hispanic, and Native American junior high and middle school students who want to find technical jobs right after graduation from high school or who want to go to college and major in science, engineering, or health fields need to take academic preparation math and science classes in high school. Academic preparation mathematics and science classes include algebra, geometry, trigonometry, calculus, biology, chemistry, and physics.

- Many Black, Hispanic, and Native American high school students are not in advance academic preparation math and science courses, particularly chemistry, physics, geometry and trigonometry.



**APPENDIX B, Continued:**
**Linkages Resource Guide**

## MATHEMATICS AND SCIENCE CLASS CHECKLIST

Black, Hispanic, and Native American junior high and middle school students who are interested in technical jobs in the 1990's should take a pre-algebra class and academic preparation mathematics and science class every year in high school. Students and their parents or guardian can keep this form and place a check mark (✓) in box when the student has completed a class. All students should take algebra, geometry, trigonometry, biology, chemistry, and physics. All students should participate in after-school, Saturday and Summer math and science programs. Students interested in going to college should take the PSAT in October of their junior year in high school and the SAT or ACT in the Fall of their senior year in high school.

## MATHEMATICS AND SCIENCE CLASSES AND EXAMS REQUIRED FOR A TECHNICAL JOB

GRADES

| CLASSES | 7th | 8th | 9th | 10th | 11th | 12th |
|---|---|---|---|---|---|---|
| Pre-algebra | | | | | | |
| Algebra | | | | | | |
| Geometry | | | | | | |
| Trigonometry | | | | | | |
| Pre-calculus or Advance Math | | | | | | |
| General Science | | | | | | |
| Biology | | | | | | |
| Chemistry | | | | | | |
| Physics | | | | | | |
| PSAT | | | | | | |
| SAT or ACT | | | | | | |

List of after-school, Saturday and Summer programs:

**APPENDIX B, Continued:**
**Linkages Resource Guide**

## "DEAR SHIRLEY" OFFERS TIPS FOR TEENS ON HOW TO DEAL WITH MATHEMATICS AND SCIENCE CLASSES

Many of the common school-related problems facing junior high and middle school students reach the desk of AAAS' special math and science advisor, Shirley Malcom, who spends a good deal of time searching for useful answers. Shirley has a doctorate degree in Ecology, is married to a physicist, and has two school-age children.

Have you ever had any of the following problems? If so, we hope that our tips will help you.

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Dear Shirley: I am going to high school next year. Does it matter what science classes I take?

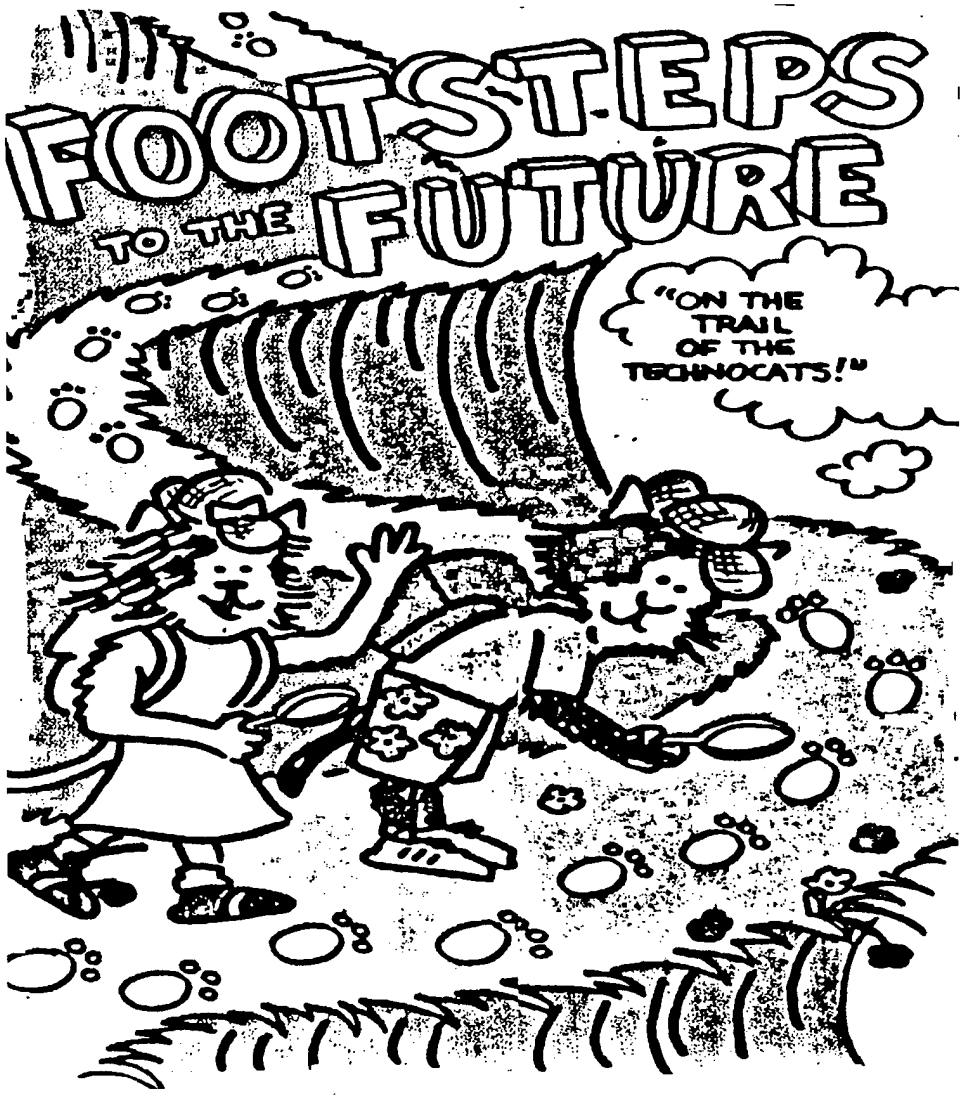
Tip: In high school you should take a science course every year. The science courses that provide laboratory experience in biology, physics, and chemistry are particularly important. What you should learn in any of these classes in addition to a body of facts, is a process--a way of acquiring knowledge in any discipline. This understanding of what's commonly referred to as the scientific method is essential to your success in the sciences.

---

Dear Shirley: I don't know what I want to be when I grow up. Does it matter which high school mathematics classes I take?

Tip: Yes! You should take a math course every year that you are in high school. If you decide to work in an occupation that requires mathematics courses beyond high school, it is best to have completed Algebra I, Algebra II, Geometry and Trigonometry in high school. If Calculus, Probability and Statistics are offered at your high school, it's a good idea to take these courses as well. The important thing to remember about mathematics is that you typically use information that you've been taught in junior high classes in high school classes, so you must really understand and remember the mathematics you learn at each level. An understanding of mathematics knowledge builds up over a period of time.

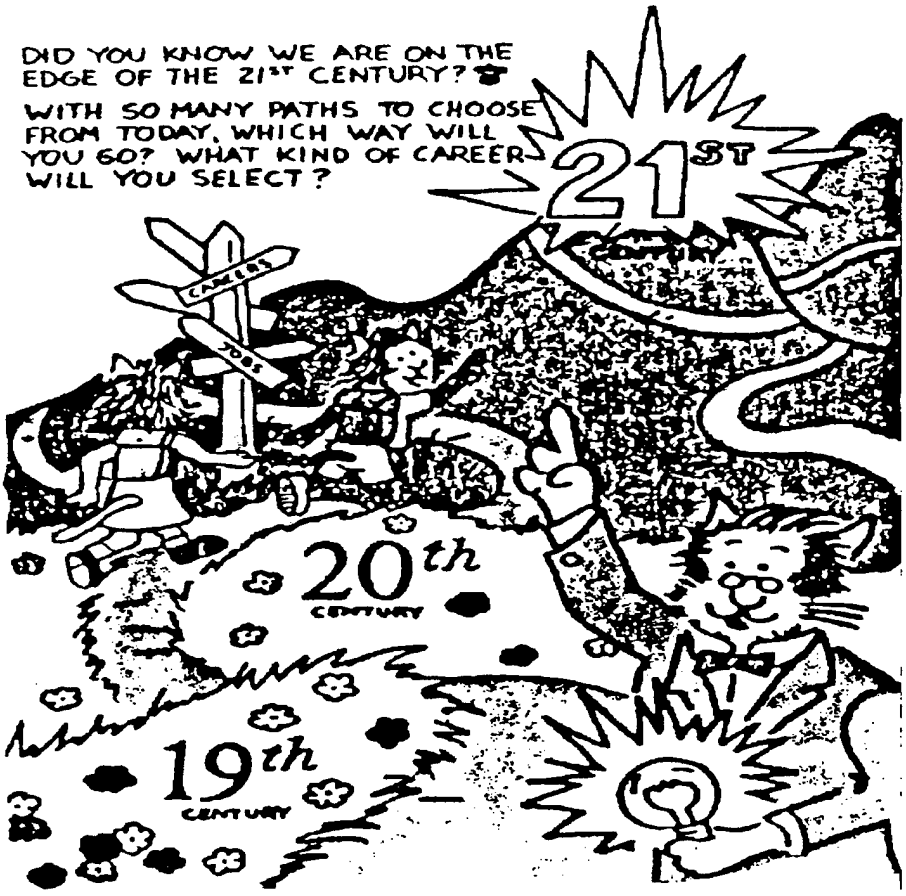
## APPENDIX C: Footsteps to the Future: On the Trail of the Technocats



**APPENDIX C: Footsteps to the Future:
On the Trail of the Technocats (continued)**



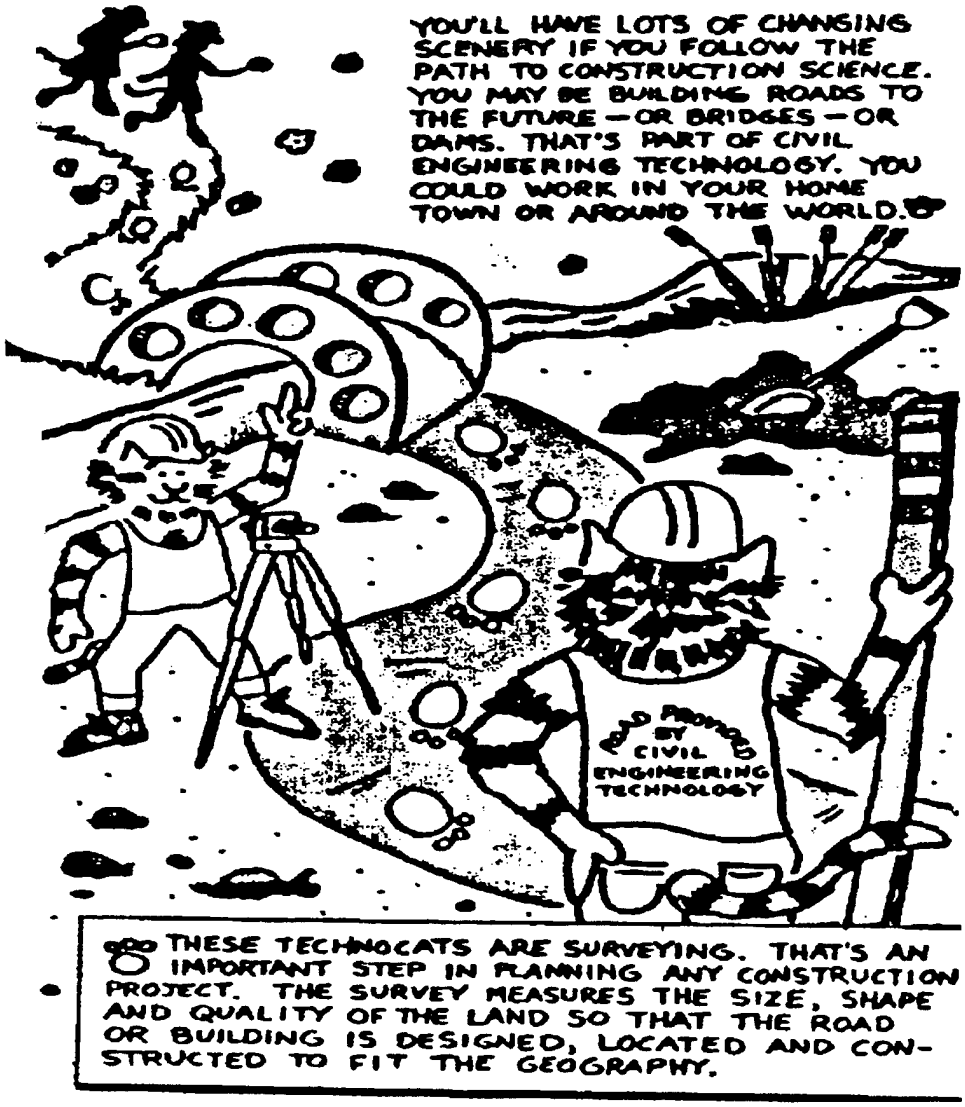
## APPENDIX C: Footsteps to the Future: On the Trail of the Technocats (continued)



## APPENDIX C: Footsteps to the Future: On the Trail of the Technocats (continued)



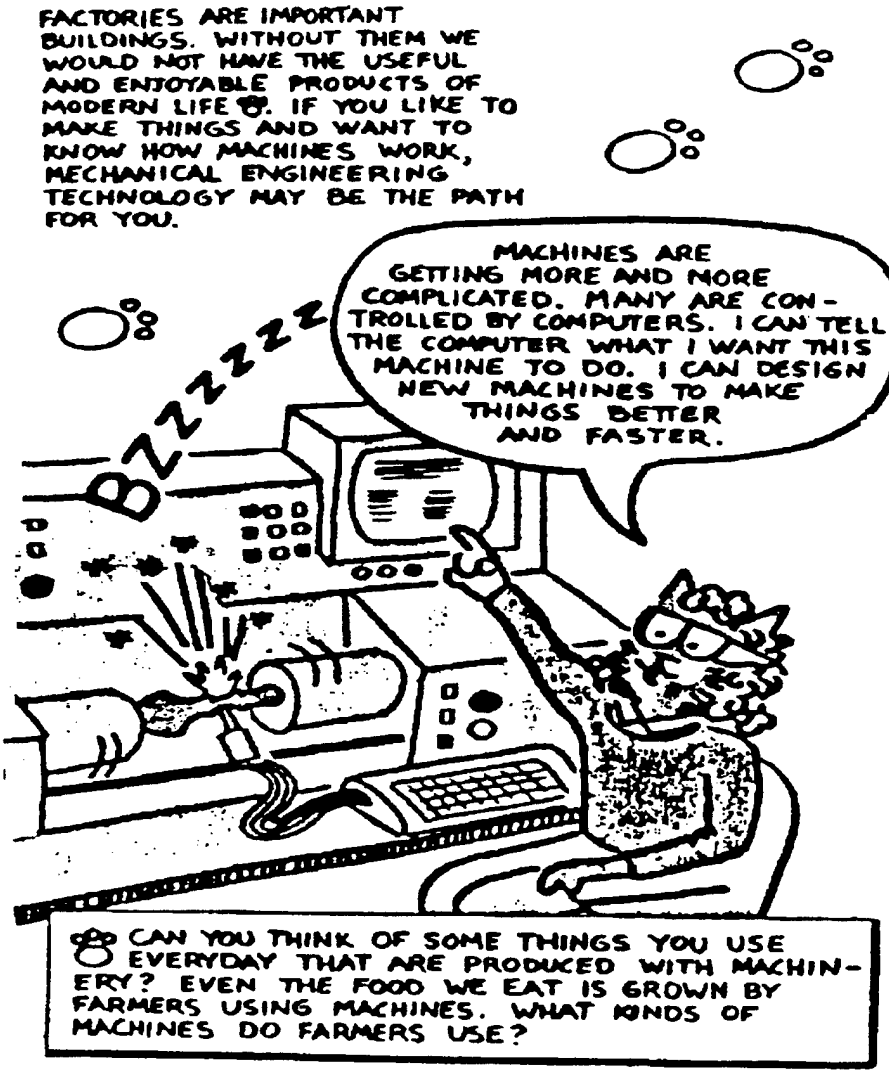
APPENDIX C: Footsteps to the Future:
On the Trail of the Technocats (continued)



## APPENDIX C: Footsteps to the Future: On the Trail of the Technocats (continued)q



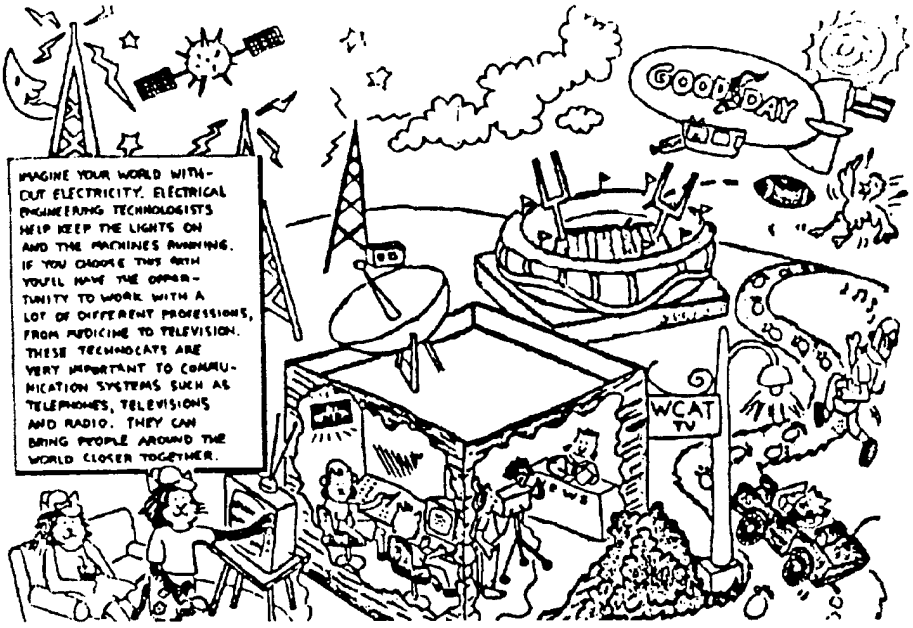
APPENDIX C: Footsteps to the Future:
On the Trail of the Technocats (continued)



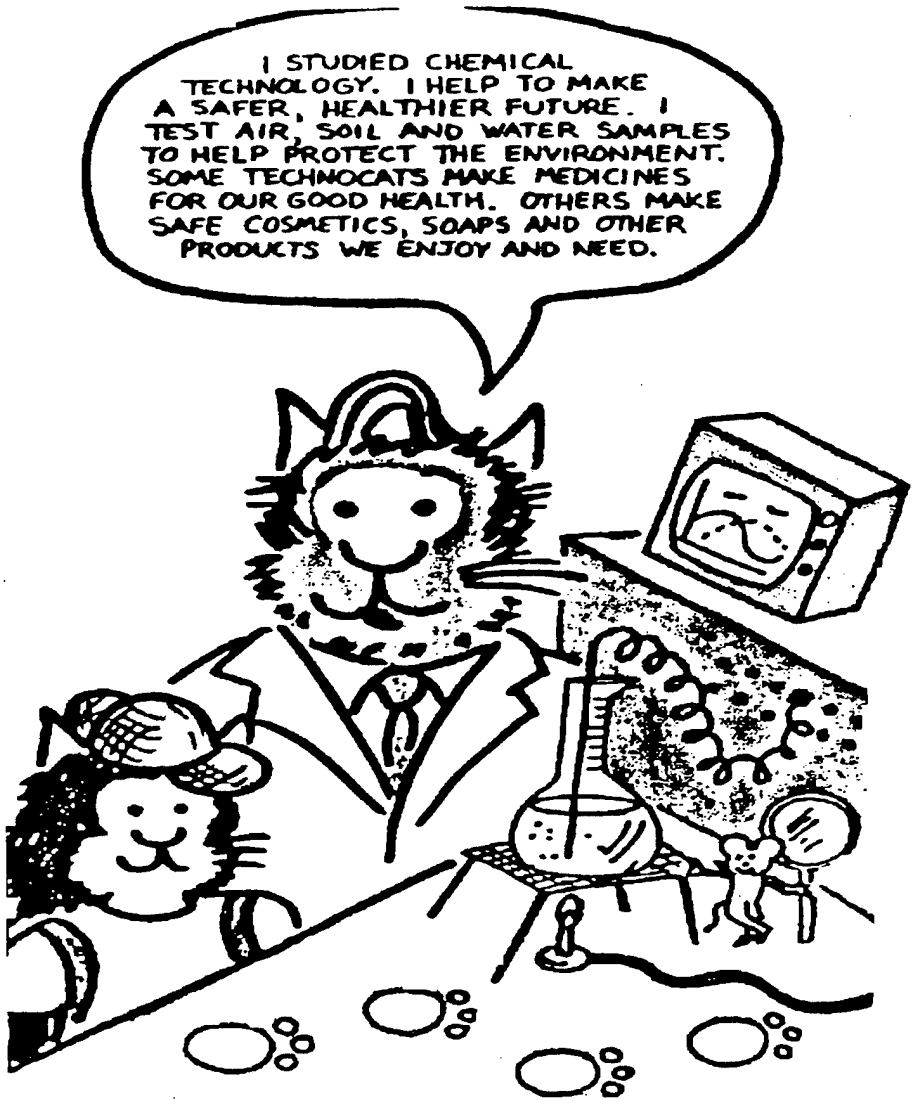
## APPENDIX C: Footsteps to the Future: On the Trail of the Technocats (continued)



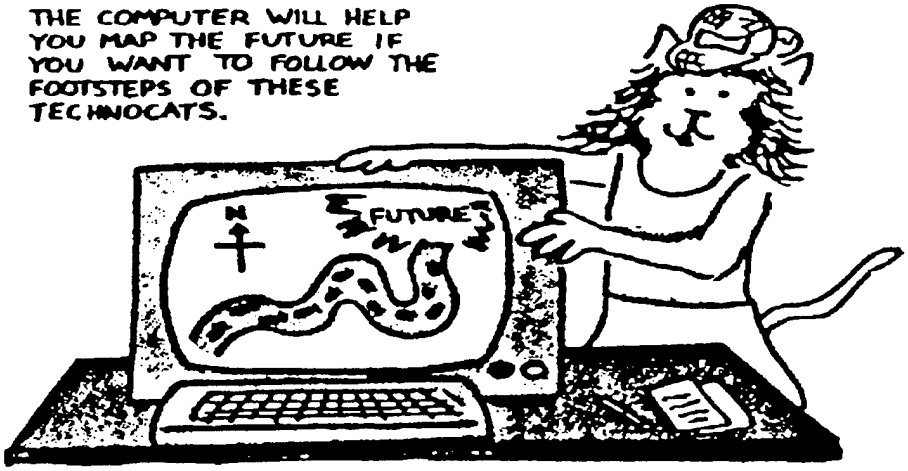
## APPENDIX C: Footsteps to the Future: On the Trail of the Technocats (continued)

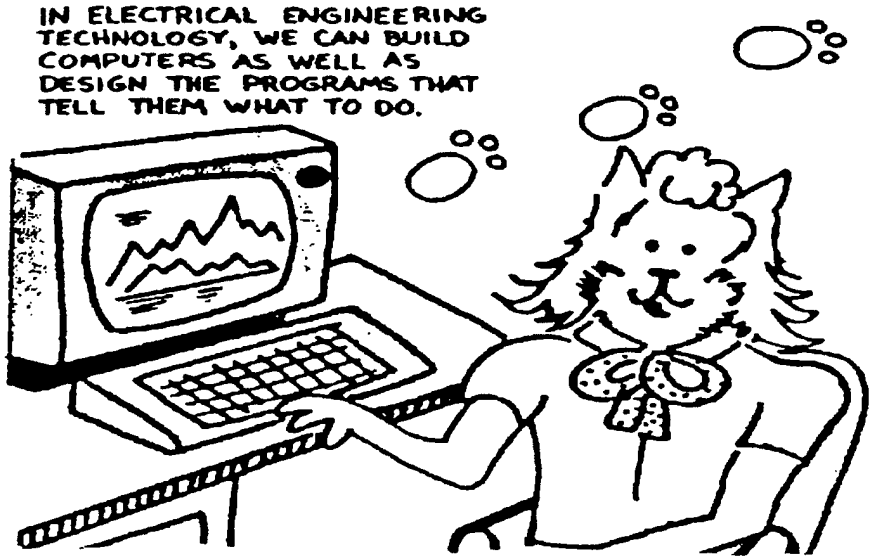


## APPENDIX C: Footsteps to the Future: On the Trail of the Technocats (continued)

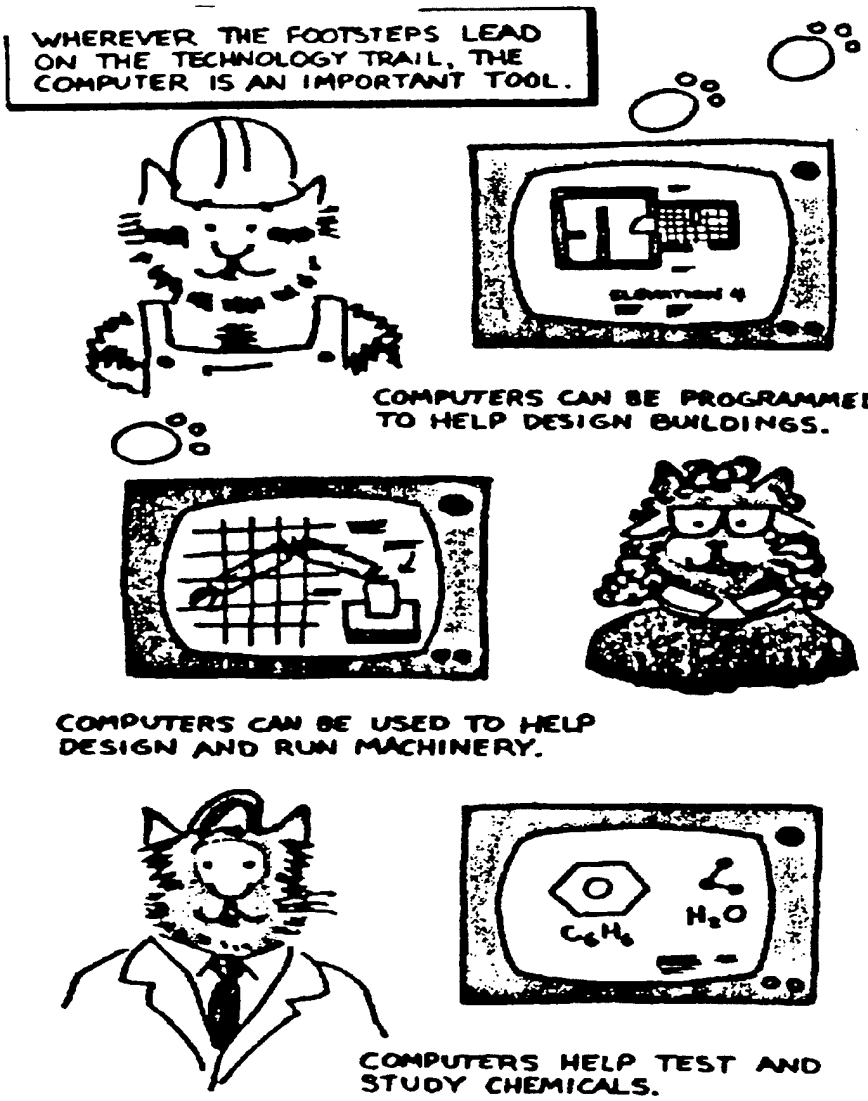


## APPENDIX C: Footsteps to the Future: On the Trail of the Technocats (continued)

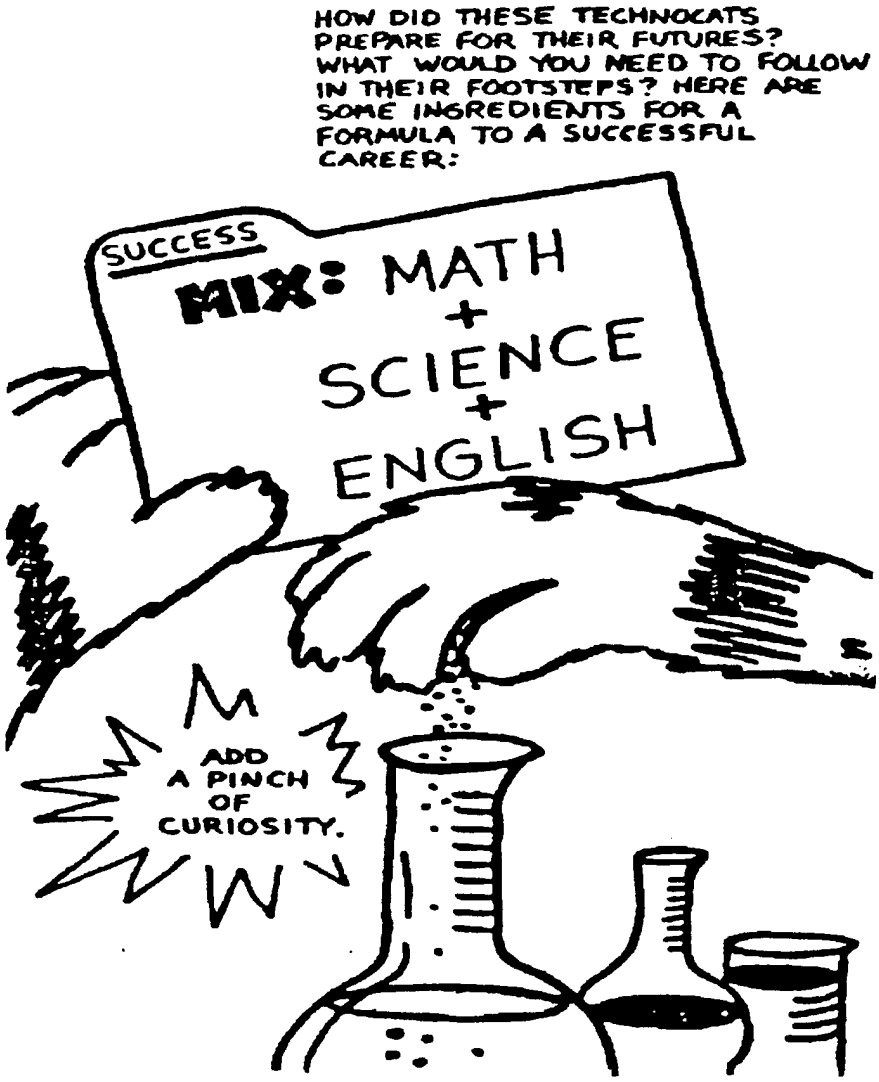


## APPENDIX C: Footsteps to the Future: On the Trail of the Technocats (continued)



## APPENDIX C: Footsteps to the Future: On the Trail of the Technocats (continued)



APPENDIX C: Footsteps to the Future:
On the Trail of the Technocats (continued)




WHAT DID THESE TECHNOCATS STUDY? CHOOSE YOUR ANSWER FROM THE BOX BELOW. LOOK BACK THROUGH THE PAGES IF YOU AREN'T SURE.

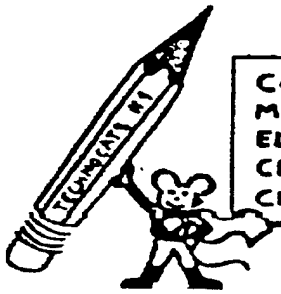
1. I DESIGN MACHINES TO PRODUCE TOYS, CARS OR CLOTHING. I STUDIED _____.

2. I WORK IN A LABORATORY, USING CHEMICALS FOR AN EASIER, SAFER FUTURE. I STUDIED _____.

3. I SUPERVISE A LOT OF ACTIVITIES TO SEE THAT A CONSTRUCTION PROJECT IS FINISHED ON SCHEDULE AND FOR THE RIGHT PRICE. I STUDIED _____.

4. I WORK ON WAYS TO HELP US TALK TO ONE ANOTHER, EVEN ACROSS LONG DISTANCES. I STUDIED _____.

5. I PLAN ROADS, DAMS AND BRIDGES. I STUDIED _____.




CONSTRUCTION SCIENCE
MECHANICAL ENGINEERING TECHNOLOGY
ELECTRICAL ENGINEERING TECHNOLOGY
CHEMICAL TECHNOLOGY
CIVIL ENGINEERING TECHNOLOGY

## APPENDIX C: Footsteps to the Future: On the Trail of the Technocats (continued)

SEARCHING FOR TECHNOLOGY!

| C | H | E | M | I | C | A | L | S | D | A | O | R |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| B | S | R | E | T | U | P | M | O | C | T | S | I |
| P | T | D | L | M | E | L | F | H | T | C | T | T |
| L | M | E | E | A | N | O | E | E | I | O | C | S |
| A | A | L | C | T | G | M | C | E | B | E | C | E |
| N | T | A | T | H | I | H | N | O | T | I | M | F |
| G | R | C | R | C | N | C | R | I | V | C | A | E |
| I | O | I | I | O | E | O | H | I | U | C | C | N |
| S | B | N | C | M | E | C | L | R | T | B | H | G |
| E | O | A | A | E | R | C | T | O | U | C | I | L |
| D | T | H | L | A | I | S | R | I | G | G | N | I |
| L | I | C | Y | L | N | Y | L | E | L | Y | E | S |
| A | C | E | A | O | G | D | L | A | B | O | S | H |
| B | S | M | C | G | N | I | Y | E | V | R | U | S |
| R | A | L | A | B | O | R | A | T | O | R | Y | B |
| D | R | A | F | T | S | P | E | R | S | O | N | L |
| N | O | I | T | C | U | R | T | S | N | O | C | D |

FIND THESE WORDS IN THE PUZZLE AND CIRCLE THEM. WORDS CAN RUN UP, DOWN, DIAGONALLY OR BACKWARDS.

TECHNOLOGY
ENGINEERING
ARCHITECT
DRAFTSPERSON
MACHINES
BUILD
CONSTRUCTION
MECHANICAL
SCIENCE
MATH
PLAN
ROBOT
ENGLISH
COMPUTERS
ELECTRICAL
TECHNOCAT
ROBOTICS
SURVEYING
FACTORY
CHEMICALS
CIVIL
LABORATORY
DESIGN
ROADS



# ENGINEERING AND SCIENCE OPPORTUNITIES PROGRAM (ESOP) FOR MINORITY PRECOLLEGE STUDENTS

**Enrique A. Olivas, Ph.D.**
**Project Director**
**and**
**Mr. Jaime Farias**
**Assistant Project Director**

**P.O. Box 20500**
**El Paso Community College, El Paso, Texas 79998**

*Enrique A. Olivas is Director of the Minority Institution Science Improvement Program (MISIP) Grants at Paso Community College and is responsible for monitoring renovation of the minority institution science laboratories and for handling personnel, purchasing, facilities, and administration matters. As Director of the Engineering and Science Opportunities Program (ESOP), Olivas is responsible for all areas of project management and coordination, including selection of participating faculty, tutors, students, hardware, software, and equipment. He received his Ph.D. in Inorganic Chemistry from New Mexico State University. He is serving currently as Adjunct Professor and Visiting Lecturer in the Chemistry Department at the University of Texas at El Paso.*

El Paso Community College, a multicampus institution, is located in the largest metropolitan region on the U.S.-Mexico border. The City of El Paso and its sister city, Ciudad Juarez, constitute a geographic area with approximately 1.5 million inhabitants. This location has provided El Paso Community College with the unique opportunity to provide access into the socioeconomic mainstream of American society for thousands of first-generation Mexican-Americans.

El Paso is the fourth-largest city in Texas, with one of the largest Hispanic communities in the country(62 percent). It boasts the youngest median age - 25 - among the largest cities in the nation. Population density for the under-18-year-old group is statistically higher than the national average (35.2 percent vs. 28.2 percent), and 71.6 percent of this younger (potentially college-bound) population is Hispanic.

El Paso Community College has recognized two precollege institutional priorities: the need to improve the scientific study preparation of precollege minority students, and the need to improve recruitment and minority student access to scientific study and careers. Barriers to meeting these priorities include open access to minority students with weak academic and motivational backgrounds, nontraditional students' fear of enrolling in the sciences, and students' inability to cope with the traditional saturated-lecture format. These students require new instructional forms and techniques if they are to be successful.

## ENGINEERING AND SCIENCE OPPPORTUNITY PROGRAM

To address the problem, the Engineering and Science Opportunity Program for Minority Precollege Students (ESOP) was developed through a grant from the U.S. Department of Education under the Minority Institution Science Improvement Program (MISIP), to improve access of precollege minority students to careers in the sciences, mathematics, and engineering.

> *"Barriers... include open access to minority students with weak academic and motivational backgrounds, nontraditional students' fear of enrolling in the sciences, and students' inability to cope with the traditional saturated-lecture format."*

The program is offered free to minority high school students (sophomore or junior level) who have mathematics and science grades above 80 percent. Students submit an application along with transcripts and letters of recommendation, and 100 participants are selected each year.

The Precollege Science and Mathematics Enrichment Program was developed around two concepts: 1) competency-based curriculum in the core mathematics and sciences in which the participants demonstrate acquisition of skills at one level before proceeding to the next, and 2) supplementing secondary school science and mathematics programs with courses to encourage college-bound students in the sciences and engineering.

The program includes lecture presentations and workshops in technical writing, computer programming, biology, mathematics, physics, and environmental engineering. Courses are held at the Valverde campus of the El Paso Community College for 22 consecutive Saturdays, not including holidays.

## PROGRAM DESCRIPTION

### Technical Writing

The technical writing portion of the program helps students to improve their written and oral communication skills. It consists of three sessions of classroom discussion and lecture followed by workshops to provide immediate reinforcement of the skills acquired. Students are administered a pre- and a post-assessment test to monitor their progress.

Topics include study skills and the writing process, use of the library, literature research methods including a scavenger hunt for topics discussed during the lecture, and technical writing as an occupation.

### Computer Programming

Computer programming is integral to the program because of its versatile applications to all fields of engineering, science, and mathematics. It consists of four sessions of lecture/discussion and a hands-on practicum on IBM PS30s. The students are introduced to terminology and the function of computers as well as design, programming, program development, and program execution.

Topics include computer architecture and orientation practicum, basic programming, introduction to minicomputers, advanced structures, flowcharts and graphics, lines, circles, rectangles, and animation.

## Biology

The biology segment emphasizes the key concepts of human life to give the student a "feel" for biology, making the concepts understandable and instilling some of the excitement of the subject. The instructional format of lecture/discussion, followed by a lab, provides immediate reinforcement of the concepts given. Topics include evolution, diversity of organisms, continuity of life, and ecology.

## Mathematics

The mathematics portion, like the computer segment, integrates applications throughout the sciences. It consists of three sessions in which the student explores the concepts of statistics, graphing, and trigonometry. The students hold discussion sessions on problem-solving techniques and applications. Each student is encouraged to use mathematics as a tool to better understand science and engineering concepts.

Topics include statistics (frequency, histograms, mean, median, mode, dispersion, range, variance, standard deviation, and coefficient of variation), graphing (graph patterns of different equations, and information extrapolation from graphs), and trigonometry of triangles (Pythagorean theorem; definition of sine, cosine, and tangent; angle elevation and depression problems; law of cosines; and solving problems with oblique triangles).

## Physics

The physics segment introduces a variety of terms and definitions commonly encountered in the field, including their applications and relationships. Students have an opportunity to measure quantities, gather data, and interpret results. The lecture/discussion/laboratory practicum format is followed.

Topics include forces (units of force, Newton's laws, equilibrium, vectors, and potential and kinetic energy), sound and light (wave motion, sound transmission and reflection, speed of sound and resonance, production of light, and characteristics of light), and electrostatics and electricity (positive and negative charges, forces of attraction and repulsion, direct current characteristics, color-coding of resistors, Ohm's law, and determination of current and voltage).

## Environmental Engineering

Environmental engineering focuses on the practices and scientific aspects of environmental pollution and conservation of natural resources. Students receive a general explanation of the problems of water and air pollution brought about by indiscriminate use of our natural resources. In addition to lecture/discussion about air pollution, water pollution, industrial hygiene, noise pollution, and refuse sanitation, the students take two field trips to water treatment plants that supply El Paso with potable water.

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# NATIONAL CHICANO COUNCIL OF HIGHER EDUCATION (NCCHE) UNDERGRADUATE SCIENCE FELLOWSHIP PROGRAM FOR CHICANOS

**Eloy Rodriguez, Ph.D.**

**Professor, Phytochemistry and Cell Biology**
**Department of Developmental and Cell Biology**
**College of Medicine**
**University of California at Irvine**
**Irvine, California 92717**

*Dr. Rodriguez holds a Ph.D. in Phytochemistry and Plant Biology from The University of Texas at Austin. He has published and lectured extensively in the United States and abroad. He is also the recipient of numerous awards and fellowships, including the Ford Foundation Mexican-American Graduate Fellowship, Fulbright-Hayes Senior Scholar Lectureship Award, Indo-American NSF Senior Scholar Lectureship, Lauds and Laurels Faculty Award for Outstanding Community Service, and the Rosser-Rivera Lectureship Award for Outstanding Research in Biological Chemistry. He has received numerous research grants, university and federal, including grants from the American Cancer Society, the National Institutes of Health, and the National Science Foundation. Rodriguez has lectured and published extensively in his field and has conducted numerous workshops at the elementary, high school, and university levels.*

Every year about 30 to 35 Hispanics receive Ph.D.s in the sciences, out of a total of about 15,000 science doctorates awarded in the United States. This means that of 700,000 Hispanic undergraduates from throughout the United States in all academic fields, we can expect (if things continue as they have) that only 30 of these per year will receive Ph.D.s in the sciences five years after they complete undergraduate school. Of those 30 Ph.D.s, we will be lucky if five become professors at major research institutions. In engineering, Hispanics probably have a worse Ph.D. record in comparison to Blacks and other minorities. It is not too surprising, because what I have discovered (like many of you) is that undergraduate Hispanics in engineering do not even think about pursuing a Ph.D., because they are rarely encouraged to do so. This is true in all major graduate institutions where there are minority undergraduate engineering students. No major engineering school in the United States has a reputation for producing minority Ph.D. engineers, especially Hispanics. On the other hand, foreign students have *no* problems in receiving Ph.D.s.

There are a lot of reasons why the thought of a Ph.D. degree rarely crosses the minds of young Hispanic engineering majors. As evident from some of the excellent high school and undergraduate programs that were described today, a lot of undergraduates in engineering finish their education as an undergraduate and then get a fairly good-paying job. The whole notion of pursuing a Ph.D. is something that has not been stressed, and of course the faculty

rarely plant the idea in a student's mind. The presence of only a few Hispanic professors who are engineers and conduct research at universities does not help matters.

## EARLY YEARS IN TEXAS: A SLIDE SHOW

I love to show this first slide, especially for my *primo* (cousin), Fred Calvillo, who is in the audience. His first job was with NASA, and now he is with Lockheed in Houston. This photograph was taken when I was a young kid and shows 14 of my cousins surrounding Grandpa Francisco, who passed away in the late 1950s. I grew up with, more or less, 67 first and second cousins; of those 67, 62 received undergraduate degrees. What is really extraordinary is that none of the parents got beyond the eighth grade, with the exception of two who received high school diplomas. I am talking about 11 *tios y tias* (uncles and aunts); we are talking about a super South Texas family! Out of this group of 14 cousins, four have Ph.D.s. I have a Ph.D. in the biological sciences, my cousin Javier has a Ph.D. in English from Harvard, Jaime has a Ph.D. in Language from Minnesota, and Lucette received a Ph.D. from the University of Michigan. Other relatives have master's degrees. For example, my brother has a master's degree in sociology, my sister's is in ornithology, and one primo has a master's in chemistry.

The reason I show this group slide is that obviously we were influenced by our primos, tios, and caring teachers. There are many other factors that got us into higher education, which included older primos and Hispanic friends who served as role models. But when we were high school students or undergraduates, did anybody ever bother to tell the bright ones that we should be studying for a Ph.D.? Was there ever any kind of a program, any kind of motivation? The answer is a definite "No!" It took some special event that eventually got us to start thinking about graduate school and a Ph.D. Remember, we did not know of even one Hispanic from South Texas who had a Ph.D. and was a professor.

## UNIVERSITY OF CALIFORNIA AND HISPANIC FACULTY

Let us look at the University of California system, which has approximately 7,230 tenure-track faculty. Out of those 7,230, 228 are Chicanos (Mexican-Americans born in the United States) and Latinos. That is 3.2%, in a university system that is about 25% to 30% Chicano/Latino in the State of California. Of course, The University of Texas is no better. In fact, The University of Texas is even worse, but I do not have the statistics.

If you break it down into the different disciplines within the biological sciences at the University of California, 1.7% ( or 17) out of those 228 are in the biological sciences. Out of those 17, I think seven are Tejano [Texas-born] Ph.D.s (probably because The University of Texas will not give us jobs). Some folks say that the reason that Hispanics are not going into the sciences is that they are going into the humanities. Well, look at this table: 2% of the 1,245 Humanities faculty at the University of California are Hispanics. Well, maybe Hispanics are going into social sciences; but only 2.9% of the faculty is Hispanic. Thus, the idea that Hispanics are going into other fields and not into the hard sciences is false. Isn't the University of California supposed to be at the forefront in the hiring and promotion of Hispanics? Well, this is certainly a very dismal record for the University of California system.

You might start asking yourself: What is happening with the young Hispanics? Where are the undergraduates? Most of them, as you know, are in two-year institutions - junior colleges and vocational schools - in California and Texas. California has a higher education system where everybody has an opportunity to go to a two-year college. Then, they can go to the California State University system or, if they are lucky, can transfer to the University of

California. Well, this system was set up in the 1940s so that everybody had a chance to get a college education. It turns out that the two-year college is a buffer zone - or better yet, a moat - for Blacks and Hispanics. Minorities are primarily loaded up in the two-year college system, and they rarely transfer into the California State University or the University of California systems. Almost 55% of Hispanics are in the two-year college system. You can almost eliminate this population as a group of Hispanics who will pursue a Ph.D. degree. I was just looking at the numbers of students potentially eligible to pursue Ph.D.s. In the Southwest, we have 373,000, more or less, who are in undergraduate schools.

## UNDERGRADUATES IN TEXAS

These are just the numbers for 1988 and how they break down. The extraordinary thing that I have found out is that most of the Texas colleges that have a high percentage of Hispanic students are in south Texas - over 30%. Every one of the students, as you would expect, is at a two- or four-year college. No four-year institution in the State of Texas or California that grants Ph.D.s has more than a 15% Hispanic enrollment. As you know, for most of us with Ph.D.s, the kind of institution we went to as undergraduates played an important role in our deciding to pursue graduate studies.

## NATIONAL CHICANO COUNCIL OF HIGHER EDUCATION (NCCHE) SCIENCE FELLOWSHIP PROGRAM FOR CHICANOS AND HISPANICS

I became involved with the NCCHE Science Fellowship Program for Chicanos and Hispanics because I liked the idea of capturing Hispanic students when they are undergraduates and directing and motivating them towards a Ph.D. degree in the sciences. Ms. Sharon Gomez is the associate director of NCCHE. She used to be with the Society of Hispanic Professional Engineers and with Mathematics, Engineering, Science Achievement (MESA) program.

The NCCHE program is funded by the James Irvine Foundation of San Francisco and Arco Foundation. The Irvine Foundation is made up mainly of farm laborers of California. Their commitment is unique. The foundations actively support the NCCHE program and realize the importance of the Chicano and Latino community in the United States. Unfortunately, the funding ends in 1990. So we are now in the process of trying to secure support from various foundations interested in the future of minority America.

The NCCHE program, designed to get students when they are sophomores and juniors in college, is the only program aimed at Hispanic students seeking Ph.D.s. We award them scholarships and a chance to do summer research as undergraduates and graduates. If they get accepted to graduate school, they get up to $14,000 - only the first year, because we anticipate (and argue) that the graduate schools should pick up the next four years of graduate studies. We have not yet had to pay the initial $14,000 since most schools provide some kind of support during the first year. This is the way the program was designed by Dr. Arturo Madrid and Dr. Eugene Cota Robles of the NCCHE, in 1984.

Last year [1987], we had close to 200 Hispanics (nationwide) applying for this program. The average grade point average of the students was 3.2. I would like to point out that we do not merely skim the cream - we are not a creaming operation. We do consider various other criteria because if we only pick up the best, chances are that they would still be going to graduate school, NCCHE or no NCCHE. To give you an idea of where the students are applying from, 50% came from California. This is not too surprising because the program first started in California and was aimed only at California students. Then, when ARCO came in, it became nationwide. In 1987, 15% came from Texas.

One fact is very clear: Texas institutions seem to do very little to encourage Hispanics to apply for graduate fellowships. I do not know all of the reasons, but it is unfortunate that the students are not properly advised. Most of the applicants apply because their mentors tell them to apply. Rarely do the students just go out and apply. We have found out that a lot has to do with the networking system we have set up. One of the things that we also do with the students, besides giving them the opportunity to get money to get into graduate school, is to send them to a summer institute and a national science conference.

The Summer Science Institute is based at the University of California at Irvine, but we set the students up at other institutes also, such as Stanford - if somebody is willing to take students into the laboratory and give them hands-on experience and treat them as graduate students. These students get their stipends. As a matter of fact, we pay for everything. In addition, we provide stipends for professors and graduate students. These faculty and graduate students are committed, and they care about their students. Each student will have the professor who they admire and who they may want to work with as graduate students. The graduate student helps them face reality and gives them a lot of survival tips. The whole idea here is not just trying to feed them technical or scientific information, but also to provide them with key bits of information crucial to succeeding - things that I wish I had known, that would have made my life easier as a graduate student.

So far in this program, we are seeing 80% of the undergraduate fellows getting into graduate school. The question is, how many are going to get Ph.D.s? Remember, many are now in their second year of graduate school, but we hope that they will complete their graduate studies.

***"The faculty determine who becomes graduate students and future professors."***

Close to 40 NCCHE fellows are in the biological sciences and 21 in engineering. We had a lot of applicants in engineering in 1987, which was really great. Something must have happened. Somebody must have told students about this program because suddenly we had a lot of applicants. It is really good to see, because they are actually thinking about Ph.D.s. As you can see, they cut across many disciplines: engineering, the physical sciences, and computer science. We had applicants from all fields. The breakdown according to state is shown on this slide, with California, of course, having the greatest number of fellows, 30.

This slide shows the group that was selected in 1987 by a faculty committee. The committee is composed of faculty that are in different scientific fields. We have engineers, biologists, mathematicians, and chemists advising and lecturing to the NCCHE fellows.

This slide shows the breakdown into males and females. What I am really happy about is that 40% of our NCCHE fellows are females and 60% are males. We are getting a high number of females who are applying to this program, and they are getting into graduate schools. So the sexist and racist notion that Chicanas/Latinas are not interested in science is certainly destroyed when you start looking at the statistics on NCCHE fellows.

Among the applicants, there was a high percentage of women who want to be Ph.D. engineers. I think that engineering schools and programs are concerned about women in engineering, but I do not know what is being done to focus on Chicanas early and to get them to think about being engineers. We network with SACNAS, the Society for the Advancement of Chicanos and Native Americans in Science. This is more than just engineering and biological sciences. There are at least 50 active SACNAS Hispanic scientists who are part of this network. This organization has been very useful and very important in the success of this program. The faculty determine who becomes graduate students and future professors.

We sponsor a symposium on basic and applied research to which we bring Hispanic role models from all over the United States to present research lectures to the fellows. They discuss what it is to pursue a Ph.D. in research and why you have to do research. These people are all established scientists, like Dr. Elma Gonzalez, the only Chicana biologist I know who is doing active research at the University of California at Los Angeles (she is a Tejana). Dr. Ignacio Tinoco is a professor in Physical Chemistry at Berkeley. He is a Tejano from El Paso and is a member of the National Academy of Sciences. Dr. Frank Talamantes, who is president of SACNAS, is a Professor of Endocrinology at the University of California at Santa Cruz. These are committed professors who interact with the students.

Let me give you a profile of what some of these students are all about. Javier Avalos, a Chicano, got his undergraduate degree at the University of California. Javier, like most of the other Fellows, comes from a very-low-income family. Javier's father is a farm laborer, and his mother is a homemaker. He has five brothers. Javier is going for a Ph.D. in pharmacology. His family values education, as do the families of a lot of these kids, whether they have any degrees or not. It is part of their success.

Ofilia Rivas, whose father is a truck driver and mother is a homemaker, is now working on her Ph.D. in chemistry at the University of California at Irvine. She did not really think about a Ph.D. program that seriously until she became an NCCHE fellow.

***"The discoveries of science are color-blind and belong to no one exclusively."***

We publish a newsletter called *Ciencias*. In the latest issue, we quoted some statements by students who want to become scientists. Once you read these essays, you know that these students have a genuine interest in pursuing research. For example, Jeoffrey Urioste from New Mexico Highlands stated that for him, "Research is the entire reason the sciences exist. We cannot expand our horizons without technical advancement, and I sincerely desire to become an integral factor in the ongoing studies in the microbiological research fields. The discoveries of science are color-blind and belong to no one exclusively."

A Chicana, Anne D. Villa-Lovoz, wrote, "My wish is to first assimilate some version of what is known about waves, then dive into the unknown." Another Chicana, Linda Tello, writes of wanting "to do cancer research in hopes of some day aiding in the discovery of a cure for this dreadful disease," and "being one of the handful of scientists that will have the expertise... to treat patients." Ramona Moritz, a Chicana majoring in mathematics, realizes "the importance of having Hispanics participating in research and making choices that have a greater impact on areas of concern for the Hispanic community."

We have students who are thinking about research, who really want to become academicians, but they need to know how. The NCCHE program plays a important role in showing students how to do research. Out of these 100 fellows, about 80% are Mexican-American. We also have Hispanics of Cuban and Central American origin.

The *Ciencias* newsletter is aimed at the undergraduates. Students read about developments in the sciences that have an impact on them, and they write about their research. It is really the only newsletter that I know of that is specifically directed at Hispanic undergraduates.

It is difficult to get the California or Texas universities to make some kind of commitment of support for continuing the NCCHE program. But if you think about it, if 50% of the students obtain Ph.D.s, that is 40 Ph.D.s in one year. In five years, we will almost have doubled the number of Ph.D.s in the sciences, just through this program alone. It is obvious that each state in the Southwest should have an NCCHE science program! Supporting the students is

very important if we are going to have an impact in getting Hispanics into the university system and training them to be our academicians. We have to get them into graduate school so that they get Ph.D.s. Remember that for every five to ten Ph.D.s we produce, you probably will get one or two who will be outstanding professors and research scientists. The road to the future is steep, but we must be prepared to endure and to succeed.



# MATHEMATICS, ENGINEERING, SCIENCE ACHIEVEMENT (MESA) PROGRAM

**Miguel Garcia**
**(1923 -1989)**

**Executive Director, 1980 - 1989**
**Colorado Minority Engineering Association (CMEA), Inc.**
**University of Colorado at Denver**
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*Mr. Garcia was Executive Director of CMEA since 1980 until his death in September of 1989. He founded CMEA in 1978 to support minority and disadvantaged youth in their pursuit of careers in mathematics, engineering, science, and technology. A retired lieutenant colonel, he served 25 years in the U.S. Air Force, where he was assigned a variety of personnel functions at all organizational levels. He earned a B.B.A. from Loyola University and an M.B.A. from Syracuse University. Colorado State University has established the Miguel A. Garcia scholarship, in his memory and honor.*

The Colorado Minority Engineering Association (CMEA), Inc., was formed in 1978 and incorporated in 1979 to provide educational support services to the Hispanic, Black, American Indian, and disadvantaged students in the State of Colorado to increase their representation in the fields of engineering, science, and technology. To achieve its objectives, CMEA organized a consortium of industry, academia, school districts, professional associations (particularly ethnic minority professional groups), community groups, and parents of the students.

CMEA is a state-wide autonomous nonprofit organization. We survive or we fall on our own. We are the fundraisers for the state-wide Mathematics, Engineering, Science Achievement (MESA) Program, and we disburse the funds as equitably as we can. We try to assure, through our office, a uniform program throughout the state, a program that measures up to our standards. We make visits to all of the school districts during the school year. We conduct a workshop during the latter part of August for the new directors coming in and the old directors, to give them instructions on the new things that CMEA will do the following year.

CMEA is essentially a clearinghouse for the students. If students have applied and done their best to find scholarships but have been unsuccessful at finding financial assistance, then they let us know that they have no funds available for attending college. CMEA then intervenes to obtain funds for them. Fortunately, only minimal efforts there have been necessary.

CMEA serves as a liaison between industry and the public sector, mostly for fundraising, but CMEA has given presentations to federal agencies interested in this approach to education.

The CMEA sponsors two programs: a program at the precollege level (MESA, the subject of this presentation) and the college-level Minority Engineering Program. These two programs provide educational services that encourage carefully selected minority students to pursue studies toward a degree in science, engineering, mathematics, or technology.

The MESA and MEP programs provide for an upward student progression, as shown in Figure1.

## MESA PROGRAM

The precollege program, MESA, begins in the seventh grade and continues through the twelfth grade. Parents of MESA students join the MESA Concerned Parents, Inc. (MCPI) group when the seventh grade student is selected for the program. Thus, parents become an integral part of the team that is delivering critical services to their children. All parents must attend a two-hour orientation session at the conclusion of which they sign an agreement with CMEA to support the program at their school and to work with their child at home. Supportive services continue through award of the baccalaureate degree via the MEP.

Starting at the seventh grade, the MESA program provides junior/ middle school students with specialized counseling, tutoring, role models, field trips, summer enrichment programs, and incentive awards to encourage them to pursue technical studies. In the middle school grades, the students do not follow a specified curriculum.

At the high school level, the basic curriculum for MESA students is shown in Table 1. In addition to the basic curriculum, all MESA students who entered ninth grade in 1983 or later are required to take at least two years of a foreign language in high school.

**TABLE 1**

**Basic Curriculum for MESA High School Students—9th-12th Grades**

| Freshman (9th) | Sophomore (10th) | Junior (11th) | Senior (12th) |
|---|---|---|---|
| English | English | English* | English* |
| Algebra I | Geometry I | Algebra III | Trigonometry |
| Algebra II | Geometry II | Algebra IV | Math Analysis |
| Biology | Chemistry | Physics | Computer Math |
| Social Studies | Social Studies | Social Studies | Calculus |
| Physical Education | Physical Education | Physical Education | College Physics or Chemistry |
| Electives | Electives | Electives | Physical Education |
| | | | Social Studies |
| | | | Electives |

* MESA students receiving incentive awards must be enrolled in accelerated English classes.
Social Studies courses include History, Government, Geography, Civics, and Psychology.

In the eleventh and twelfth grades, students are offered an incentive award for the *A*s and *B*s that they make in mathematics, science, or academic English. The award has been increased this year from $280 for the year for the top student to $800 per year now. Although the requirements for receiving the award have been made more stringent, one student has received it twice. He received $800 one year and $700 the other, so he will be getting $1,500 towards this college expenses.

This award, we hope, will motivate more students to come in and want to be part of MESA from the beginning. We are going to see how this works on a trial basis. We hope that we can

raise the funds to continue this award, because if we start getting more students, then the cost will be fairly high. The year before, we paid out $14,530 in this type of an award. This past year, we had other logistical problems, and the awards dropped down to about $5,000 total. We are working now to bring this up again for next year.

Having prepared students through middle school, junior high, and high school, of course, CMEA tries to get as many of them into the universities as we can and then keep them there. The engineering campuses have agreed to help us with as much of this as they can. They have to fund it because at this time we can't provide any funds to the students for this kind of service. The idea then is to shoot for 100 percent. We are not making it, totally, but as we improve our data gathering and our follow-up on these students, we will be able to get a firmer figure on what that percentage will be.

When the students graduate from college, they go out to work in private industry, or for the government. We ask them to come back to their own community, wherever they may be in Colorado, to help the local MESA program. This phase has already started. One student has come back after finishing dental school to help us with tutoring in his community in one of the middle schools near where he lives. As we start bringing more and more of these students back, we will have a good resource to help our students.

Summer enrichment is one program effort. This small enrichment program is for the metropolitan Denver middle school students (seventh- and eighth-graders). The majority of the students were girls. One activity involved Floyd Boyard, a chemical engineer with Marathon Oil, who talked to the students about what he does and how he was educated. We have 25 students, and we assigned them two projects. Engineers helped them with an electrical-board-assembly project and with a rocket-assembly project. The rocket they assembled became a symbol for the two weeks that the students were with us. They attended school at the University of Colorado at Denver and used classrooms and laboratories made available to us. The College of Engineering has backed up the MESA program from the beginning and, in fact, provided us with office space, furniture, and telephones - a contribution totaling $10,000 a year in in-kind support. This summer we brought the engineers from industry, and next summer we are going to use faculty from the University of Colorado. We will be switching back and forth so that we can keep industry involved and so that the faculty will make contact with the students. That is the way to recruit students to your campus.

***"The rocket they assembled became a symbol for the two weeks that the students were with us."***

The Brain Fair is another enrichment program that we run during the school year. Hewlett-Packard in Colorado Springs put this one-day program together and has been doing it for about four years. About 25 engineers participate, and all of the MESA students come from one school district in Colorado Springs. Wherever we find laboratory technicians or professors willing to spend some time with the students (the students ask for this help through their MESA advisor), we make these arrangements for them.

CMEA operates the MESA program and is responsible for training all of the directors. Each school district must contribute the time of a director to monitor the program within its district. The advisors in the school building that have a program are paid a stipend for their extracurricular work. Right now, some of the districts pay for the expenses of their own program because CMEA has not been able to raise the funds - Colorado is barely beginning to recover from the downturn in the economy of three years ago. Although funding is CMEA's responsibility, the districts have been helping.

**TABLE 2**

**MESA Students by Ethnic Group, Sex and Grade Level—June 1987**

| Grade | Black | | Hispanic | | American Indian | | Asian | | Other | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | F | M | F | M | F | M | F | M | F | M | F | M+F |
| 7 | 16 | 20 | 72 | 101 | 0 | 5 | 23 | 12 | 39 | 40 | 150 | 178 | 328 |
| 8 | 30 | 43 | 75 | 111 | 6 | 3 | 13 | 12 | 52 | 40 | 176 | 209 | 385 |
| 9 | 5 | 23 | 66 | 60 | 0 | 4 | 3 | 5 | 25 | 20 | 99 | 112 | 211 |
| 10 | 9 | 14 | 39 | 37 | 1 | 1 | 11 | 9 | 9 | 20 | 69 | 81 | 150 |
| 11 | 15 | 22 | 46 | 45 | 3 | 1 | 9 | 7 | 19 | 25 | 92 | 100 | 192 |
| 12 | 7 | 14 | 26 | 19 | 0 | 0 | 7 | 7 | 20 | 15 | 60 | 55 | 115 |
| Total | 82 | 136 | 324 | 373 | 10 | 14 | 66 | 52 | 164 | 160 | 646 | 735 | 1381 |

**TABLE 3**

**MESA Program Growth—Number of Schools, School Districts, and Students**

| Year | Schools | School Districts | High Schools | Middle Schools | Students |
|---|---|---|---|---|---|
| 1980-81 | 3 | 1 | 1 | 2 | 30 |
| 1981-82 | 22 | 4 | 8 | 14 | 240 |
| 1982-83 | 41 | 6 | 15 | 26 | 557 |
| 1983-84 | 50 | 7 | 19 | 31 | 799 |
| 1984-85 | 55 | 9 | 22 | 33 | 980 |
| 1985-86 | 63 | 9 | 25 | 38 | 1200 |
| 1986-87 | 72 | 9 | 28 | 45 | 1381 |
| 1987-88 | 77 | 12 | 31 | 46 | 1431 |

The statistics for this past school year [1987] are provided in Table 2. All the ethnic groups in the state are represented the Blacks, Hispanics, American Indians, and Asian Americans. The Asian Americans are the new arrivals. The Vietnamese and the other Far East people who have recently arrived in Colorado are doing very well. The "Other" category includes students who do not want to identify themselves, but are mostly Anglo students who have asked to join the program. A peculiar situation exists in the Denver public schools, because they are still under a desegregation court order which says that any program started in the district after the court order was issued must be made available to all students. So the majority of those 129+ students are Anglo students from the Denver public schools. Some others are scattered in some of the other school districts. That is the total that we hope to increase this coming year.

The track record of the MESA Program starts with 1981 and ends with 1988. Table 3 lists the number of school districts in the program, the number of schools and school districts, the number of high schools and middle schools participating in the program, and the number of students.

**TABLE 4**

**CMEA/MESA Graduates, 1983-1986**

| Year | Number of Seniors | Attended College | Rate |
|---|---|---|---|
| 1983 | 31 | 26 | 84% |
| 1984 | 50 | 43 | 86% |
| 1985 | 85 | 81 | 95% |
| 1986 | 115 | 111 | 96% |

The output of the program, from 1983 (the first year we had seniors graduating in the MESA program) to 1986, indicates that the percentages are holding up very well for the rate of those entering college (see Table 4). In 1985, the rate was 95 percent and made it a particularly good year. I think 1988 is going to be similar. We do not have all of the data in for 1988, but we are meeting our target as far as increasing the number of minorities in the mathematics-based professions. Table 5 gives the rates at which we are getting students into college with mathematics-based majors. The other 28 percent of students are going into political science, communications, strict liberal arts, and other fields. Tables 6 and 7 provide more statistics on MESA students by year, from 1983 to 1986.

**TABLE 5**

**College Majors of CMEA/MESA Students, 1983-1986**

| Year | Attending College | Mathematics-Based Majors | | Other Majors | |
|---|---|---|---|---|---|
| | | Number | Percent | Number | Percent |
| 1983 | 26 | 18 | 69% | 8 | 31% |
| 1984 | 43 | 28 | 65% | 15 | 35% |
| 1985 | 81 | 60 | 74% | 21 | 26% |
| 1986 | 95 | 71 | 75% | 24 | 25% |
| Total | 245 | 177 | 72% | 68 | 28% |

What CMEA has done is to bring together the resources that have always been there - industry and the universities. The universities are just beginning to develop some good outreach programs. Because of the effort that we instituted here, universities see the need of this grouping of MESA students to get some support. Of course, we helped the professionals get organized. Those organizations did not exist prior to CMEA, and it was through our effort and the parents' that they became a working organization. Bringing all of these resources together with the understanding that the ultimate objective is to prepare students to go to college and to be ready when they graduate from the twelfth grade has been the thrust of our effort. Following that lock-step basic curriculum (see Table 1), the students cannot have a

deficiency. We watch their grade point averages very closely. The majority of the MESA seniors are getting some type of scholarship money, academic scholarship, or funds as a result of their scores on the SAT and the ACT. They are being contacted by colleges and universities. With all of these entities working together, we are producing prepared high school students in numbers higher than Colorado had seen in any minority communities.

**TABLE 6**

## College Majors of MESA Seniors, 1983-1986

| Major | | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|---|
| ENGINEERING | Electrical | 1 | 6 | 19 | 12 |
| | Aerospace | | 1 | 6 | 2 |
| | Civil | | | 4 | 1 |
| | Chemical | | 3 | 3 | 2 |
| | Mechanical | | 1 | 1 | 2 |
| | Petroleum | | 1 | | |
| | Biomedical | | | 1 | 3 |
| | Biochemical | | | | 4 |
| | Architectural | | | 1 | |
| | Engineering Science | 1 | | | |
| | Engineering-undecided | 8 | 8 | 4 | 9 |
| | Industrial Construction Management | | | 1 | |
| | Electronic Technology | | 2 | | 1 |
| | **Total** | 10 | 22 | 40 | 36 |
| OTHER MATH-BASED | Mathematics | 1 | | | 1 |
| | Math and Science | | 1 | 4 | |
| | Natural Science | | | | 1 |
| | Computer Science | 2 | 2 | 7 | 9 |
| | Mining | 1 | | | |
| | Chemistry | | | | 2 |
| | Biological Sciences | | 2 | 4 | 3 |
| | Environmental Biology | | | | 1 |
| | Premedicine | 1 | 1 | 4 | 3 |
| | Forensic Medicine | | | | 1 |
| | Veterinary Medicine | | | | 2 |
| | Pharmacology | | | | 2 |
| | Nursing | 1 | | | 1 |
| | Medical Technology | | | 1 | 1 |
| | Architecture | | | | 1 |
| | **Total** | 6 | 6 | 20 | 28 |
| OTHER | Psychology | | 1 | 1 | |
| | Sociology | | | 1 | |
| | Political Science | 1 | | 1 | |
| | Liberal Arts | | | | 10 |
| | Business | 3 | 4 | 14 | 10 |
| | Communications | 1 | | | 3 |
| | Arts | | | 3 | |
| | **Total** | 5 | 5 | 20 | 23 |
| **UNDECIDED** | | 3 | 10 | 1 | 5 |
| **Unknown** | | 2 | | 10 | |

**TABLE 7**

## Institutions Attended by MESA Students, 1983-1986

| 1983 MESA STUDENTS | | 1984 MESA STUDENTS | | 1985 MESA STUDENTS | |
|---|---|---|---|---|---|
| **Institution** | **Students** | **Institution** | **Students** | **Institution** | **Students** |
| ***Colorado Colleges*** | | ***Colorado Colleges*** | | ***Colorado Colleges*** | |
| Colorado College | 1 | Colorado College | 1 | Adams State College | 1 |
| Colorado School of Mines | 3 | Colorado School of Mines | 3 | Colorado Christian College | 1 |
| Colorado State University | 4 | Colorado State University | 10 | Colorado State University | 12 |
| Denver University | 3 | Denver University | 1 | Colorado Technical College | 1 |
| Metropolitan State College | 1 | Metropolitan State College | 1 | Loretto Heights College | 1 |
| Regis College | 1 | Pikes Peak Community College | 1 | Metropolitan State College | 2 |
| Univ. of Colorado at Boulder | 2 | Univ. of Colorado at Boulder | 6 | Univ. of Colorado at Boulder | 18 |
| Univ. Colorado—Colorado Springs | 2 | Univ. Colorado—Colorado Springs | 3 | Univ. Colorado—Colorado Springs | 10 |
| University of Colorado at Denver | 1 | University of Colorado at Denver | 2 | University of Colorado at Denver | 4 |
| University of Northern Colorado | 2 | Western State College | 2 | University of Denver | 1 |
| | | | | University of Northern Colorado | 1 |
| | | | | University of Southern Colorado | 8 |
| ***Out-of-State Schools*** | | ***Out-of-State Schools*** | | ***Out-of-State Schools*** | |
| Arizona State University | 1 | Boston University | 1 | Arizona State University | 1 |
| Massachusetts Inst. of Technology | 1 | Brown University | 1 | Memphis State University | 1 |
| University of Texas at El Paso | 1 | Prairie View A&M University | 1 | Prairie View A&M University | 1 |
| University of India | 1 | Tuskegee Institute | 2 | Stanford University | 1 |
| | | Creighton University | 1 | Tuskegee Institute | 1 |
| | | DeVry Institute | 1 | University of California—Berkeley | 1 |
| | | Gonzaga University | 1 | Benedictine College | 1 |
| | | Northwest Nazarene | 1 | Carnegie-Mellon University | 1 |
| | | University of Tulsa | 1 | Claremont College | 1 |
| | | | | College Santa Fe | 1 |
| | | | | Eastern New Mexico University | 1 |
| | | | | Johns Hopkins University | 1 |
| | | | | Occidental College | 1 |
| | | | | Oklahoma University | 1 |
| | | | | University of Arkansas | 1 |
| | | | | University of Central Florida | 1 |
| | | | | University of Nebraska | 1 |
| ***Total in college*** | ***24*** | ***Total in college*** | ***40*** | ***Total in College*** | ***77*** |
| U.S. Air Force Academy | 2 | U.S. Air Force Academy | 2 | West Point | 1 |
| | | U.S. Merchant Marine Academy | 1 | U.S. Air Force Academy | 1 |
| | | Armed Services | 3 | Armed Services | 3 |
| ***No college*** | ***3*** | ***No college*** | ***2*** | ***Undecided*** | ***2*** |
| ***Unable to locate*** | ***2*** | ***Unable to locate*** | ***2*** | ***Unable to locate*** | ***2*** |

**TABLE 7 continued**

## 1986 MESA SENIORS

| Institution | Students |
|---|---|
| *Colorado Colleges* | |
| Adams State College | 1 |
| Boost Prep School | 1 |
| Colorado College | 2 |
| Colorado School of Mines | 9 |
| Colorado State University | 22 |
| Denver University | 3 |
| Fort Lewis College | 1 |
| Loretto Heights College | 1 |
| Metropolitan State College | 3 |
| Pikes Peak Community College | 3 |
| Red Rocks Community College | 1 |
| Regis College | 5 |
| Sterling Junior College | 1 |
| Trinidad Junior College | 2 |
| Univ. of Colorado at Boulder | 14 |
| Univ. Colorado—Colorado Springs | 4 |
| University of Colorado at Denver | 1 |
| University of Northern Colorado | 1 |
| University of Southern Colorado | 5 |
| Western State College | 1 |
| *Out-of-State Schools* | |
| Boston University | 1 |
| Brown University | 1 |
| Massachusetts Inst. of Technology | 2 |
| Memphis State University | 1 |
| Notre Dame University | 2 |
| Stanford University | 4 |
| University of California | 3 |
| University of New Mexico | 2 |
| Bethel Nursing College | 1 |
| Brigham Young University | 1 |
| California Polytechnic State | 1 |
| Catholic University | 1 |
| Emory University | 1 |
| Harvard University | 1 |
| Hastings College | 1 |
| Howard University | 1 |
| New Mexico Highlands University | 1 |
| Oral Roberts University | 1 |
| Southern Methodist University | 1 |
| Texas Southern University | 1 |
| University of Missouri | 1 |
| Williamette University | 1 |
| *Total in College* | *111* |
| *No college* | *3* |
| *Unable to locate* | *11* |

## QUESTION/ ANSWER SESSION

Question from the floor:

What does it take for a student to follow the MESA curriculum in high school? If you have a high school student who attends this particular high school and who wants to follow the MESA curriculum, is it up to the principal to say "Yes" or "No"?

No. Without being a MESA member, you do not have to say you want to follow the MESA curriculum. The student just says, "I want to prepare myself to go to college; I want to take algebra, geometry, trigonometry." You let the counselor figure it out for you.

Question from the floor:

So it is only MESA members who can follow that particular curriculum?

No, there are students in the school who are taking the same curriculum but who have chosen not to be part of MESA. I am talking about minority students. Some students do become members of MESA, which is fine.

Question from the floor:

Do the students who receive financial incentives have to be financially needy?

No, we just base it on the academics. Most of the students in the program who do not have economic need do not find themselves in the program of their own choosing. I have had discussions with parents. Financially, they are well off, and their students need the MESA program, but they are leaving it up to them to make the decision. We have found out that economic advantage does not necessarily give you academic advantage, especially among the Hispanics. I am really concerned because now they can buy the Cadillac, and they can buy the $150,000 home. They think that this is taking care of the whole education problem, but it is not true. It is very far from true because the parent who can now enjoy this salary really did not have an academic background by which to counsel their youngster right from the beginning - in the elementary years.

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# THE SAN ANTONIO PRE-FRESHMAN ENGINEERING PROGRAM (PREP): A Model For A Successful Precollege Science and Engineering Minority Intervention Program

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## ABSTRACT

*Since the summer of 1979, The University of Texas at San Antonio has conducted the San Antonio Prefreshman Engineering Program (PREP), an academically intense eight-week program for high-achieving middle school and high school students that stresses the development of abstract reasoning skills, problem-solving skills, and career opportunities in engineering and science. More than 1,700 students, 78 percent minority and 49 percent women, have completed at least one summer in PREP. As of Fall 1987, 75 percent were attending college and 13 percent had graduated, with 67 percent majoring in science or engineering. Financial and full-time in-kind manpower staff support for PREP comes from local, state, and national colleges and universities, military commands, other government agencies, professional organizations, private industry, local school districts, and Private Industry Council/Jobs Training Partnership Act sponsors. PREP has now been replicated in six other Texas locations, in TEXPREP.*

*Some general recommendations for intervention program features and linkages are listed.*

According to a 1987 report on Texas public college enrollment data issued by the Texas Higher Education Coordinating Board, about 33 percent of the 14.2 million Texas population is composed of American Indian, Black, and Hispanic minority groups, ethnic groups severely underrepresented in the science and engineering professions in the United States. The number of baccalaureate degrees in engineering and science awarded by Texas public colleges to minorities in 1986 was approximately 12 percent of the total number in those areas. These figures reflect the underrepresentation in Texas of minorities in the engineering and science professions.

The greater San Antonio area has a population of approximately one million people, 46 percent of whom are Hispanic and 6 percent are Black.

Since the summer of 1979, The University of Texas at San Antonio has conducted the San Antonio Prefreshman Engineering Program (PREP). The purpose of this program is to identify high-achieving middle school and high school students of the 15 Greater San Antonio Area school districts, private schools, and parochial schools who are potential engineers or scientists and to give these individuals needed reinforcement so that they can successfully pursue future college engineering and science studies.

The program participants must agree to commit themselves to eight weeks of intellectually demanding classes and laboratories. The participants are given class assignments and laboratory projects. They also take scheduled examinations, including a final examination in each course. All participants are expected to maintain a performance standard of 75 percent average or better during the program. Each student earns a final grade which is reported to his or her school. A student may participate for three summers. When participants complete one summer of the program, they should be convinced that they can successfully pursue studies in a college setting through commitment and hard work.

During the academic year, the San Antonio Alliance for Minorities in Engineering (SAAME) conducts an outreach program in predominantly-minority middle schools and high schools of San Antonio. PREP students in these schools participate in SAAME activities. Also, SAAME recruits students for PREP. The PREP office offers secretarial services to SAAME as needed.

Since 1979, 1,741 students have completed at least one summer in PREP, of whom 78 percent have come from minority groups underrepresented in science and engineering and 49 percent have been women.

**Table 1. Status of College-Age Former PREP Participants**

| PREP YEAR | College Eligible | Number of Responses | Not in College | ATTENDING COLLEGE | | | | COLLEGE GRADUATES | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Engineering | Science | Other | Total | Engineering | Science | Other | Total |
| **1979** | 42 | 40 | 9 | 1 | 1 | 1 | 3 | 10 | 9 | 9 | 28 |
| **1980** | 49 | 40 | 4 | 4 | 4 | 2 | 10 | 17 | 4 | 5 | 26 |
| **1981** | 64 | 54 | 13 | 14 | 3 | 10 | 27 | 6 | 4 | 4 | 14 |
| **1982** | 164 | 140 | 28 | 42 | 29 | 36 | 107 | 4 | 1 | 0 | 5 |
| **1983** | 213 | 186 | 7 | 62 | 42 | 75 | 179 | 0 | 0 | 0 | 0 |
| **1984** | 96 | 75 | 4 | 33 | 24 | 14 | 71 | 0 | 0 | 0 | 0 |
| **1985** | 21 | 20 | 1 | 13 | 3 | 3 | 19 | 0 | 0 | 0 | 0 |
| **Total** | 649 | 555 | 66 | 169 | 106 | 141 | 416 | 37 | 18 | 18 | 73 |

Each summer, PREP follows former participants. As of Fall 1987, 649 former participants were of college age. In the 1987 follow-up, responses were received from 555 individuals, of whom 416 (75 percent) said that they would attend college in the fall of 1987 and 73 (13 percent) had already graduated from college. Thus, 88 percent of the respondents were going to college or were college graduates. Of this number, 67 percent indicated that their majors were in science or engineering.

Table 1 is a statistical summary of the status of college-age former PREP participants from the 1987 follow-up.

Since a significant number of minority students come from low-income families, PREP charges no tuition or fees. In this way, low income does not become a barrier for application. Also, PREP has been designated a Summer Youth Employment and Training Program (SYETP) worksite. In 1987, 38 poverty-level participants earned as much as $800 by their work experience in PREP.

Financial and full-time in-kind manpower staff support has come from local, state, and national colleges and universities; local school districts, military commands, other government agencies, private industry, and the San Antonio Alliance for Minorities in Engineering (SAAME).

In the 1987 PREP, 537 students started the program and 420 successfully completed it. Of the participants completing the program, 82 percent were minority and 59 percent were women.

***"Former San Antonio PREP students have been very successful contenders in science and mathematics at the regional, state, and international levels."***

As in previous years, approximately half the students who left the program did so because of financial reasons. These students usually leave within the first 10 days. Because of their low family income, they cannot afford the daily expense of attending PREP, and historically PREP never has had the financial resources to support students. The other half who leave, usually within the first three weeks of PREP, leave because of academic difficulties.

Former San Antonio PREP students have been very successful contenders in science and mathematics at the regional, state, and international levels. In particular, one student in 1984 won the grand prize in the Alamo Regional Science and Engineering Fair. This accomplishment automatically qualified her for the International Science Fair, in which she was awarded third place in the mathematics division. A 1984 participant was one of 40 finalists in the 1988 Westinghouse National Science Talent Search.

In 1987, the United Negro College Fund, Inc. presented San Antonio PREP the Frederick D. Patterson Award for rendering outstanding service in the interest and support of the minority community. TEXPREP, the statewide replication of San Antonio PREP, was designated an exemplary EESA Program by the U.S. Department of Education in 1986. In 1987, the Texas Senate issued a resolution commending the work of TEXPREP.

## PROGRAM DESCRIPTION

The goals of PREP are:

1. To acquaint the students with professional opportunities in engineering and science.

2. To increase the number of competently prepared minority and women high school students from the San Antonio area who will ultimately pursue engineering or science in college.

3. To reinforce the mathematics preparation of these students in the pursuit of mathematics and science/engineering studies at the precollege and college levels.

4. To increase the retention rate of these students in college.

5. To increase the number of women and minority college graduates, particularly in science and engineering, from the San Antonio area.

Traditionally, the principal obstacles for students in engineering and science include mathematics and its problem-solving applications. A major objective of PREP, therefore, is to strengthen the participants' abstract reasoning skills and problem-solving skills. The program efforts are directed toward the reinforcement of the normal precollege mathematics instructional program by discussing college level topics not offered in high school or middle school. The science and engineering awareness thrusts are given in the engineering and physics courses, research and study sessions, and career opportunity components. Most courses are eight-week courses that meet for one hour daily, Monday through Friday. Friday is usually reserved for field trips, practice SAT examinations, or other special activities.

The courses and components for the program include: Logic and Its Applications to Mathematics (first year), Algebraic Structures (second year), Introduction to Probability and Statistics (third year), Topics in Problem Solving, Introduction to Engineering (first year—4 weeks), Introduction to Computer Science (first year - 4 weeks), Introduction to Physics (second year), Introduction to Technical Writing (third year), Research and Study, and Career Opportunities Awareness.

Almost daily, visiting scientists or engineers - a significant number of whom are women or minorities - make presentations to the participants about career opportunities. Other times, presentations are made on college selection, financial aid, and other appropriate topics.

On the first day of the program all students take mathematics placement examinations, and in the first year they take computer science placement examinations. Based on the results of these examinations, their academic background, and school grade level, students are placed in seminar groups of 20 or fewer. Each section in logic or algebraic structures consists of two seminar groups of similar preparation; for example, two groups of eighth-grade students. Sections of all other classes consist of one seminar group, provided that adequate manpower is available; otherwise, some doubling up may have to occur in some sections. The problem-solving seminars and research and study sections always consist of one seminar group.

Each seminar group is assigned a program assistant who is an undergraduate engineering or science major. This assistant monitors his or her group throughout the day and provides supplementary instruction to students as needed.

Each student is expected to follow a routine that requires attendance and independent outside participation for these components. The student is evaluated on the basis of performance in these components on assignments, examinations, and quality of laboratory projects. At the end of the program, each participant with a satisfactory overall performance receives a certificate of achievement and a final grade, which is reported to the participant's school with the permission of the participant.

Below is a typical daily (Monday through Thursday) schedule for the summer program:

| | |
|---|---|
| 9:00 | Staff meeting |
| 9:50 | Roll call |
| 10:00 - 10:50 | Visiting speaker |
| 11:00 - 11:50 | Logic/Algebraic Structures/Probability and Statistics |
| 12:00 - 12:50 | Engineering/Computer Science/Physics/Technical Writing |
| 1:00 - 1:50 | Lunch |
| 1:50 | Roll call |
| 2:00 - 2:50 | Research and study |
| 3:00 - 3:50 | Problem-solving seminar |
| 3:50 | Dismissal for Non-SYETP students |
| 4:50 | Dismissal for SYETP students |

Friday is usually reserved for special presentations, field trips, and practice SAT examinations. The daily beginning and ending times may differ in the various PREP locations.

## FACILITIES AND STAFF

The San Antonio PREP is conducted on the campuses of the University of Texas at San Antonio (first-year students), Palo Alto College (second-year students), and Trinity University (third-year students). These institutions provide the needed classrooms, laboratory facilities, and staff office space.

Participants have access to most facilities available to regular students, specifically, libraries, cafeterias, and recreational facilities. Participants are expected to observe all normal or special program regulations established by the respective institution or program.

The staff of the program includes the program director, assistant (campus) directors, program faculty, and program assistants. In 1987, the program staff included four local college faculty members, five high school teachers, a practicing engineer, 25 U.S. Air Force and two U.S. Navy engineering and science officers, and 25 program assistants.

The week before instruction starts is staff orientation week, during which the experienced college and high school teachers hold instruction workshops with the Air Force and Navy officers. In the program, the officers for a given course are under the supervision of a course coordinator, who is a college or a high school teacher.

Each year, the Navy and the Air Force assign officers trained in engineering and science who can work full-time for nine weeks in the program. Most years, however, because of military needs, some of the assigned officers must work in five-week shifts. The fourth week of the instructional program is an overlapping week that serves as an orientation period for the new officers, who work with the officers they will be replacing. A serious effort is made annually with the sponsors and benefactors to recruit women and minority faculty and program assistants. The 1987 PREP staff included seven Anglo women, one Black woman, and one Hispanic woman. Among the males, the program included 26 Anglo, four Black, 22 Hispanic, and two Asian (race/ethnicity) participants.

## METHOD OF AND CRITERIA FOR SELECTION OF PROGRAM PARTICIPANTS

In January, program brochures and applications are distributed to all middle and secondary schools of the Greater San Antonio Area.

Beginning in November, the director visits various area middle and high schools to discuss PREP with students, teachers, counselors, principals, and PTAs. Special attention is given to schools in predominantly economically and educationally disadvantaged areas.

*"A potential pool of no-cost military assistance is the most recently commissioned officers of the military academies and the ROTC units (as instructors)."*

Students are expected to have at least a *B* average in their current academic year. High school students, in addition, need a level of precollege mathematics achievement appropriate for their grades. Sixth- and seventh-grade students are required to have an *A* in mathematics and an *A* in either science or English.

Each student is required to write an essay on the reasons he or she wants to participate in PREP. Each new participant must be nominated by two teachers or counselors, one of whom must be a mathematics teacher. A copy of the latest grade report must be submitted.

Historically, all students who have satisfied the admission criteria have been admitted to PREP.

## INDUSTRIAL AND INSTITUTIONAL COMMITMENTS FOR THE PROGRAM

Since the San Antonio PREP was started in 1979, it has received substantial financial and in-kind manpower support from local, state, and national colleges and universities, industry, military commands, government agencies, and local school districts. For example, in the 1987 PREP, these sources supported the equivalent of 27 full-time faculty members in mathematics, engineering, computer science, and problem solving, 25 program assistants, and numerous one-day visitors. The total in-kind and financial support for 1987 PREP was at least $300,000, of which $70,000 was in direct financial contributions.

In the 1987 PREP, local SYETP sponsors supported 38 participants from poverty-level families in an amount totaling nearly $26,000.

## PROGRAM EVALUATION AND FOLLOW-UP

In the closing week of PREP, an attitudinal evaluation is given to the students. During the summer, a follow-up survey form is mailed to all former participants. The principal purpose of this survey is to track the numbers who go to college, select major studies in science or engineering, graduate from college, and graduate with degrees in science or engineering. San Antonio PREP has devised a survey instrument for which the current response rate is 85 percent of those former PREP students who are now of college age. The results of the 1987 survey are shown in Table 1, above (75 percent attending college, 13 percent graduated, 67 percent science and engineering majors).

## TEXAS PREFRESHMAN ENGINEERING PROGRAM (TEXPREP)

Because of the San Antonio PREP record in preparing minorities for college science and engineering studies, the Texas Higher Education Coordinating Board has partially funded the establishment of PREP in six other locations in Texas. The statewide program is known as TEXPREP. It has operated since 1986. Each location has its own director. In 1987, TEXPREP served a population of 2,200,000, of whom 1,300,000 are minority students. In 1989, the TEXPREP will be offered in El Paso and Houston.

The San Antonio PREP has a substantial file of course notes, problem sets, placement examinations, and program forms which are available to all TEXPREP directors wishing to use this material in the organization of their respective programs. These materials include:

1. Complete set of classroom notes for logic.
2. Complete set of classroom notes for engineering.
3. VAX Basic Manual for computer science.
4. Problem sets in Pre-Algebra, Algebra I, Algebra II, Geometry, Analytic Geometry, Trigonometry, and Physics.
5. Placement tests in mathematics and computer science.
6. Current program evaluation forms.
7. Follow-up survey forms.
8. Brochures, student application forms, and teacher recommendation forms.
9. Sample agendas for parents' orientation, opening day, and closing day assembly.
10. Sample correspondence and other forms.
11. Statistical table forms.
12. Final reports.

San Antonio PREP shares some resources with the other TEXPREP locations; for example, in 1987 the Air Force and the Navy contributed staff, consisting of engineering and science officers, to the other locations. San Antonio PREP is willing to share its materials with other locations interested in beginning a similar program.

## RECOMMENDATIONS FOR ADDRESSING AND SOLVING THE PROBLEM OF MINORITY UNDERREPRESENTATION IN SCIENCE AND ENGINEERING THROUGH INTERVENTION PROGRAMS

Intervention programs should encompass the following features:

1. Organize summer intervention programs (for elementary, middle, and high school students lasting six to eight weeks) that stress academic enrichment and that have high expectations from the participants.

2. Establish the intervention programs on college campuses so that successful participants realize that they can negotiate studies in a college setting through commitment and hard work.

3. Develop both residential and commuter intervention programs.

4. Offer transportation and lunch support to intervention program participants who qualify for school district free lunch and reduced cost lunch programs but do not qualify for a Job Training Partnership Act (JTPA) program. Offer small stipends (determined by a point system based on academic performance) to those participants (that is, the better the performance, the higher the stipend).

5. Require strong accountability and reporting components that will emphasize the tracking of participants through high school and college. The only meaningful payoff for a high-quality intervention program is measured by the number of students who graduate from high school, the number who go to college, the number who major in science and engineering, and the number who graduate from college.

6. Offer long-term support for successful intervention programs, so that the director does not have to spend an unreasonable portion of his or her time in money-raising activities.

*"Offer long-term support for successful intervention programs, so that the director does not have to spend an unreasonable portion of his or her time in money-raising activities."*

In the area of linkages, the following steps are recommended:

1. Encourage linkages between intervention programs conducted by colleges in minority-impacted areas and other colleges committed to recruitment of minority students. A cooperative college might provide in-kind manpower support to a summer intervention program. In a subsequent summer, the college might invite some outstanding minority participants for eight weeks of academic enrichment at the expense of the college. If a participant does well in the local school, the cooperative college might then agree to offer automatic admission (all needed academic scholarship and financial aid) to this student upon graduation.

2. Develop linkages with well-known private preparatory schools interested in recruiting minority students. A private school may offer to staff a program with one of its own teachers; in turn, the program will agree to share participant lists with the school so that the school can recruit minority students.

3. Develop linkages between intervention programs and military services whereby the latter will contribute the services of officers to teach in the program. A potential pool of no-cost military assistance is the most recently commissioned officers of the military academies and the ROTC units. Many of these officers are commissioned in May and do not report to a long-term assignment until August or September. Rather than giving them orders for temporary assignments at some military base, the command can use the skills of these individuals more effectively and more

productively in summer intervention programs. These officers serve as strong role models for the program students, and it is a very inexpensive contribution of the military services to the development of our human resources.

4. Develop linkages between local JTPA sponsors and intervention programs so that poverty-level students can participate in summer intervention programs and have this experience to serve as work experience in the JTPA program. In this way, poverty-level participants can earn up to $800 during the summer months.

5. Develop linkages between intervention programs and local science and engineering professions whereby the latter will sponsor limited activities with the program participants during the academic year.

6. Establish linkages between intervention programs and participants' parents. At the beginning of a recruiting cycle, hold orientation programs for parents of prospective applicants after recruitment is completed. At the end of the program, hold a closing day assembly to which participant families and friends are invited.

7. Give credit incentives to public and private industry and agencies for responsibly and consistently supporting good intervention programs as opposed to giving public relations donations to doubtfully beneficial programs.

8. Encourage local school districts to contribute services of premier teachers to summer intervention programs and to give independent studies credit to successful program participants.

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# HISPANIC PARTICIPATION IN HIGHER EDUCATION: THE NEED FOR EFFECTIVE PRACTICE

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The rates at which Hispanics participate and succeed in higher education in the United States are unacceptable. For every 1,000 Hispanic children who enter the educational system, only 70, on the average, graduate from college. In some areas of the country, the figure is even more dismal - as low as 25 out of 1,000.

The implications of these low participation and success rates are of momentous importance to American society in general, but critical to the western and southwestern states and to Florida, New York, New Jersey, and Illinois. The consequences of such a situation are not limited to issues of social justice; they are also economic. The continued economic growth of these regions will require the fullest development possible of all of their valuable human resources, most of whom are now Hispanic.

The changing demographics are of critical importance to higher education. According to a report from the Education Commission of the States (1986), "progress toward full participation of minorities in education has become distressingly stalled." This same document reports that high school graduation rates for all racial and ethnic groups have risen in the past 10 years, but the college attendance rates for minorities have risen little since 1976, and, for Blacks, have actually declined.

This situation speaks of a crisis in education. Students are not being prepared successfully for the transition to postsecondary schools. This lack of preparation is reflected in the attrition problems found on many college campuses.

An important consequence of the current status of education is the recent media attention to the problems of public education in the United States. This attention has been focused through a comparison of problems here at home with the tremendous successes abroad.

Unfortunately for minority students, the major effort to redress educational disadvantages has been in the form of remedial programs targeting the high school and college years. It is likely that insufficient attention is being paid to elementary school training and the failure of traditional educational practices.

***"It seems obvious that the differences are not entirely due to the students, per se, but rather to the system, both in its application and in the attitudes it engenders."***

According to Cummins, Kagan, and others, the discrepancy between racial or ethnic groups' performance on achievement measures does not become significant until the third or fourth grade. This observation means, for example, that the difference commonly seen on college admissions tests between Anglo, Black, and Hispanic mean scores has not always been there. This important piece of information suggests immediately that the educational intervention is at least partially responsible for the performance difference between students, since it is the common variable between groups.

This consideration is an important one to make when we compare the poor performance of American children to their peers in other countries. This poor performance is evident as early as kindergarten. According to Harold Stevenson, for example, Japanese 5-year-olds perform significantly better than their American counterparts in mathematics, and their performance improves relative to that of their American peers throughout the elementary years. Why is this true?

Stevenson, in further discussion, dispenses with the myths that Asian children are more intelligent than American children and that Asian children get an earlier start and/or more intensive training. Juku, or after-school programs, enroll fewer than 50% of the eligible students. And, interestingly enough, the most popular subjects for Juku are art, music, dancing, and calligraphy. Classroom observation in both the United States and the Far East indicated that American kindergarten teachers spent 90% of their time in direct teaching and structured experiences, whereas Chinese teachers spent 61% and Japanese teachers spent 65% of their time in these activities.

According to Stevenson, many unfamiliar with the Japanese educational system subscribe to the myth that Japanese classrooms are characterized by group recitation and rote learning. In fact, teachers in Chinese and Japanese classrooms rarely rely on rote. Rather than emphasizing choral recitation, Asian teachers use a mix of approaches that emphasize problem solving, application of principles, and, in general, higher-order thinking skills. It is likely that the consequences of this approach are the higher performance level of Japanese students relative to their American counterparts in solving word problems, utilizing graphs and tables, understanding spatial relationships, and learning estimation.

It seems obvious that the differences are not entirely due to the students, per se, but rather to the system, both in its application and in the attitudes it engenders. When asked to evaluate themselves academically, American children rate themselves highly, whereas Asian children rate themselves much lower. This rating corresponds to reported measured perceptions of the children's mothers. Such evaluations of high ability and achievement by children and mothers cannot be conducive to a child's diligent study. Unfortunately, these perceptions are based partially on fact. In a comparison of the Japanese and American curricula, although each curriculum contains about equal number of concepts and skills, they are introduced earlier in the Japanese system. Attributional research suggests that these perceptions should result in low levels of effort and persistence - " If I do well because I am able, then, when I do not do well, it is because I am not able enough, so why try?"

In a comparison of academic versus total classroom time, the percentage of time devoted to academics was much lower in American fifth-grade classrooms. According to survey and observation data collected by Stevenson, the difference was as much as 28%. In fact, Asian teachers surveyed were incredulous that American teachers were responsible for the custodial care of their students all day long in addition to their classroom responsibilities.

*"Our typical reaction to failing student performance is to raise requirements, test students, and claim that they are not motivated."*

Examination of all the data leads to the conclusion that our schools as well as our children need to change. All too often, the blame for poor student performance is placed solely on students, parents, and/or teachers - not on educational practice. Our typical reaction to failing student performance is to raise requirements, test students, and claim that they are not motivated. These actions, while in some way ensuring quality, do nothing for the students for whom we guarantee that quality. Until substantial institutional change is realized, it is up to concerned individuals and organizations to focus on the more expensive and less effective alternative of special programs and remediation.

## HISPANIC ASSOCIATION OF COLLEGES AND UNIVERSITIES

The Hispanic Association of Colleges and Universities (HACU) is one such concerned group. HACU is a national association of colleges and universities committed to institutional and student excellence. HACU has three membership categories: full, associate, and business. Full membership is open to institutions of higher education with, at a minimum, 25% Hispanic enrollment. Associate membership is available to institutions of higher learning not meeting the enrollment criteria but that are interested in furthering educational opportunities for Hispanic students. Business membership is open to corporations or other business concerns sharing HACU's goal. At present, 60 institutions nationwide are eligible for full membership, and 40 of these are HACU institutions.

## HISPANIC STUDENT SUCCESS PROGRAM

In response to the crisis in education, HACU, through grants from the Pew Charitable Trusts, the Ford Foundation, and others, has developed and is in the process of implementing the Hispanic Student Success Program (HSSP). HSSP is a comprehensive, intersegmental, and integrated pilot program designed to increase the higher-education participation and success rates of San Antonio and South Texas Hispanic students. Interested in stemming the high Hispanic drop-out rates, HSSP incorporates various aspects of model programs throughout the United States. Its three major goals are to:

- Increase the high school graduation rate of Hispanic students in the target region from the present 55% to 70% by 1992.
- Increase the college-going rate of Hispanic students in the target region from the present 40% to 60% by 1992.

- Increase the college retention rate of Hispanic students from the present 32% to 45% by 1992.

The achievement of these goals will mean that 420 out of 1,000 Hispanic students entering elementary school will go on to college (a 91% increase over the present rate). In addition, it will mean that 189 of those Hispanics will graduate from college (an increase of 170% over current conditions).

***"But beware of the theorists! Education has fared poorly in adjusting to the unsubstantiated dictates of how it should be administered."***

The HSSP contains strategies to improve the performance of San Antonio and South Texas Hispanic students at various points along the educational pathway. What distinguishes the HSSP from other projects that focus on minority students is that HSSP seeks to reach and influence thousands rather than just hundreds, that activities are directed at students at all levels, and that each activity is subject to modification as a direct result of empirical evaluation.

The HSSP established five *action components* as the vehicles to accomplish the project's goals: institutional change, marketing, training and technical assistance, community organizational/ parental involvement, and enrichment services. The *institutional* change action component seeks to bring about substantive changes in federal, state, and local policies and practices that inhibit the participation and success of Hispanic students in higher education through research and the dissemination of information. The *marketing* action component communicates to large numbers of students and other influential individuals clear and focused messages about the value of higher education through commercial-quality advertisements in the media. The *training and technical assistance* action component delivers educational and support services to school district teachers, counselors, and other personnel. The *community organizational/parental involvement* action component serves as a catalyst in fostering meaningful relationships between parents of Hispanic children and the schools that educate those children through the activities of community-based organizations. The *enrichment services* component provides academic support services to students from elementary through postsecondary levels. The specific activities of the enrichment services component include the elementary Prescholars program, a leadership development summer program, enrichment centers, academic year enrichment program, and a two-year/four-year program.

## HACU'S MAJOR CONCERNS

As director of the enrichment services, aside from the implementation of programs I have two major concerns. The first concern deals with the lack of data relating to what we are doing. Our limited review of the literature in the course of program development resulted in the identification of a great deal of descriptive information but very little in the area of empirical evaluative data. We welcome the efforts of CASET and others to remedy this situation. We encourage CASET to disseminate its findings as widely as possible so that those of us involved in remediation and intervention can benefit and so that ultimately the students we serve also can benefit.

It is important that our programs not merely duplicate and repeat what is traditionally happening in the classroom. This ineffective model, developed during the onset of the Industrial Revolution, views education as a product rather than as a process and conceives of

schools as education factories. Consider how schools are designed: assembly-line-like with lock-step progression, with each "lump of clay" requiring identical molding. Our testing of children is the product quality control, and response to remediation is retention, "reprocessing," or worse. This model is, and clearly has been, ineffectual. An examination of test scores, drop-out rates, and college matriculation rates confirms this. Our programs should emphasize the implementation of the best research in cognition, information processing, learning, motivation, sociology, and anthropology. We teach students to read but not how to study or even to think. Clearly, there are individual differences in the way students study and in the effects of these differences. Weinstein and others have demonstrated that differences in study strategies are related to differences in achievement. Students need the benefit of process thinking. They need to know why and how as well as what and when. But beware of the theorists! Education has fared poorly in adjusting to the unsubstantiated dictates of how it should be administered. We should not make the same mistake as in the past of basing educational policy on "expert" judgment. Finally, let me say that students are responsible for their own learning in terms of effort, but we cannot expect aimless effort. We must provide students with the goals, the methods, and the prospects for success.

My second concern relates to what I have already mentioned: we need to be out of business! Our programs need to be effective to redress current educational deficits, but we must make an impact on the educational process itself so that the need for remedial activities is reduced to a minimum. Our students are equally capable but not equally achieving. Our programs can imply that success of minority students depends on "special help" because of inadequacies inherent in our students. But this clearly is not the case. We must investigate and specify modifications to the traditional academic pathway that will result in achievement commensurate with potential.

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# MINORITY HONORS TRAINING AND INDUSTRIAL ASSISTANCE PROGRAM

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Luna Vocational and Technical Institute (LVTI) is located in Las Vegas, New Mexico. LVTI opened its doors in 1970 and was established under the provisions of the 1967 Laws, Chapter 177, which permitted school districts to participate in vocational institute programs. The programs are approved through the electoral vote, whereas school districts pay the five mill levy to participate in particular programs.

A feasibility study was conducted in 1970 and, as a result, a program of studies and an operational plan were submitted to the Municipal Board of Education. The program at LVTI began with nine training programs and has now grown to 31 certificate training programs. This year will be the first in which LVTI will offer Associate of Applied Science degrees. The first classes were held in a job corps center. The buildings were a conglomerate of barrack buildings abandoned by the U.S. Army after World War II. In the 17 years following, 17 million dollars was committed to new construction and renovation.

Currently, we serve six school districts and our training programs are designed to provide theatrical background, practical training, and on-the-job training experiences. Our departments include an extensive Business Occupations department and Technologies, Trade and Industry, Developmental Studies, and Health Occupations departments. The average age of our students is 26, and 95% of our students are on some type of financial aid. Before the effectiveness of the educational process at LVTI can be assessed adequately, it is necessary to take a broad look

at the people from the service area - ethnically, culturally, and educationally. Additionally, the philosophical posture of the Institute must be examined.

LVTI serves a population of six school districts within five counties. They include San Miguel, Guadalupe, Mora, Colfax, and Union County. Because of the sparsely populated area, the institute conducts two satellite centers in the communities of Springer and Santa Rosa. The area contains communities with the lowest per capita income in the whole country. The average income for the counties that LVTI serves is $7,023. The area is predominantly Hispanic, with a population of approximately 75% Spanish-speaking and 7% American Indian. The rest is composed of various ethnic and racial groups, mostly Anglo, whose sociological characteristics are highly rural, conservative, and removed from the contemporary technical-industrial and economic world.

The Hispanics from this area are predominantly descendants of the Spanish colonials who moved from Spain in the sixteenth and seventeenth centuries. They left briefly with the Pueblo Rebellion of 1680 and returned to remain in the area in almost total isolation for the next 250 years. The primary culture has remained relatively intact, and the vestiges of the Spanish colonials are still present. The family structure, the extended family, the roles of family members, the language of the homes, cultural values, and artifacts are still virtually intact from the sixteenth and seventeenth centuries. The people from this area call themselves Spanish; Mexico was, relatively, a foreign country and a foreign culture.

***"The program has provided scholarships to over 300 minority students pursuing high-technology careers, and approximately 80% of the graduates are now gainfully employed in energy-related areas."***

Most vocational schools in the country concentrate their efforts in preparing students in the area of job skills, vocational attributes, and working functions. LVTI has a dual role to perform: to provide training, and to prepare students for the world of work. Training includes the skills and the concepts necessary to perform the functions of a job. Students are prepared to live in a work environment whose culture is different, unfamiliar and many times in conflict with the one from which they came. In the area that LVTI serves, the high schools are small, and many of them have weak curricula in some of the high-technology areas. There is limited funding, little or no exposure to high technology, few role models in high-technology fields, and limited access to postsecondary education.

The Minority Honors Training and Industrial Assistance Program provides minorities with opportunities for training and employment with high-technology energy related industries and scientific institutions. With the support of the Department of Energy (DOE), Office of Minority Economic Impact, LVTI was selected as one of eight post-secondary schools in the nation to participate in this program. The program provides scholarships to minority honor students pursuing high-technology careers. It also has provided for the establishment of linkages with major high-technology industry and scientific institutions. The program is providing better job opportunities, and it is providing technology transfer to the educational institutions and the minority communities. It is providing a closer relationship between energy industries and educational institutions for a better trained work force to facilitate the participation of minorities in energy-related fields. The program recognizes outstanding scholarship of minority students, and it supports and enhances minority student involvement in high technology. The program has enabled greater interaction and partnership linkages for our institution with private industry and national scientific institutions.

Other programs similar to LVTI are located at Bronx Community College in Bronx, New York; Coahoma Junior College in Clarksdale, Mississippi; Greenville Technical College in

Greenville, South Carolina; Houston Community College in Houston, Texas; Laney College in Oakland, California; Oklahoma State University, Technical Branch, in Okmulgee, Oklahoma; and the University of Hawaii, Hawaii Community College, in Hilo, Hawaii. DOE selected these sites because of the large minority populations in each one. I believe that LVTI is the only vocational-technical school that has this program.

The Minority Honors Training and Industrial Assistance Program at LVTI has been extremely successful and has offered LVTI a unique opportunity to serve both its student population consisting, of approximately 82% minority (of which 75% is Hispanic), and New Mexico's growing high-technology industry. The program has provided scholarships to over 300 minority students pursuing high-technology careers, and approximately 80% of the graduates are now gainfully employed in energy-related areas.

Students selected to participate in the program must qualify by:

1. achieving "honors" status as evidenced by a record of 3.0 or above grade point average in high school or other previous education, and possessing high potential for completing the prescribed program of study;

2. providing evidence that financial support is needed;

3. being a member of a recognized minority as defined by Public Law 95-619, Sec. 211, Paragraph (F); and

4. pursuing a career in a high-technology, energy-related area.

The participating students live in northeastern New Mexico within the LVTI service areas of San Miguel, Colfax, Guadalupe, and Mora counties. The area's population is approximately 75% Hispanic and 7% American Indian, with the remainder a variety of ethnic and racial groups, mostly Anglo, whose sociological characteristics are highly rural, conservative, and removed from the contemporary technical, industrial, and economic world. A large proportion of LVTI students (58.66%) come from families with incomes less than $9,000 per year. Half of these students come from families with incomes less than $3,000 per year. These characteristics show that the LVTI service area is one of high unemployment, underemployment, and more specifically, minimal high-technology training and employment opportunities. Because of the geographical location of the population served, many of the students participating in the program travel in excess of 140 miles daily to receive training (LVTI Institutional Self-Study, 1987, 12).

The Minority Honors Training and Industrial Assistance Program has assisted in the technology transfer to LVTI and the minority communities that it serves. The program has enabled LVTI to establish linkages and articulation with 17 major corporations and scientific institutions. Sixteen of these are located 125 miles from LVTI. They include:

*Las Vegas, NM*

Montana de Fibra

*Albuquerque, NM*

Computer Sciences Corporation
Digital Equipment Corporation
Intel Corporation
EG&G, Inc.
Kirtland Air Force Base Operations
General Electric Co.

Aircraft Engine Business Group
Sparton Technology, Inc.
Motorola Inc.
Siemens Transmission Systems
The BDM Corporation
Kirtland Air Force Base
Lasertechnics, Inc.
C-VI Lasers
Gulton Data Systems
Sandia National Laboratories

*Los Alamos, NM*

Los Alamos National Laboratory
EG&G, Inc.
Los Alamos Operations

Through linkage efforts, these corporations have provided career opportunities for LVTI students and have assisted in curriculum development in high-technology areas. They have provided on-site tours and have donated equipment for instructional use. Cooperative education programs, specialized training programs, and summer employment programs also have been established, thus enabling students to further develop their training and job skills in high-technology careers. This cooperative effort provides students with many job-related experiences and permits them to apply their classroom theory to future employment. The cooperative effort also provides students with levels of technology and application skills that will be demanded of them by the high-technology work force. Cooperative projects, training positions, summer employment programs, and major high-technology employers have selected graduates for full-time employment.

Presently, students training in electronics, laser electro-optics, and computer programming commute on a weekly basis to Albuquerque to participate in the cooperative effort with industry. The training effort is probably one of the first for LVTI in that different companies provide tours, instruction, classroom facilities, course development, guest lectures, or on-site classes in Albuquerque. LVTI has had the opportunity to take students from these rural communities to see what high-technology industry is doing, to get a feel for high-technology industry, so that in the future they will not be afraid to seek employment and work with these companies. Many of these companies also have provided cooperative education programs for our students.

The articulation and linkages with these industries is providing a greater awareness of the application of technology to the educational training at LVTI and to the northeastern sector of the state. This interaction and input from industry is helping to develop in-state resources to begin to meet some of the work force needs of high-technology industry in our state and country.

In continuing the minority honors program, LVTI plans to extend this successful program to include other minority students. The program goals are to: (1) provide jobs in high-technology fields for minority honor students from low income, high unemployment areas; (2) meet the needs of energy-related industries by developing training curricula to fit their objectives; and (3) encourage technology transfer from industry to LVTI.

The objectives are to:

- Provide scholarship assistance to minority honor students.
- Create additional linkages with high-technology industry and scientific institutions.

- Improve LVTI's ability to provide qualified graduates through increased emphasis on appropriate curriculum and certifications.

- Establish cooperative efforts with other technology-related institutions in New Mexico.

- Establish joint agreements with institutions of higher learning for sharing resources, curriculum design, and advisory committees on technological education.

Unlike most vocational-technical schools, LVTI has a dual role to perform - to train and prepare students for the world of work with the skills and the concepts necessary to perform the functions of a job, and to prepare them to live in a work setting which is, many times, in conflict with the one in which they were born. I believe strongly that the minority honors program helps LVTI to meet these goals by:

- Encouraging and rewarding academic achievement.

- Training students to compete in today's environment by offering them opportunities to work within industry during their training period.

- Preparing them to participate in the environment of high technology by providing relevant curriculum.

- Providing a realistic sense of motivation, which encourages students to set higher goals for technology vocations and makes a visible impact on their growth and development.

- Providing for strong interaction, partnerships, and linkages among education, private industry, and national scientific institutions.

- Providing expert consultants to keep LVTI current on industry needs and technology, and providing constant informal evaluation of LVTI students and programs.

- Providing faculty expertise, equipment acquisition advice, and assistance with program development, and giving students and faculty knowledge on the application of theoretical training to industry use.

- Making LVTI more effective in planning new technology programs and reviving existing ones.

The continuing success of our program will be measured yearly by the job placement of students. Presently, 80% of the students who have completed their studies and have participated in the program are now employed gainfully in an energy-related area. Some of the graduates have elected to continue their education, and a few are waiting placement. I believe there is a need for more innovative programs, like the Minority Honors Training Program.

Programs as such will help to enhance the opportunities for all minorities to participate and contribute their talents in the areas of science, engineering, and technology. We are very grateful to DOE, the Office of Minority Impact, and of course, our congressional delegation for their funding support of this program. We are very grateful to the many industrial firms and scientific institutions that have supported and cooperated jointly in the program. I believe that the support that we have received has contributed to LVTI's mission of preparing our students for productive and relevant employment.

## QUESTION/ANSWER SESSION

**Question from the floor:**

Have you had an opportunity yet to graduate students that you later knew went on to four-year colleges?

Yes, there have been some, but I do not have the complete figures. There have been some for whom we do not show placement information. These students have been contacted, and some of them have pursued higher education. In many cases, they have used their vocational training as a stepping-stone to get into higher education. This is the first year that we will be granting associate degrees in applied science, so students participating in this program can now easily transfer to a four-year institution.

**Question from the floor:**

Are the four-year institutions accepting them and do they agree to accept them?

Yes. We have some agreements with New Mexico Highlands University, New Mexico State University and New Mexico Institute of Mining and Technology in Socorro, New Mexico. We will be working on agreements with other universities.

**Question from the floor:**

Do programs seem to be for science students only, and have you looked for other ways of taking the average student to increase their talent, too?

Well, the guidelines are set forth by the DOE Office of Economic Impact. When we first began the program, we had the grade point average cut-off set at 2.7, so that more students would be able to participate. We had this for two years. After that, the DOE recommended and mandated that the students participating have a 3.0 grade point average or better. I would like to see the 2.7 GPA used. I feel that we could involve more students because, as other participants talked a while ago about "the cream of the crop," we need to involve some of those who are below the 3.0 cut-off. Students who participate are nominated by their departments and by their instructor. They do go through an application process, and they do go through a screening committee.

The students selected to participate must be pursuing a career in one of the seven areas. If a student's grade point average falls below a 3.0 at any given trimester, we do not automatically expel the student from the program. We provide advisors all through their training, and we can provide tutors to assist them to improve their GPA. A student will be dropped from the program if the GPA falls below 3.0 for two consecutive trimesters. Any student who has been dropped from the program can re-apply to the program once their cumulative GPA is again 3.0 or better.

**Question from the floor:**

You have internships, work studies, and co-ops. When you talk about 125 miles - this isn't daily, is it?

No, we do this on a weekly basis, usually on a Monday or a Wednesday. This is only one example of a cooperative effort.

**Question from the floor:**

So that is all the same thing. In other words, they work there for a semester, right, and then they are back on the weekend?

No, what they do in one particular program, a program with Digital Corporation, is that the students leave a classroom setting to get some hands-on experience at Digital Corporation every Monday morning and return at the end of the day.

**Question from the floor:**

The other four days of the week, are they in school?

They are back in school at LVTI. That is just one example of one of the programs.

**Question from the floor:**

Does Digital pay them, or is that part of the program?

No, Digital does not pay them. That is part of the linkage portion of the program providing hands-on experience for our students in electronics.

**Question from the floor:**

They are not actually working while they are there, but they are training, right? So the student does not get paid?

That is correct.

**Question from the floor:**

But what about on the cooperative education?

The company will pay for that.

**Question from the floor:**

And for that, they spend five days in Albuquerque?

Or longer. It has been summers or a regular co-op program.

**Question from the floor:**

How do you arrange where they stay - their living arrangements?

The company usually provides them with some assistance. Kirtland AFB has been very helpful in trying to obtain places for these students. Usually the students are making enough money to live in Albuquerque. All co-ops have been in Albuquerque.

**Question from the floor:**

They are at Co-op for one semester, then one semester back at LVTI?

It depends on the company. We have left it open because we feel that it is important that the students at least get their "foot in the door." If they work for a company for only three months, that is very valuable experience. Another industry may see that their work at a certain company was successful and hire them.

**Question from the floor:**

One of the problems that I have found in other rural areas is that because of the strong family and cultural links, the students do not want to leave the area - and yet jobs are not there. Where you had mining at one point, there is no mining now. So, do you find that this going 125 miles to Albuquerque helps break some of these links?

This has helped tremendously. Many students may have, in the back of their minds, "I think I want to go into computer programming," or, " I think I want to go into laser electro-optics," and they have never been to big industry to see how it operates.

**Question from the floor:**

Or never thought about leaving the home area?

Or never thought of leaving the home area, that is correct. It has done so many things for these students. These students are not afraid to venture out once they have graduated because they have been exposed to major industry and to the national laboratories during their two years of training.

I did not mention that, in May of this year, LVTI hosted the first national conference for the eight schools that participate in this program. These schools had never come together to meet as one. LVTI was honored by DOE to host the first national conference for the program. The conference featured speakers from across the nation, representation from the eight participating postsecondary institutions, state and federal government officials, congressional delegation members and industrial supporters of the program from throughout the nation. United States Senator Pete Domenici joined the Office of Minority Economic Impact Director, Raymond Massie, in headlining a program which focused on minority involvement in high-technology education and careers and strengthening industrial linkages. Attendance from LVTI's industry linkages was excellent, with over 100 representatives from 53 research, scientific, academic, and industrial organizations present.

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# SUMMER PROJECT TO ORIENT HISPANICS IN SCIENTIFIC AND TECHNOLOGICAL FIELDS

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I am compelled to make it clear at the outset that we do not yet have an operating mentoring program at Community College of Philadelphia because we have not identified the students who would be involved. Instead, Chemistry Instructor Lucila Paramo and I have been engaged in a process over the last two years to develop a project aimed at creating an authentic context to effect a viable mentoring program for Hispanic community college students.

We are guided by the conviction that there is - that there can be - no quick fix for years of discouragement of intellectual capacities and academic achievement. We are convinced that it is irresponsible, unrealistic, and counterproductive to attempt to artificially induce a mentoring program to satisfy rhetorical and ideological objectives or priorities on a short-term basis. We are both aware - painfully so - that consistent lack of exposure or underexposure to standards of academic achievement and concomitant negation of vocational options or professional alternatives cannot be compensated or countered exclusively by high expectations or through token endeavors.

It is not in our interests as professionals to contribute to the retrenchment of limited aspirations and narrow domains of experience. Therefore we reject short-term plans (and reimbursements) to produce instant role models (to be touted as credits to their race, gender, or ethnic group) who serve to satisfy minimal quotas for targeted representation within externally defined parameters. Also, we depart from the conventional approaches to institutional incorporation of target populations which invariably concentrate recruits at the lower or upper reaches of traditional career ladders. Both of these methods have little impact on expanding the collective consciousness about intermediate alternatives that are open, reasonably accessible, and far more viable options for a greater number of aspirants.

Although we may be accused of setting lower standards for Hispanic youth, or of not being ambitious enough, or of leaving out the truly disadvantaged, we propose, with clear conscience, that it is a disservice to ignore intermediate career options. Many career options can be attained less expensively, more expediently, and with greater real possibilities for employment and advancement that not only benefit the individual aspirants, but also signify a greater impact on friends, family, and associates.

The Summer Project To Orient Hispanics to Career Options in Scientific and Technological Fields, at the Community College of Philadelphia (CCP), consists of 14 days of active learning sessions and field trips from 9:00 a.m. to 1:00 p.m. with consultation time extended to participants who wish to meet with session leaders or project coordinators. It is currently in its second year of operation and has been expanded from exposure to chemistry, mathematics, and data processing to include biology, electronics, and architecture. In the last two years, we have personally recruited 32 students from three high schools, two GED programs, and promising first-year CCP students, to participate in our orientation program.

We encourage activity sessions that focus on exposure and observation and promote discussion sessions that focus on inquiry and exchange as the means to sustain participation and assert mathematical and scientific ability. Given the fragmented and incomplete educational experience that the majority of participants bring to the experience along with minimal expectations for success, educators need to make more intensive efforts to lead them toward filling gaps. This should be done without reminding them of inadequacies, overwhelming them with information, or precluding original insights.

By permitting them to become familiar with apparatus and equipment through the performance of simple tasks that have clear, practical, and often impressive results, we help them to be less self-conscious, intimidated, and insecure, and more receptive to simple explanations of the underlying concepts manifested in the experience. The main objective is to create enough excitement so that participants can generate enthusiasm for active participation and enrichment. We attempt to get away from a preoccupation with what they do not know, and ought to have learned. We focus on what they can learn, once their interest is sparked, and the knowledge they can achieve once a context is created and the tools for disciplined study are clarified.

*"We attempt to get away from a preoccupation with what they do not know, and ought to have learned. We focus on what they can learn, once their interest is sparked."*

The program is open to high school juniors and seniors, GED candidates and graduates, and first-year community college students. We attempt to lay the foundation for a context of experience that makes it possible to recognize and pursue options. We want participants to begin sharing their experiences with others and develop a base from which to operate in the extension of the project in subsequent sessions.

Again, the main objective is not to teach, impart information, or help. It is not to cram. It is to provide inspiration, a context for accomplishment, a climate of achievement. We want participants to return to friends, family, and associates to recount positive experiences that will capture their interest as well. We want them to have the vocabulary and insights that will allow others to relate to their enthusiasm and perceive possibilities and alternatives for themselves. We want high school students to go back to their local schools and put into practice positive approaches to learning that will strike a chord with their peers.

We want them to return to their families with the excitement that comes from being taken seriously for what they have to offer and what they can hope to achieve without placing

unreasonable or impossible demands on the family unit. We want families to be in the position to encourage two-year degrees that lead to jobs that pay well enough to enable students to save money and continue their studies in a stepping-stone fashion. The best way to accomplish this is by developing concrete experiences that students can easily recount in terms that can be understood and with possibilities that do not require six to eight years of full-time study.

Our approach has been deliberately slow. Now, at the end of two summer projects, we have a much better idea of how to organize a work group of session leaders, devise comprehensive guidelines, plan activity sessions, and expand the scope of the project. We foresee that in the next six to eight months, we will be in the position to develop a rough manual for project planning and implementation. Then, we will focus on curriculum development and initiate the developmental process of a mentoring program.

We see the need to develop a manual for instituting what we might refer to as a prementoring project that summarizes the content and objectives of session activities. It should include guidelines for recruitment and participation at different levels and stages, organization and execution of activities, and evaluation techniques.

We believe that a major limitation of many special programs is that the idea of participation by a larger group is overlooked. We feel that young people need to be placed in situations in which they are engaged in processes that permit them to begin exploring and asserting definitions in their own terms and developing appreciations that are genuinely comprehensible. This includes both academic requirements and social reality.

Whether participants return to high schools or enroll in college courses, they will bring a different perspective to the classroom that can be perceived by others. They are in the position to influence different attitudes among their peers.

*"Whether participants return to high schools or enroll in college courses, they will bring a different perspective to the classroom that can be perceived by others. They are in the position to influence different attitudes among their peers."*

As students begin opting in large enough groups for the career alternatives we propose, only a minority will not complete courses of study. The majority will be placed in jobs that pay substantially more than the average per capita income for Hispanics. Mentoring can then realistically be added to the agenda. Unless there is a genuine commitment by a self-appointed core group, mentoring does not really take place. Students need the context of their peers to be able to take full advantage of the mentor. For now, they can be advised and assisted during regular office hours and incorporated as assistants in summer projects. Occasional reunions can be organized to exchange status reports and maintain contact. High school students can call on project faculty and are eligible to participate in subsequent sessions.

We believe that this approach is necessary since, for the average Hispanic high school graduate, exposure to a career option in electronics, for example, presents a far more tangible means of awakening self-awareness to the significance, possibilities, and requirements of becoming an engineer. To propose an engineering career as an original goal, in the majority of cases, is to preclude successful achievement and has the effect of lowering expectations and aspirations. The goal of a six- to eight-year career of study places the average aspirant in an extremely untenable position and ignores the social and cultural reality that created underrepresentation in science and technology in the first place. Unless there is a real possibility for more than one or two aspirants to attain an original goal, then it is, in our view, unreasonable to set up the majority for failure and continue the cycle of containment.

Although there is a large Hispanic population in the Philadelphia area (80,000 to 120,000), its representation on the institutional level is insignificant. The majority live in poverty or eke out a meager livelihood as unskilled or semiskilled workers. The majority of Hispanic professionals are concentrated in social service agencies and typically command lower salaries and limited opportunities for advancement. We are represented minimally in the allied health fields as doctors or even as entry-level workers. Although there is a small group of successful merchants, the majority operate within the bounds of "the community," and a handful of teachers, professors, lawyers, and corporate employees fill the professional ranks. Although CCP has an open admission policy, few Hispanics take advantage of it. An even smaller percentage of high school graduates attend area colleges and universities. Typically, middle-class Hispanics do not reside long within the geographical confines of what is euphemistically termed "the Hispanic community." Comprising a relatively small group, Hispanics find mobility out of the ghetto limited and scattered. The possibility of youth to be exposed to the skilled trades or professions represented in this group is minimal. There is very little first-hand exposure to what their work entails or familiarity with the language to make it comprehensible.

Within the cultural and academic domain of experience of the reduced numbers of Hispanic youth who remain in high school, there is limited exposure to any but traditional options. Only a very small number are culturally or academically prepared for the fundamental requirements of coursework. As pioneers, they receive minimal moral support from their primary groups, cannot depend on families for financial support, and are regularly isolated within the student body. Intellect, determination, and commitment may abound. But the fact remains that the limitations imposed by the environment put them at a tremendous disadvantage. Whether they communicate regularly in Spanish or English or both, few have the foundation to comprehend, let alone express, elementary academic principles or concepts because it simply does not manifest itself within their realm of experience.

Our aim is to break the cycle of feast or famine in efforts to open doors to excluded groups. We propose a project that stimulates autonomous demand for a program that practically opens a path for Hispanics to careers with a future and clear possibilities for advancement in science and technology.

It is not our intent to obligate participants in the summer project for career options in scientific and technological fields to commit themselves to study at CCP. It is not our intent to impose a roster compatible with scientific or technological majors on participants who eventually enroll or are enrolled at CCP. Nor is it our intent to discourage or deter recruits from pursuing careers in highly competitive but relatively closed fields or those toward which Hispanics are typically steered. Our primary objective is to *expose* participants to *activities* that are relevant to scientific and technological fields and have a direct bearing on accessible career opportunities.

At CCP, we have the freedom to develop a project with long-term goals, thanks to the support of the new administration and its openness to dedicated experimentation and new approaches. Although there is a minority mentoring program in preliminary stages of development, we are not pressured to bring the project under its wing and modify it according to distinct goals and objectives. Rather, we have been encouraged to forge ahead, learn from experience, and revise the project accordingly.

At the same time, however, the fact that our project transcended preliminary stages and is in the operative developmental stage does not imply pressure to conform to our thrust. It is possible to sustain autonomy and maintain avenues of communication and cooperation open with proponents and directors of other projects or programs. We believe that now there is clear institutional support for the affirmation of special interests to promote integration and unity, rather than chauvinism or supremacy.

This probably would not occur at other institutions in the Philadelphia area because "minorities" are a minority of the student body. At CCP, minorities comprise about 50% of the student body and mainly attend the Spring Garden campus where we teach. It makes administrative sense to promote autonomous efforts to address academic needs that satisfy the

institutional mandate to serve as a community college that delivers low-cost, quality education as an academic alternative.

Evidence of the benefits of CCP policies is not restricted to a collective need in the student body alone. Certain area four-year colleges and universities have perceived the distinct advantage of relying on CCP as a stepping stone to baccalaureate studies. Recruiters actually recommend enrolling in CCP to facilitate admission to their own institutions. Also, administrators and faculty are approaching CCP with explicit proposals for cooperative efforts to formalize referrals and career-oriented continuing education.

In addition to the relationship with institutions of higher learning, CCP has earned the respect of area corporations, labor unions, and government as a source of intermediate-level employees and trained technicians. This is another factor that has guided our objective to focus on intermediate career goals for Hispanics. The wage and benefit packages offered by employers not only permit greater economic stability, but they also represent concrete resources for continuing education. Numerous incentive, reimbursement and grant programs are open to intermediate-level employees who could not otherwise aspire to higher goals with reasonable security for achievement. Hispanics are seriously underrepresented in these areas because of lack of exposure and access to these opportunities.

In summary, for projects and programs promoting science and technology to be effective and have a significant impact on target groups, they must cultivate and nurture ties with local school districts, community and four-year colleges, equivalency-degree programs, union and corporate training and recruitment pools, community development projects, nonprofit agencies, business and social organizations, and local government. Each is an important component in its own right in developing an effective alliance to achieve subjective and objective goals. Within this scheme, community colleges are probably islands in the middle of a wide river to cross.

A significant challenge to any effort aimed at Hispanics is the thorny issue of language. This very sensitive and controversial element must be taken into account and dealt with seriously, and with an open mind. The issue should *not* be "Spanish or English," but the crucial need of Hispanics in the United States is that they be fluent, proficient, and literate in *some* primary language system. No group can hope to advance if it persists in jealously and defensively protecting a restricted language system that narrows its spheres of experience and influence.

To insist on ANY language to the exclusion of all others is chauvinistic and self-defeating. Instead of focusing on the inherent power of language and its relation to thought, expression, and communication, a language becomes the issue and even a fetish. In an environment where concrete alternatives are being proposed, where English *primacy* - *not* supremacy - is a fact, English proficiency cannot be ignored. Neither ought Spanish proficiency to be abandoned. There is no reason why proficiency in both languages cannot be achieved.

In concrete terms, achieving depends on having a solid language base. We observe that English becomes a problem, and Spanish or mixed idioms (switching) becomes a defense, when participants do not have the background to comprehend or interpret an experience. It is not enough to be exposed to experiences. People must be equipped to make sense out of them. If they do not have the essential linguistic tools and know how to use them, they cannot register experiences well enough to think about them, develop insights, or pose problems for disciplined solutions. Without an ample or adequate language base, they are easily overwhelmed, frustrated, and discouraged.

The ability to make the transition from one language to another is enhanced by comprehension and knowledgeability that can be unambiguously communicated in some language. Our appeal is *not* for "English only," but for English *also*.

We recognize the need to develop a working vocabulary in both Spanish and English that conforms to standard language systems. We believe that this can be achieved most expediently through emphasis on intentional English mastery, although not necessarily English dominancy, and most certainly *not* through English-only policies. We believe that Hispanics must become

fluent in standard English simply in order to take full advantage of opportunities, just as the Venezuelan students I taught had to be proficient in standard Spanish, regardless of their preferred form of colloquial expression.

Colloquial expression, informal conversation replete with regionalisms among peers in academic settings, is admissible and positive as long as it is not to the exclusion of formal communication within a larger sphere of literate proficiency. We refuse to pander to romantic patronization of dialects or argots as viable media of expression and discourse. This limits speakers to a narrowly circumscribed realm of experience and expression that serves to restrict the resources required to enrich the very dialect that is so staunchly and possessively defended.

That English is the primary language of communication in the United States simply signifies that individuals who regularly converse in Spanish have the obligation to supplement English language experience with literature and discourse in Spanish or relevant topics. The abundance of English language publications in Latin American libraries indicates clearly that it is possible to become informed through one language without sacrificing the primary language system. The facility with which language transference occurs is not a function of any particular language system in itself, but rather a function of the degree of proficiency and literacy achieved in some primary system. At a certain point, new insights and information that are the product of one language experience automatically translate themselves into another.

*"Our aim is to promote authentic bilingualism. We do not see English as a second language or another language but as an idiom on the par of any other that just happens to enjoy primacy (not supremacy) in the United States."*

Our aim is to promote authentic bilingualism. We do not see English as a second language or another language but as an idiom on the par of any other that just happens to enjoy primacy (not supremacy) in the United States. Were we to be involved in a similar project in Venezuela or Colombia, where we came from originally, we would be promoting Spanish literacy along with proficiency in English simply because it is necessary. Clearly, I would be far more relaxed right now if I were communicating in Spanish. Nevertheless, I prefer to endure to a bit of discomfort in order to become comfortable with noncomplacency.

Another main concern is maintaining autonomy within the current trend to address "minority" issues. For our project to function and achieve the objective of developing core groups of Hispanics who will aspire to intermediate career goals, it is essential that we promote an authentic agenda that genuinely addresses interests and priorities of Hispanics. All too often, plans for incorporation of traditionally excluded groups clump different racial and ethnic groups and women under one umbrella as if general, shared interests, priorities, and goals implied identical plans of action and fields of operation.

We must face the challenge of comprehending our own experience and recognition at CCP, recruit some non-Hispanic and nonbilingual session leaders, and begin the process of developing an ongoing work group committed to long-term project participation. As a result of working with four session leaders this summer who fit this description, we have gained positive insights into how to recruit and incorporate non-Hispanic session leaders as allies who are genuinely responsive to participants' needs. It is up to us to provide the necessary context and opportunity.

It is not enough to accept the aid of well-intentioned people inspired by logical commitment to social justice and civil rights. We cannot content ourselves with compassion for our unique cultural experience or social status, the stuff of "multi-cultural awareness" and "sensitivity training" workshops that tend to embellish the mystique and exoticness of different

socially defined groups. Instead, we propose to cultivate relationships with interested and qualified faculty whose primary motivation is to engage in active learning sessions, not only with participants, but also *as* participants.

This process is, of course, not limited to non-Hispanic faculty. We are as vulnerable and susceptible to divisive, patronizing, and exclusionary forces as other humans. We need to be able to affirm and assert our identity, not as part of the "Latino monolith," but as competent and responsible representatives of a collectivity that rejects being "helped" to not exceed 2% of the "good life" by our own opportunists and tokens, as well as the well-intentioned and not-so-well-intentioned sympathizers.

By the time that the next summer orientation project begins, faculty members who commit themselves to comprehensive guidelines for session leadership will be expected to engage in the same inquiry, discussion, and evaluation in terms of the group dynamic as current participants are. We feel that by being placed in the position to identify how much is shared experience and how much responds to cultural differences, such understanding will compel session leaders to relate to participants more in terms of common ground shared in other familiar contexts.



# MINORITY HONORS ENERGY-RELATED PROGRAM

**Irene M. Pocarello**
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*Ms. Pocarello received her education at the University of Houston, where she obtained a Bachelor of Arts degree in English, a Master of Science degree in Social Work, and is a doctoral candidate in Higher Education Administration. She is currently Dean of Student Services at Houston Community College System (HCCS), Southeast Campus. She has written several proposals in math and science for minority students pursuing careers in these fields and received funding of half a million dollars from the U.S. Department of Energy. She initiated a Hispanic Women's Program, established an effective on-site Financial Aid Office for the Milby Campus students, and formed an advisory committee consisting of educators and community leaders. She is very active in community affairs and serves on the board of the YWCA, the HCCS College Administrative Council, LULAC Learning Center Advisory Council, and Texas Association of Chicanos in Higher Education.*

The Houston Community College System, a public two-year educational institution accredited by the Southern Association of Colleges and Schools in 1977, offers a broad spectrum of life-long educational opportunities that include occupational/ technical education, college parallel courses, and adult and continuing education. The purpose of the HCCS is to provide educational opportunities for students in the Houston area who desire its services. In August 1971, approximately 5,700 students enrolled in the first occupational/technical courses offered by HCCS. Currently, the HCCS enrollment is 48,000 annually, at 33 instructional locations.

The HCCS has an open-door admissions policy. The open-door concept provides equal access to the traditionally underrepresented. Over 50% of HCCS students are minority, 60% are women, 46% are disadvantaged, and 5% are handicapped. The college makes a continued effort to assure equal representation of minorities, women, the disadvantaged, and the handicapped.

The HCCS is unique in its accessibility, flexibility, and sensitivity to the needs of the community and is dedicated to the delivery of quality services in the most effective and efficient manner. The college offers two types of degrees: the Associate in Arts (AA) and the Associate in Applied Science (AAS). The AA is awarded to students who have completed the first two

years of a program designed to lead to a bachelor's degree. The AAS is awarded to students who complete one of the curricula in the technical area.

## PURPOSE

The purpose of the Minority Honors Energy-Related Program at the HCCS/Milby Campus is twofold:

- To provide better job opportunities for minorities by establishing closer linkages between the energy industries and the college.
- To facilitate a technology transfer program for minority honor students transferring to a four-year institution.

The goal of the program is to provide scholarship opportunities to increase the number of minority students in energy-related careers.

The objectives of the program are:

- To identify and select 25 minority students to participate in the Minority Honors Energy-Related Program, of which 70% will complete their studies and 50% will transfer to a four-year institution.
- To establish an energy-related job placement system within the HCCS Placement Office that will assist the presidential honor graduates with job opportunities.
- To incorporate a viable Energy-Related Program consisting of four curriculum plans that will transfer to four-year institutions.
- To implement a guidance and counseling program to serve as a support system to meet the educational, financial, and career needs of the students.
- To establish an Energy-Related Industrial Advisory Committee that will help develop linkages between the energy-related industries and the college.

## TARGET POPULATION

The target population for the Minority Honors Energy-Related Program is currently:

37 Hispanics (12 female, 25 male)

2 Blacks (both male)

39 Total number of students

## PROJECT LOCATION

The HCCS operates 33 instructional locations throughout the City of Houston. The facility proposed for this project is located on the east side of Houston. Enrollment at the Milby campus is 1,200 students, of which 70% is Hispanic, 15% is Black, 1% is Anglo, and 5% is "other." The median income for students enrolled at Milby is $13,000 annually.

## FUNDING SOURCE AND PROPOSED BUDGET

The Minority Honors Energy-Related Program is funded by the U.S. Department of Energy, Office of Minority Economic Impact. The budget proposed for one year is $60,000.

## PERSONNEL

The personnel involved in the Minority Honors Energy-Related Program include the director, counselors, job placement specialist, secretary, and instructors (English, mathematics, history, and chemistry).

## INSTITUTIONAL IMPACT OF THE PROGRAM

The quality of the technology programs as a whole will be improved by attracting both full-time faculty and students to the college. The program will serve as a recruitment tool to attract more minority students and thus increase the visibility of HCCS. Program success will ensure future expansion in energy-related fields within the college.

**Table 1. Grade Point Averages of Honors Program Students, Fall 1987 - Spring 1988**

| Number of Students | Grade Point Average |
|---|---|
| 1 | 4.0 |
| 12 | 3.0-3.9 |
| 10 | 2.0-2.9 |
| 2 | 1.6-1.7 |
| 1 | Withdrew |

The honors program will have a significant impact on student retention. At the end of two years, more minority students will have completed their studies in energy-related fields at Milby Campus than ever before. Also increasing significantly will be the number of minority students transferring to four-year institutions.

## RESULTS

From the Fall 1987 to Spring 1988, 26 students were enrolled in the honors program. Out of the 26 students, one student dropped out because of pregnancy, one transferred to a junior college, and one transferred to a data processing program at HCCS. In the Summer 1988 (an 11-week session), 10 students were enrolled in trigonometry, seven in college algebra, two in intermediate algebra, and 10 in MS-DOS On The IBM/PC.

The cumulative grade point average scores for the 26 students are shown in Table 1.

## RETENTION FACTORS

The factors contributing to student retention in the Minority Honors Energy-Related Program are:

- Individual counseling
- Selection process
- Assessment (English, Mathematics, Reading)
- Development courses (English and Mathematics)
- Tutorial assistance
- Mentoring
- Field trips (local/ state colleges, local energy companies)
- Advisory counseling
- Faculty selection
- Administrative involvement

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# MAKING THE TRANSITION FROM A COMMUNITY COLLEGE TO A FOUR-YEAR INSTITUTION

**Margarita H. Colmenares**

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*Ms. Colmenares has been with Chevron since 1980, serving in a variety of capacities including Environmental Specialist, Compliance Specialist, Foreign Training Representative, Recruiting Coordinator, Field Engineer, and Designs Engineer. Active in community and professional organizations, she was the first female to serve as president of the Society of Hispanic Professional Engineers (SHPE) and went on to serve a second term. She holds a Bachelor of Science degree in Civil Engineering from Stanford University. In 1991 she was honored with a one year White House Fellowship, serving as a special assistant on the Office of the Secretary of the Department of Education. Recently, she was profiled in Hispanic Engineer.*

My topic today is to share with you my experience and personal observations in transferring from a community college to a four-year university.

First, I would like to explain to you how I found out about engineering. During my first year in college, I was dating a young man who was studying engineering. One day, we were at the library studying together, and I leaned over to see what he was working on. He had his book open to a diagram that had many geometric shapes along with little arrows that showed pressure points, or loads, on the schematic diagram.

I asked him, "What is that? What are you trying to figure out?"

He explained to me, "This is Statics, a course you take in engineering."

Drawing him out more, I asked, "What is engineering?"

It fascinated me. It seemed like a really interesting subject, but up to that point I had not prepared myself to go into that field. So the next day, I went to see the dean of the engineering school.

I remember walking into his office and telling him, "I'd like to study engineering."

And he asked, "What classes did you take in high school to prepare yourself for this? Have you taken calculus?"

"No."

"Physics?"

"No."

"Chemistry?"

"No."

He said "Well, hmm."

At that point, he really could have discouraged me - he really could have said, "Well, you're not prepared. You're crazy." But he did not. He sat me down, and he helped me work out a schedule. That first semester that I decided to enter engineering I took my first classes in physics and chemistry and calculus at the college level. But he did warn me. He said, "If you don't do well this semester, then you had better stick with Business. Be prepared to work and study more." And he was right. That first semester, I got *A*s and *B*s, so I felt I could do it. The work was so interesting and so different from Business that I really did get into it. At the time I was enrolled at Sac State (California State University at Sacramento), and I finished up the semester there.

My friend who introduced me to engineering had just transferred in from a community college but, more importantly, he had been awarded a scholarship called the General Electric Engineering Scholarship for Minority Students that paid for up to 80 percent of whatever school you were admitted to. And I thought, "You can't beat that deal. You really can't." So I decided to go back to the community college to win that scholarship - that was my goal. I wanted to compete for that scholarship, and the only way I could do it was by being a student there.

I did win that scholarship and ended up being awarded four others. And so with a total of five scholarships, I was able to go to Stanford. That was the only way that I was able to make that financial transition from one area to another.

If you have any questions as I go along, feel free to interrupt me. I want this to be an interactive presentation.

**Question from the floor:**

What general scholarships did you get?

I received the Tenneco Tractor Scholarship from the local company, Cordova Chemical. I got a scholarship from the state and one from the National Hispanic Scholarship Fund (NHSF). I saw Ernesto Robles two years ago when I was in San Francisco at an NHSF fund-raiser. I went up to him and said to him, "Did you know I was a former NHSF scholarship winner?" He did not know that, so really I think organizations like that are just beginning to see the fruits of their labor from the scholarships they have given out. I did not apply for a SHPE scholarship at because I think there were not any when I was going to school.

Let me go ahead and get into the transition from the community college to the four-year university. At the end, I will make some recommendations that I have thought about that maybe will help make that transition easier. I think all of you will agree that, right now, there is a great pool of resources that is being left undeveloped at the community college level. I looked at some figures and it turns out that, nationally speaking, of Hispanics who continue their education beyond high school, about 53 percent of them go to community college. They do not enroll at your four-year university - they do not go to Rice University, they do not go to University of Texas-Austin - they go to Houston Community College or whatever the local community college is. In California, fewer than 4 percent of community college students transfer to a four-year college. They attend the two-year college, and that is it. I do not know if anybody here has any figures for Texas, but it is probably pretty similar to these.

It is a tremendous resource that is being lost. Now some of the reasons that I attended the community college had to do with my financial resources at the time. In those days, community college cost nothing. I know that California has recently enacted a bill to charge tuition, and when that bill came up there was a lot of concern within the Hispanic community, because it was going to impact minorities the most.

One of the reasons I went there was my lack of academic preparation. I felt that by going to the community college I could really build up my base, get my basic courses out of the way.

I am glad I did that, because I found out when I got to the four-year college that most students who quit engineering do so within the first two years because they get wiped out. They get wiped out by chemistry, by calculus, by physics. If you do not get past those core courses, you do not continue to the junior- and senior-level courses.

***"The preparatory schools are feeder schools into the four-year universities - why can't certain community colleges also act as feeder schools?"***

At the community college, it is not as stressful or competitive. At a four-year university, you are talking about a large campus. A community college is smaller, has more of a community atmosphere. It is more complicated, more sophisticated, than high school, but not as sophisticated as a four-year university. My own personal feeling is that a lot of our students go there because they feel familiar with those surroundings. What we need to do is to figure out a way to make them feel comfortable in making that transition. They have already invested two years of their time, and all they need is two additional years.

Now, some of you may be thinking, "Well, there must have been a big difference in academia between Sacramento City College and Stanford." Yes, there was. Not only in level of instructors, but also in timing of courses. If anyone is thinking about transferring, or if you have students who want to make that transfer, it is very important to pick out what school you want to transfer to and then to specifically find out from that school when its courses are going to be offered. It turns out that at Stanford, required classes only get offered once a year, and if you miss the cycle, you have to come back an additional year. That happened to me, but it was good that it did, and I will tell you why everything worked out beautifully for me.

At that time, I did not know I was transferring to Stanford. I did know that I wanted to try to get into the best college I could, so with that incentive, I worked really hard in school. I took on extracurricular activities because I felt that it would help me to better manage my time when I did get to the four-year university. Realizing that it would be more demanding, I felt that if I could handle going to school, working, and running a dance group, then maybe I could handle Stanford. So what it did for me was build up my confidence. It allowed me to grow and just really become very assured. It also allowed me to work to save money to go on to the four-year college and to gain some valuable experience in engineering. That, I think, is the key - whether you are at a community college or a four-year university - to get that engineering work experience, to really know what it is that that job or that field or that career could possibly mean for you.

I knocked on some doors and finally got hired by the State of California, in the Water Resources Department. I worked in a group called the Project Surveillance Group, which went around inspecting the structural integrity of the California aqueduct system and the 22 dams and pumping stations that we have. I was in the group that would go out to do the physical inspections, come back to the office and write up a report, and assure the people of California that everything was "hunky dory," especially after an earthquake. We would get on a plane and we would be the first ones out there. It was a pretty exciting job. I saw the connection between the classroom and the field - the application of engineering.

After I finished school, I realized that the last two years were actually easier than the first two because in the first two years you get all the theory, all the abstract stuff. In the last two years you get the applied courses and apply them to problems - you are solving problems. Stanford was great in that respect. Stanford professors even had us do projects like building a three-story building within certain parameters. We would have to break up into project groups, into teams, and actually design this building. It was not just one problem out of a book.

Every class ended with a real-life project which I found to be very applicable, even later on, even though I have not really used everything I learned in engineering. My point is that it really gave you a sense that you were learning something useful.

Some of the things that I thought would help to improve that transition - I am directing myself right now to academic institutions - is to strengthen the links between community colleges and four-year universities. There are feeder schools, for example, into the Ivy League schools - the preparatory schools like Choate. These are feeder schools into the four-year schools. Why can't certain community colleges also have a memorandum of understanding with some local college that their student will transfer on? Why can't there be a liaison between the two universities to really promote that? A lot of programs are in the works, but a lot of them are directed at elementary and junior high students who come visit on campus day events (for example, Open House, Career Day). These programs completely ignore the community college student. That is another area where we can use existing programs and bring in the community college student as a guest to the university.

We need to set up a tracking and mentoring program very similar to what Irene Pocarello talked about - that is the first program of its kind that I have ever been exposed to at a community college level. I had the opportunity to be one of her mentors this past year, and believe me, I really feel that all 24 of those students are going to transfer. One of them, who happens to be my mentee, is a computer science major. She may end up going into engineering. Hopefully, the talent is there, and the resources are there. We just need to really hook up, do a better job of making the connection between existing groups in the community and those students who are at the community college.

I think we need to offer financial incentives to the community college student to go to a four-year university. For example, a four-year college can set up a special scholarship for students who are transferring from a particular community college that students have to compete for. I think it is important to compete. I do not believe that it is right that we just give things to people. I think you should earn it because then you really learn the value of what it took to get that. The same thing applies to corporations. If more companies could do the kind of scholarships that General Electric did, I would not be surprised if more Hispanics transferred to four-year universities. Eighty-percent funding of whatever school you go to is a very good scholarship. I hope that corporations like General Electric continue to make those kinds of scholarship offers.

I also recommend that we establish partnerships programs with industry to promote work experience. Corporations presently do have programs, but they are for high school students, for four-year-college students. There really is not any program at this time that I am aware of that will work with community college students to try to bring them into corporations to work in the engineering fields.

Finally, we should encourage the formation of chapters of organizations such as the Society of Hispanic Professional Engineers or the National Society of Black Engineers on campus. You need to make that connection between professionals in your field and the students, to establish a support group, very similar to what Irene Pocarello's program is doing. She really has hit the nail on the head. I was really glad to see that something like that was started.

Any questions so far?

**Question from the floor:**

Where are you from?

Houston Community College.

For counselors, I have these suggestions. Do we have any counselors in the audience? Be aware of requirements and scheduling of required courses at four-year institutions so that transition will be smooth. I alluded to this a few minutes ago. When I went to Stanford, I was

accepted as a junior, but it turned out that some of the classes I needed to take in order to graduate I should have taken as a sophomore, and I could not do that because I was not there as a sophomore. So that caused a backup in some of the other required courses. When I got to the end, there was one semester in which I had to take three required classes at the same time. Physically, that was impossible. So I decided I had to take some time off from school; actually, it was forced upon me in order for me to come back that remaining quarter to finish up those required classes. Luckily, I had interviewed with Chevron by then. At the time I interviewed with Chevron, I thought I was going to be graduating in the fall, not realizing that this scheduling conflict was going to come up. Chevron had made me an offer and had given me three choices. I could go work in either the El Paso refinery, the Richmond refinery, or for CUSA marketing. Well, sadly, I had to call Chevron to say, "It doesn't look as if I am going to graduate this semester. I have this dilemma." Chevron said, "No problem - come and work for us for nine months, then go back to school, finish up, and you will be done."

I thought that was a great idea. But where should I go to work? I had those same three choices. Being from California, from Sacramento, I had already left home and gone to Stanford, which was three hours away. I will go to Texas, I decided, because I know I will have to come back. If I did not like Texas, there was no risk to me. I knew that it was a set assignment, plus it would give me a chance to see something besides California, so I went to El Paso to work as a designs engineer. I was mainly assigned to the Rheniformer plant, which changes the grade of regular-cut gasoline to unleaded, a higher stock. I got to do a lot of interesting things while I was there. I was a shutdown engineer, one of a trio of engineers that managed the shutdown of that plant, hired the contractors, and put all the bid work together for that. I was the first Hispanic female engineer to work in that refinery. They hired me along with 11 others that year - it was great because we were all young students.

**Question from the floor:**

How long ago was that?

About seven years ago.

I have been here in Houston almost three years. My present job is in the area of environmental safety, fire and health regulations. It is in a five-state area and is directed at the marketing facilities. I am now going to back to the refinery as a lead engineer working on a cleanup project that we have going on at the refinery.

**Question from the floor:**

Did you like El Paso?

I loved El Paso. Hey, you are from El Paso - do you think I am going to say anything else? I really did like it. So what I was getting at was that for me it turned out that not fitting in my courses was a blessing in disguise. When I graduated from school, obviously Chevron decided they wanted me back and I decided I wanted them back. So I went to work for Chevron again, but this time in marketing operations, and I have been in several jobs since then, including in Salt Lake City, Denver and San Francisco.

**Question from the floor:**

What is your degree in?

My degree is in civil engineering, nothing to do with what I do. To some extent, when I was in school I was going to be a structural engineer, building bridges. Then I got very

interested in studying the effect of earthquakes. I became somewhat of an earthquake expert while I was at Stanford because that was the field of one of my professors, the only female professor at Stanford. She was into statistical analysis, finite element analysis, and how you predict risk of an earthquake event. She had been trying to convince me that I should stay on and go for a Ph.D., but the money was too good, and I got swept away into the working world. I do not regret it, because I really enjoy what I do.

**Question from the floor:**

Have you thought about pursuing your graduate work?

Not in engineering. If I go back it is going to be for a degree in public administration/government affairs because that is what I want to do. That is one of the reasons why I have moved around as much as I have within the company, to find out as much as I can about the different aspects of it, because a good public affairs/government person needs to know the different aspects of the industry and of the company.

Another recommendation is that counselors should maintain contact with students during their first semester in college - I am talking about the counselor of the school that the students come from. I had a very sad experience with a young lady with whom I lost touch. I picked up the phone one day to see how she was doing, and she was not doing very well. Already two semesters of this had gone by. If someone had talked to her earlier, there might have been something that could have been changed or done differently so that she did not fall into the hole that she did, which was basically taking on too much at one time.

***"Another recommendation is that the counselor of the school that the students come from should maintain contact with students during their first semester in college."***

I am an advocate of obtaining a balance in your life, not just hitting the books, especially when you are moving into a four-year university. If you do just that and you fail miserably, you end up getting *C*s and *D*s, and that does not do very much for your confidence level. Now, on the other hand, if you go and at the same time you have been doing other things, you have that other area at least to hold you up while you are trying to prioritize yourself. As I mentioned earlier, while I was at the community college, I was very active in the community. The hardest thing for me when I went to Stanford was thinking that I was going to have to give this up, that all I would have time for would be studying in order to keep up. Look at the competition - look at where these people went to school. I felt a lot of pressure, that first semester at Stanford. It was like either sink or swim. I let that get the better of me for maybe about a month or two months. Then I said, "No, it is not worth it. I need to be involved because that is the kind of person I am."

I was tutoring in the neighborhood, there at Stanford. One of the poorest communities in California is East Palo Alto. Right across the street on the other side of the railroad tracks from Stanford, the median income in that neighborhood is $6,000 a year. Helping others has always given me the inspiration I needed to do better, even in my own classes and in what I have done with my life, so for me it works. But the point I am trying to make is that if students go to college and all they do is academia and they do not do well, it is hard, very difficult, to bring them out of that. They will have lost a lot of self-esteem. I do not know if

any of you have any experience with that. Please feel free to disagree - these are just my own observations.

**Question from the floor:**

Did you form any study groups while there?

At Stanford, yes, everybody does it. That is the first thing you learn when you get to a four-year university. There are all kinds of groups. The fraternities are extremely good at this. They have exams going back to the 1920s, and they have the ins on what is going to be on the test. It is really the same thing that carries on into anything you do in life: being prepared and knowing, thinking ahead to what the questions might be. So yes, groups were formed. But again, sometimes minority students have trouble forming into groups because they are not used to it - they have been by themselves so long. They have been "the only one," so it is not something that they would normally do. They might feel that it is cheating, almost, to find out beforehand what is going to be on the test.

Let me tell you another thing about being a female - living away from home for the first time, and trying to explain to your parents that you are going to live in a coed dorm. It is not an easy thing. When I was going to the community college, I would come home every night. My parents knew where I was at 10:00 p.m. Going away to college - and, on top of that, to a coed dorm - it is just not looked upon favorably. Going to college and then getting there and finding out you have to share the bathroom with 20 other women and there are no shower curtains, for example. I am getting personal now, but I think you need to know some of the things that went through my mind when I first arrived at Stanford that were shocking for me.

In addition, the diversity of students was absolutely incredible. We had the heiress to the Wrigley fortune in my dorm, mixed with Chicanos from East L.A. So it really made for some very interesting discussions at night. To me, that was one of the beauties. I would like to encourage students to go away to school because I feel that it gives you more of an opportunity to get involved in academic life. When you are living at home, you have a lot of distractions - you are working, you have a family, and so on. It is hard to really just give yourself to academia.

**Comment from the floor:**

My version of what we told the girls in the program was, "Finish your college as fast as you can, but once you attain that level of achievement, go away to somewhere new." Then you can see the different perspectives of people. You are looking, logically, from a totally detached point of view, and there are different surroundings of people around you, that give you different ideas than you had before. You do have to get away at some point. For the girls who have not, it is more difficult for them to get away. Do it as soon as you finish with college.

It is a difficult decision. It really is, because you have these strings that are pulling at you saying, "Don't leave." I remember when I first went to Stanford - it is a three-hour drive from my house to Stanford - and my mom approached me and said, "Can you live at home and commute to school?" She was dead serious. She had some friends that were commuting from Sacramento to San Francisco, and Stanford was still about another hour away. Well, she saw these people going back and forth every day and thought I could, too. I said, "Mom, I can't do that." My parents were understanding enough, and they have always encouraged us to go to school. They knew what it meant, having the opportunity to go there, so they let me go. They visited me, gosh, I can't tell you how many times.

That leads into a little story. When I call my mom, she does not ask me, "*Como estas?*" ["How are you?"], she says, "*A donde estas?*" ["Where are you?"] That is her first question for me, "Where are you calling from?" My parents have visited me in every place I have been located with Chevron. My mom told me on the last trip when she came out to Houston that they did not want to stay in Houston, they wanted to go to Disney World. So there we go to Disney World. She said if it had not been for my leaving and going away, they would have never visited as much of the country as they have.

**Comment from the floor:**

Can you elaborate more on how your mother encouraged you to go to school? How early in life? Your mother or your father?

They both set a very good example for me. The whole Colmenarez family has gone to Sacramento City Community College. First of all, let me tell you that my parents' educational level is as follows: my father went up to the third grade, and my mother completed high school. When they came here, my mom was the first one who decided to go back to school. When we were little, she was going to night school, learning English, learning how to drive, getting all her *comadres* to go with her. She was one of these ladies that would get everyone else to come with her. Slowly over the years, she went to Sacramento State University - she went to City first, then to State. Today, she is a teacher. She received a bachelor's degree in education about six years ago, so she was a very good example for us.

My father also went back to school, also to Sacramento City College. Then he really knew what college was like because, before, I would go home and he would say, "You have to clean the house first, then you can do your homework." After he saw what it was like, he changed. He realized what it took to get an *A*. It was not just his telling me, "You had better get *A*s or else." Because that is the kind of attitude they had, with us. I had to bring home *A*s. I used to get paid a dollar for every *A* I brought home, but that is beside the point. School was like *lo maximo*, especially for my father. He did not get the chance to do it, but I had to do it.

**Question from the floor:**

How many brothers and sisters are there in your family?

There are five. I am the oldest. My sister who follows me started in engineering, but her true calling is artistic. She is a folklorical teacher, full time, the only one in the U.S. who is funded. It is fantastic - she gets to go to Mexico whenever she wants, and she has a blast. My brother is next; he works as a supervisor for UPS. Another brother just graduated from UC-Davis with a degree in mechanical engineering and is now working for Rockwell in Los Angeles, with the space shuttle group. My youngest brother has not decided what he is going to do. But yes, every one has been a paper boy, and we have all worked since we were in our teens. Going to school, we have put pressure on each other, too. That little brother has not quite escaped yet - he thinks he has, but he has not.

**Question from the floor:**

Did you all work because you had to?

Yes, we did. My father was a cannery worker, raising a family of five. My mom had to go work too. She used to work at Gemco, and we used to get extra goodies whenever she did that. But yes, it has always been a working-class family.

**Question from the floor:**

How was the transition from the community college to Stanford? It must have been quite a transition. Well, in chemistry, at least, Stanford is one of the top-ranking schools in the nation - the academic level is really high. Did you find a difference in stamina?

**Comment from the floor:**

There was a professional there in chemistry who won a Nobel Prize.

Oh, yes, that is what I was mentioning earlier, just the amount of time I had to study, was well over 50 percent more than what I was doing before. Mentally, you just have to be prepared for that. I am not going to argue that, but again I think it goes back to building up that confidence. I had a lot of confidence when I went.

**Question from the floor:**

Is that why you have such positive self-confidence? What brought that about?

I think, my parents, for one thing, and this idea that you have to do well in school. I did do well in school. I was the teacher's pet, in first through eighth grade. I was teaching students how to read English. By the second grade, I was a tutor for some of the slower students. I was not very good in math, but I liked it. There is a difference between liking it and being good at it. I just worked very hard at it. Math was not my strength, but I did not let that stop me. I just wanted to learn.

Somehow, I used to go to the library when I was very young. I used to take a little red wagon with me, and I used to check out books by the wagonload and take them home. I lived about five blocks from the city library. It was a ritual. My little brothers would all go, pick out the books we wanted, and take them home. I really feel that reading is a key, a key to many of us to increase our knowledge. Reading took me to places I had never been. Vocabulary and spelling are so important. I am a formidable speller. There wasn't a boy who could beat me, and that was important to me. I remember in elementary school, we used to have these spelling bees, and I was always the girls' champion, our representative.

**Question from the floor:**

What other extracurricular activities were you involved in?

Folkloric dancing. I have been a teacher and performer for the past 15 years.

**Question from the floor:**

How old were you - without trying to find out how old you are - when you started?

I am 30, and I was 15 when I started.

**Comment from the floor:**

You were much older than a lot of folkloric dancers.

In those days, it was not popular. When I first started, I was riding that crest, that wave of when it was first coming into being. I remember being seven years old and being

embarrassed to death because I had to dress up in my costume. This was my mother's doing - she made us dance at our elementary school. At that time, it was not in vogue, not popular at all. All the kids made fun of me that I had to dress up and wear this hat and the whole thing. I thought, I am never going to dance again. Then seven years later there I was, teaching a kids' group.

**Question from the floor:**

How about the student council or other activities in the school?

When I was at the community college, I was selected to represent the college in a competition called the Sacramento Community Festival. We had to go around and introduce ourselves - I must have given about 60 talks that period. It was so great because it was my first experience at public speaking, getting up in front of a bunch of people and telling them who I was and what I did - that is easy, to tell people who you are. It gets more difficult when you have to pick a subject and so on, but it gave me experience in being in front of a group, at a very young age.

**Comment from the floor:**

I have always thought that those students who are very involved in extracurricular activities are the leaders of the school because they are naturals to succeed because of their positive self-confidence.

Yes, I agree. I also started a group called the Mexican American Youth Association. I was the founding president of that group. It was funny because they used to have to meet at 7:00 in the morning - they had to meet my schedule because I had to go to work after school. So most of the other clubs, the French club, the Spanish club, met at 3:30 or 4:00 after school, but our group met at 7:00 a.m.

**Question from the floor:**

I have two questions. One, you said you were involved in a folklorical group in California. Did you ever get involved in theatrical groups?

When I was at Stanford, yes, I joined a group called *Teatro Sin Verguenza* [Theater Without Shame]. You can imagine what that group used to do. We were pretty outspoken.

**Question from the floor:**

Earlier, you brought up financial aid and scholarships. Did you ever get involved in financial aid and scholarships?

Before Stanford, at the community college level, there was no such thing as financial aid, but there was no tuition charge at the community college level.

Another recommendation is to get to know your financial aid officer at whatever college you are going to. I used to go visit that woman and ask, "Is there anything coming up that I can apply for?" I applied for everything that was possible.

**Question from the floor:**

Was there a minority engineering program in Stanford, and were you involved?

It was just starting. It was a group called the Latino Engineers and Scientists. I was involved but not to the degree that I am today as a professional. It was just in its beginning stage. I think that year that I left, that last quarter, it was just forming, so I missed the benefits of that. There really are benefits to participating in a group like that. When I was going to Sacramento State, the nearest minority group was at UC-Davis, and I used to commute from Sacramento to UC-Davis to hang out with those students, just to feel like I was going somewhere. To this day, there are 13 of them, UC-Davis graduates. They are all over the place. They are all moving up in their careers. Some of them are becoming first-time supervisors, like me; some of them already have. We keep in touch. We are the group of thirteen, and I am the adopted one. I am the thirteenth because I used to hang out with them.

**Comment from Gloria Rodriguez:**

Two of my brothers-in-law graduated from Stanford. One became an engineer and one became a doctor, Rudy and Roy Rodriguez. They also came from a very low income community.

I know them - aren't there more brothers than that?

**Comment from Gloria Rodriguez:**

Yes, my husband, who is also an engineer.

There are some students at Stanford who are there because their grandfather went there. Let me just touch on that briefly. When I first went to Stanford, there was a period where I felt inadequate. "Why did they let me in? Am I really qualified to be here?" Then I started looking around, seeing why some of the other students were there, especially the ones that were not doing that well. Some of them just happened to be from very wealthy families, or they knew somebody. Then I did not feel so bad - I did not feel that I had just edged my way in there. Maybe I had, but hey, I did well. When I was at Stanford, I graduated with a 3.2 GPA, and I am very proud of that.

**Question from the floor:**

Were there a lot of foreign students there?

Not as many as in the graduate school. You see more foreign students in graduate engineering schools; there are a lot of them.

If there are no more questions, let me make sure that I have covered everything since we jumped around a little bit. Just a few more points - this is for the students themselves who are going to be transferring:

1. Visit the campus before you actually go to attend and be comfortable with the surroundings.

2. Expect to study more, at least 50 percent more than you already do.

3. Seek assistance from professors, from teachers, from other students. Take that first step if you need it. Do not wait for help to come to you.

**Comment from Manuel Berriozabal:**

One of the problems I find also is that many students in the high school level and junior colleges do not think they know how to study. I think the problem is that you have to rely on memory and other forces. It is really hard to draw a line where memory stops and understanding begins. Whereas in mathematics, it is really understanding - you have to understand. The same thing applies in chemistry. Some people have the misconception that chemistry is memory. It is not memory; the amount of memory in chemistry is limited. For the courses in history, for instance, and liberal arts, you have to rely on memory - history, government, geography and even some courses in biology. You take a course in anatomy and you have to memorize what these bones are, what these tissues are. There are people with really good memories, and they do great because they are memory-oriented. When you put them in a forum where understanding concepts is required, they cannot do anything. I think the problem is, How did we fail the students? Where do you stop with memory, and when do you start to understand? It is not easy. If somebody has an idea, I would like to hear it because I tell my students in my classes that memorization in this course is minimal. As a matter of fact, often, I give copies of exams. I want to know how they can do, I do not want them to just memorize a problem and give it back. Does anyone have any opinions on that? When do we stop memorizing, and when do we start understanding?

**Comment from a Student:**

I can give an example only in math, like in terms of the way the questions are worded. Someone commented about problem solving that does not make sense. But if the teacher words the question so that it is applicable to the field, the student will find it more interesting. If the problems are just too theoretical, it does not interest me. So I feel that it is the way the questions are worded.

**Comment fron Manuel Berriozabal:**

Since I feel I am qualified to talk, I will go ahead and give my opinion. I feel, even now, there is a lot of emphasis on certain things in education. The goal is not necessarily teaching someone how to learn. You come up with a certain score on a SAT. Therefore, the emphasis is not something you are going to tell the kid as he goes into college. It is something that he had to have learned how to learn. I do not think this is being taught to a lot of groups.

The example I can think of is Asians coming in without even knowing English. Yet they can function very well, so they have some skills these English teachers do not have, and that is knowing how to learn.

**Comment from the floor:**

Engineering is process-oriented. As we were talking about yesterday, I was shocked at what I did not know when I started working. My supervisor on my first day said, "Your degree is a *license* to learn - now you start learning."

★

# PROCEEDINGS OF THE FIRST ANNUAL BLACK SYMPOSIUM ON SCIENCE, ENGINEERING, AND TECHNOLOGY CAREERS

October 11-14, 1988

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# IN MEMORIAM

## Rufus Hayes Cox, Jr.
## (1920-1988)

*Rufus Hayes Cox, Jr., eminent American scientist, humanitarian and educator, died October 27, 1988.*

*Born March 17, 1920, in Christiansburg, Virginia, Rufus Hayes Cox, Jr. was educated in the public schools of Virginia and Pennsylvania, graduating from the Overbrook High School in Philadelphia. As a young man, he joined the Boy Scouts of America. Rufus became an Eagle Scout, and later, as an adult, he became an Assistant Scout Leader and ultimately a Scoutmaster. It was an affiliation he would continue throughout his life.*

*He served his country in the United States Navy in World War II, enrolled in the University of Hawaii in the service, and after his release entered Temple University to complete a B.S. degree in 1948. Before his graduation he married Geraldine Byrd, and they became the parents of a son, Walter Hayes Cox. In 1966 he earned an M.S. degree in Organic Chemistry at Drexel University.*

*From 1948 to 1960 Rufus worked at the Frankford Arsenal in chemical research. Soon, however, he found his true niche in life and began what would prove to be an illustrious career as a teacher. He taught at Spring Garden Institute (1960-1965), organizing its Science Department. After a year of work with the Society of Friends Community Motivation Program, in 1966 he joined the faculty of the Community College of Philadelphia, where he remained until his death on October 27, 1988. He founded the college's Chemistry Department and served also as its chairman.*

*A good and gentle man, Rufus Hayes Cox, Jr. used his talents to inspire generations of college students. He was a model for young people, someone to whom they could look up and whom they could emulate. A devout Christian, Rufus Cox put his spiritual philosophy into practice, keeping in touch with his students and exulting over their triumphs.*

*In 1980 Rufus Hayes Cox, Jr., was awarded the prestigious National Chemical Manufacturers' Association Award for his remarkable contributions to chemical research, industry, and education. He was recipient of other honors as well, and a member of the Energy Educations Advisory Council and Director of the CCP's Energy Club.*

*His colleagues at the Community College of Philadelphia remember him as a man of enormous charm, dignity, and integrity. One said, "There was an aura about him that was simply infectious"—the undisputed aura of the Master Teacher. We salute his record here and, like his students, describe him as a great American.*

John Q. Taylor King, Ph.D.
CASET Director and Chair

# KEYNOTE ADDRESS

**The Honorable Wilhelmina R. Delco**

**Texas Legislature**
**Austin, Texas**
**PO Box 2090, Austin TX 78769**

*State Representative Wilhelmina Delco has been involved in politics for the past 20 years. She has exerted her influence at the county and state levels as well as nationally, in her role as a Democratic delegate to the 1974 and 1984 Presidential Conventions. Representative Delco received her Bachelor of Arts degree in sociology from Fisk University and, in 1980, was awarded an honorary Doctor of Laws degree from Huston-Tillotson College. As a seven-term State Representative, she is Chairman of the House Higher Education Committee and a member of the Business and Commerce Committee. She has served also on the Education Select Committee on Higher Education. Her commitment to education and the community has led to her membership on the Advisory Committee of the Texas Employment Commission and to her active involvement with the National Assessment of Educational Progress (NAEP). She has received countless awards in recognition of this commitment, including an award in 1987 from the Texas Alliance for Minorities in Engineering (TAME) for Distinguished Service to the Engineering Profession. She has been cited as one of the "bright spots in the House" during the 68th Legislative Session by the Texas Observer and described as dedicated and forthright. In 1986, she was elected to the Texas Women's Hall of Fame.*

We think that Texas is a state that, in spite of all of its past problems, is once again on the move. Since the thrust that we have chosen for our state is in the area of science, engineering, and technology, we think that you as professionals in that area can help us a lot because Texas is confronted with some very serious problems. In the first place, we had relied to a very great extent on oil and gas to support our state, and they did very well by us for a long time. But we have found ourselves in the position of having, in the recent past, what is laughingly called a "revenue shortfall." For the first time many citizens have been asked to reach into their pockets and, through taxes, help the State do the things that we had previously been fortunate enough to do because of the natural resources we had in our state. Now we are having some very difficult times because people are very reluctant to reach into their pockets to provide services for others.

Secondly, demographic projections for Texas show that the fastest growing population in Texas is Black (African-American) and "Brown" (Hispanic) people. The state that has the largest number of metropolitan areas is Texas. Most people think of Texas as fairly wild and fairly rural, and it is neither. It is important to recognize that in terms of the growth in Texas, all of those urban areas by the year 2010 will be majority minority, and the school systems will reflect that. Those are the populations that are underutilized, underrepresented, and underserved. Those are the young people who for so long have been tuned out and turned off of education. Yet we are going to need those bright young minds if Texas is going to move forward. Having gone through the heyday of agriculture and the later heyday of oil and gas, we have finally realized that our only real, renewable resource is the minds of our people. Therefore that is the best investment we can make. At the same time, we look to our young people to help us as we grow older.

We are looking at the other fastest growing population in Texas and in this country: people over 65.

People are living longer and are being more active and productive in their older years. We are finding at a time when we need resources that we have competing and, in some senses, conflicting influences demanding limited resources. It is going to be very important for all of us to work together and convince young people that education and careers in the more difficult aspects of education are important to them. It is also going to be important to convince older people that they are better served by an investment in education: Whereas ten years ago there were about eight people contributing to every Social Security check, we are rapidly reaching the point where there will be fewer than three. It is important to you, whether you are younger or older, to recognize that education is well worth the investment. I say that to you, and have a sense that I am "preaching to the choir" when I say that. I am sure you know that, but you know also that the group that is probably participating the least in the process is our Black youth.

*"It is also going to be important to convince older people that they are better served by an investment in education: Whereas ten years ago there were about eight people contributing to every Social Security check, we are rapidly reaching the point where there will be less than three."*

When we look at Texas and at the two dominant minorities, Blacks and Hispanics, people suggest that we organize a drive to recruit "minorities." I argue you do not recruit the same way. Hispanics are, by and large, the people who have never really turned to education. They are turning to education now in droves; the doors have been opened, and they are in large measure going through those doors.

Blacks came out of slavery looking with enthusiasm to education, and the doors were cracked at historically Black colleges (HBCs) that were created to accommodate their desire for learning. However, the promise of education for a lot of Blacks has not been fulfilled. A lot of our people were led to believe that education was a sure road up and out of the ghetto, up and out of poverty. We have had in recent years a lot of young Black people with college degrees who have not been able to get the kinds of jobs or keep the kinds of jobs they thought were in their future. Whereas one group has been turned on to education, another group has been turned off.

There are young people who are looking for ways to pay for their BMWs and their condos and all of those things you see on television. Some young people are not looking for income through the route of education, but through the route of street economics. These young people say, "I can make more money selling cocaine and drugs in one day than you can working as a professional in education for your whole life." That is a persuasive argument to other young people on the street, and if we are going to turn our bright young minds back to the kinds of pursuits that drove us, we have to recognize that our people, more than any other group, represent a serious challenge to our greatest skills in getting them into the areas of science, mathematics, engineering, and technology. They have the capability; that is not the question. The question is the desire, the question is the motivation, the question is the excitement—and that is what I hope you will address.

The way we go about turning our folks back on—it is important for us to be a part of this process. It is important for us to convince our young people that this is where they ought to be. As this group grows through the years, the numbers ought to double and triple and quadruple. That can happen only if the young people who are looking to the pimp and the prostitute and the drug pusher now turn to the scientist, the technologist, and the engineer and find encouragement from role models and motivation in the future.

It is important also to turn to the political process. Most of the time, those of us who deal in the higher levels of education and professional status think that if we are doing our job, everything else will fall in place. Well, it is not necessarily so, especially now that we have a federal government that is increasingly returning to the states those kinds of services that at one time were assumed by the Federal Government: human services. Now, people who have been accustomed to going to Washington to petition the Federal Government for redress of their needs and problems are turning to the state legislature. In the past, the

state always ensured that education would get at least half of the state budget, but now other causes are competing actively for those dollars, and education can no longer assume that most of the money will automatically go to them.

After all, a young welfare mother who wants an opportunity to go to work and needs desperately somebody on whom she can rely to take care of her child, sees good day care as a higher priority for a 3-year-old than a good public school for a 6-year-old. A person who has spent his entire life working and paying taxes sees adequate nursing home supervision and care as a higher priority than their taxes being spent on public or higher education since they have already educated their own children. So we have competing forces for limited dollars. The charge to you is to:

1. Reach down to those young people who desperately need you as friends, counselors, and role models and help them to understand that this is the path that needs to be taken.

2. Reach up to older people who are saying, "Why should I pay taxes to do that?" to show them the value of what dollars spent on education can mean in their later years.

3. Reach across to the policy makers, the people whom you helped to elect to public office, to help them understand that if we are going to have a better quality of life for everybody, then we have to be willing to invest the tax dollars that can make a difference.

That is not an easy task, but it can—and must—be done.

# THE LEAKY PIPELINE

**Shirley M. Malcom, Ph.D.**

**Program Head, Office of Opportunities in Science**
**American Association for the Advancement of Science**
**1333 H Street, Washington DC 20005**

*Dr. Malcom has served as Program Head of the Office of Opportunities in Science (OOS) since 1979. The Office is concerned with increasing the participation of minorities, women, and disabled persons in science and engineering and with determining the impact of science and technology on these groups. From 1977 to 1979, Shirley Malcom served as Program Officer for the Science Education Directorate of the National Science Foundation. She received her doctorate in ecology from the Pennsylvania State University, her master's degree in zoology from the University of California at Los Angeles, and her bachelor's degree in zoology from the University of Washington. She is a member of the Advisory Council of the Carnegie Forum on Education and the Economy, and has served on numerous boards, including the Education Advisory Committee of the National Urban League. In 1987, she was recognized as one of five honored by the National Council of Negro Women/Frito-Lay in their "Salute to Black Women Who Make It Happen."*

I am happy to be here to talk to you about a topic I consider to be of the utmost importance to all of us, the "Leaky Pipeline." The title of my presentation really describes the problem we are having here.

I went to the American Association for the Advancement of Science (AAAS) to head the Office of Opportunities in Science (OOS) in 1979. At that time, if you wanted to talk about the problems of minorities in science and engineering, a few of us would meet in a room. We all knew each other, we all grew up together in the movement, we knew what other people's programs were, and we had full knowledge of everybody who was involved in this particular issue.

An amazing thing has happened the movement has actually gotten out of control. You know when a movement is actually a movement; when you go to a meeting and you do not have to give the equity speech, you know that you are now in something very special. I knew that something very special had happened when the September 19th [1988] issue of *Business Week* hit the stands with the cover words, "Human Capital: The Decline of America's Workforce." I just want to read you what is underneath the headline:

> The nation's ability to compete is threatened by inadequate investment in our most important resource: people. Put simply, too many workers lack the skills to perform more demanding jobs. And as the economy comes to depend more and more on women and minorities, we face a massive job of education and training—starting before kindergarten. Can we afford it? We have no choice.

This is from *Business Week*. I have seen articles about what business can do about education in *Fortune*. Now when you get this kind of writing out of *Business Week* and out of *Fortune Magazine*, you have hit a nerve. When you get reports out of the Office of Technology Assessment, and when you get our leading agencies talking about these issues, you know that you have hit a nerve.

## FEDERAL TASK FORCE TO DEAL WITH THE LEAKY PIPELINE

I knew that we were into something very special in 1987 because Public Law 99-383, Section 8, called the Hatch Amendment, was passed. [The law was named for Senator Orrin Hatch, who introduced the amendment into the National Science Foundation (NSF) authorization legislation.] This particular amendment called for the establishment of a Federal-wide Task Force on Women, Minorities, and the Handicapped in Science and Technology. The basic idea was to configure a group within the Office of Science and Technology policy consisting of representatives of all the agencies involved in science and technology, including the National Science Foundation, the National Aeronautics and Space Administration, the U.S. Department of Defense, the U.S. Department of Energy, the U.S. Department of Health and Human Services, and all of those agencies and departments that in fact depend on scientifically and technically trained people to continue to do business. There are a lot of these agencies around. You do not realize it until people call up and say, "You did not put me on the task force. I have that need, too." This particular issue is a big issue now, and it is not just our issue now. Although we have been working in the area for a long time, we are going to need everybody involved in order to solve the problems that are presented, the challenges that are presented.

The major focus of the work of the task force was to devise a plan for coordinated Federal response to a developing national crisis. Some of you may have seen this new *Civil Service 2000* report that was commissioned by the Office of Personnel Management that says that the Federal Government is going to have problems, too. The Government already has problems in some of its metropolitan areas finding enough highly skilled workers. Government cannot compete with private industry for systems analysts and computer people in places like New York and San Francisco, where they make the same money as the people in Wichita but where the cost of living is much higher. Technical people can get a lot more money for those technical skills in the private sector. So the Federal Government is now having problems recruiting people in the very technical fields. And the work of our government is increasingly technical.

> ***"The pipeline is leaky, but the thing that people don't understand is that it is leakier for some than for others. For the groups that we have been looking at in our office—women, minorities, people with disabilities—the pipeline is very leaky."***

I live in Columbia, Maryland, which is right down the road from Baltimore. The Social Security Administration buildings are located there. Do you know that it is a massive systems analysis problem to track, send checks to, and monitor all of the payments just to our senior citizens, this growing population of senior citizens? There are huge buildings and thousands of employees, and they require technical skills. A Social Service function is not something we usually think of as requiring technical skills, but many of these jobs require that people have technical skills.

The particular targeting of those groups by the task force (women, minorities, and people with physical disabilities) is not accidental. Those are the groups who are not now participating at the levels that they need. In fact, they are two-thirds of who is out there; and it is the realization that that is most of who is out there (from whom we are not able to pull at the present) that has driven the formation of this task force and that is driving a lot of the efforts within our agencies to try to deal with the leaky pipeline. The growth in our workforce is going to have to come from those groups. Our scientifically and technologically driven economy is going to depend on those groups, and that is really what we are talking about. Issues of equity and fairness raise our interest in these groups, but national need is what compels us to act. And that is where we are—national need.

## PRODUCTION AT THE END OF THE PIPELINE

The legislation emphasized the whole issue of production at the end of the pipeline. One of the things we found is that the pipeline is continuous. The pipeline goes, as the Office of Technology Assessment (OTA) report says, from "grade school to grad school." I would even suggest that the pipeline begins before grade school. But let us first look at the other end of the pipeline for just a moment to see what kind of problem with which we are dealing.

The 1986 figures on the production pipeline are not encouraging. (The 1987 figures are coming, but they do not look any better; as a matter of fact, they look a little worse.) But let us just look at what we have here at the end of the production pipeline. I consider movement into employment as part of the pipeline, too. In terms of actually getting our people into technical fields, this is what we are talking about in 1986: five Ph.D. degrees awarded to Black U.S. citizens (for the entire United States); we are talking about zero—no—Ph.D. degrees in computer science in 1986. We are talking about seven Ph.D.s in physics and astronomy, 13 in chemistry, none in earth, atmospheric and marine sciences, 14 in engineering (most of those are Howard Adam's GEM students). We are talking about 40 in the biological sciences, 17 in the health sciences, and seven in agricultural sciences. The numbers get better as we go into the social and behavioral sciences (four to 21 in education). I do not begrudge Education for those people, but everybody goes into Education. Even at that, we are still not getting proportional representation out of Education. We just do not have enough people coming out of technical fields. That is what we are dealing with. This is the problem at the end of the pipeline.

## BEGINNING OF THE PIPELINE

I first met Wilhelmina [Delco] through my work on the Carnegie Task Force on Teaching as a Profession. I worked on that particular task force, chaired by Lewis Branscomb. One day, we were talking about these particular issues. Lew looked at me and said, "I have a name for you people who work on this pipeline problem."

I said, "What's that, Lew?"

He said, "Educational plumbers." I never thought about it, but, in fact, we are talking about trying to figure out where the leaks are in the pipeline.

The pipeline that we are talking about is this one that starts in elementary school. Now, what happens to somebody in elementary school—what has happened to them that they are lost to us? One of things that happens is *tracks* in high school. Tracks in high school do not just appear out of nowhere; they began as groups in elementary school. They may be called the Bluebirds, the Redbirds, the Orioles, or the Dolphins. Whatever we call them, they are ways of assembling people who we think have common sets of abilities. If we give them the wrong start, it is very difficult, not impossible, but difficult to give the right start and point them to the right things in middle school. If you have a problem or you opt out of the sequence that gets you to algebra quickly in middle school, it is very difficult, though not impossible, to regroup and get the people in high school into the right sequence so that by the time they get to college, they do not have a lot of fixing to do. If you get to college without certain basic courses in mathematics—and mathematics is even more crucial than science in this respect—it is difficult though not impossible to remedy the situation. The right sequence for mathematics is more crucial than the sequence for science.

Our Black colleges have proved that it is difficult though not impossible to get such students to the point where they can move on and get this bachelor's degree. You do not have to have a bachelor's degree to get a Ph.D. degree. I actually know people who have Ph.D. degrees and have no bachelor's or anything in between, but they are very different folks. They do not walk and talk like the rest of us. Usually, you get the bachelor's degree, and then you go on. This sequence is the part where we talk about people actually being in the pipeline, where they can go on out someplace and be employed as a scientist or an engineer or a technical person.

So if we have gotten them to that point, we still have to get them into graduate school. Howard [Adams] would tell you that it is not always easy to tell a student coming out with a bachelor's degree in

engineering to go straight to graduate school, when somebody is getting ready to hand the student a check for more money than he or she has ever seen. Black students do not always get fellowships at the same rates as other students. They do not get teaching or research assistantships at the same rates as other students. They oftentimes are paying out. I paid out. So when people talk about getting a free ride, it is not necessarily true.

So, we have to get them into graduate school, and then we have to get them out of graduate school. Getting somebody into graduate school is very different from getting him or her to complete a course of study with a degree and a set of skills and the ability to go on.

The result of all this filtering process, all this leaking out, is what we have. You are going to be surprised—you should be surprised—that this many have survived when you realize there are so many places that people can be lost. The leakage is out of the pipeline. You occasionally find folks who are over in the humanities who leap back over into computer science. I meet those people every once in a while, but they, too, are very different.

> *"The greatest outflow occurs early in schooling, so that most of the diversity in kindergartners at the beginning of the system has been lost by the time you get to the college freshman class of science and engineering majors."*

Now, why do we care about Ph.D.s? I am going to tell you why I care about Ph.D.s. I want to illustrate how bad the problem is and who teaches in our colleges and universities. If we cannot get the role models, if we cannot get the people on to the faculty to nurture and care for and mentor our students through, if they cannot be a living testament to the fact that it can be done, then we have serious problems. That is why we all have to care about this particular part of the pipeline.

We have heard a lot of talk about the nature of the demographic change. Let us just see what this looks like. This is the change everybody is talking about, a dip in the number of 18-year-olds among Anglos. This particular proportion of the age group among Blacks and Hispanics is growing, but it is viewed in a different way. You can see the effect at the other end—you can see the bulge coming in the older group while the trough is coming in the younger folk. We have to come to understand that we have a problem with regard to those people who are already in the system, already in college actually making the choice for science. The problem is even worse than we thought because it is not only how many people are in the pipeline and it is not only how many people there are with the right kinds of skills, abilities, having to take the right courses, but it is also a matter of what kinds of choices of fields they are making. These are the people who took the SAT who said they were planning to major in mathematics, science, or engineering. Those lines are going down. The percentage of people who are saying they are going to major and are majoring in the field is a good predictor of whether or not they are going to graduate in that field. We are seeing this interest declining among Anglo males, Black males, and Anglo females, but interestingly it is at least holding its own for Black females.

When we talk about the pipeline metaphor, we are really using an imperfect metaphor, but it is useful enough. We have talked about other kinds of things, we have talked about talent pools. We need some kind of physical manifestation to try to describe what we think we are seeing as people move through the educational system. As a biologist, I think of semipermeable membranes, the movement of going out and going in. But we know that as people move through the system, they had to acquire the course work, the knowledge, and the skills and complete the required years of preparation for careers as scientists and engineers. To get to the next level, you have to pass through the first level with some degree of success. Just getting through is usually not enough. We know that you will not be encouraged to go on if in fact you have not demonstrated some capability at earlier levels; that is just the nature of our fields. If we have a weakness in one part of the system, it imperils the flow throughout because it is one system. The pipeline is leaky, but the thing that people do not understand is that it is leakier for some than for others. For the

groups we have been looking at in our office—women, minorities, people with disabilities—the pipeline is very leaky.

The greatest outflow occurs early in schooling, so that most of the diversity in kindergartners at the beginning of the system has been lost by the time you get to the college freshman class of science and engineering majors. The science community has tended in recent times to focus its attention, its resources, and its time on the flow that is closest to the point of the end product, and that is the graduate and the upper-division college student. People do not want to teach freshman classes. They tend not to be interested in the people until they are "for-real" majors.

This focus has been extremely effective in building a world-class science research establishment, so effective that it is attracting students from around the world. It is working less well in maintaining a human resource base that supports a science and engineering establishment here over the long haul. Since the conditions that feed our current success are subsiding, we see that interest in science majors is down. The supply of American talent looks very different from those for whom replacements must be found. The faculty who perceive their jobs as weeding out the unfit and investing in those remaining find that they must learn to cultivate those who are interested, bright, and creative but who often lack confidence and/or adequate preparation. Whether a person will become a scientist or engineer depends on a number of factors, including interest, ability, and access to informal and formal educational experiences that allow interest to be maintained and ability to be developed into demonstrable skills. But individuals can be members of groups for whom, as a class, access to science and engineering has been limited. That is the challenge of the new demographics. There were around 4.3 million 18-year-olds in 1979. In 1995, it is estimated there will be around 3.3 million 18-year-olds. That is the magnitude of that decline; the minority share of that is increasing.

What does a country do when its talent pool for science and engineering shifts from its traditional source of Anglo males? We talked about the declining interest in science among freshman majors. We know that there is low performance on tests of mathematics and science achievement when compared with students in other countries, as well as with levels of performance that we would say would be respectable even if you did not compare them. The tests indicate what people ought to know, what they ought to be able to do.

The nature of all work is changing. New jobs are projected to be increasingly those which demand higher reasoning skills, especially those based on science, mathematics, and strong written and oral communication skills. "We are fast reaching a point when we are likely to have people without jobs at the same time that we have jobs without people." This was said by a representative of Kodak. Think about it. Listen to that again: we are fast approaching the time when we are likely to have people without jobs at the same time that we have jobs without people. It is not just a matter of creating the next generation of scientists, engineers, and technicians and technologists, although I care most deeply about those kinds of things. The nature of work has changed. Secretaries no longer type and file. They keyboard. They input into databases. If you have a mechanic who can fix your car, take good care of him or her. It is a matter of all the things we need and all the services we require, and people needing strong technical skills to do them. Remember what I said: strong verbal skills, strong literacy, being able to read and understand, being able to write so that someone else can understand.

I think that a lot of people had not paid any attention to the problem. They thought it was our problem, for a long time, until something very interesting happened. We started to find that the problems were among the "talented tenth;" that is, that our brightest students are not scoring that well on tests in comparison with students in other countries. Our brightest students are starting to make different choices about subjects in which they are going to major.

The OTA report discusses policy options to improve science and engineering education—that is obviously something we have to do. It categorizes the issue in two separate ways: (1) strategies for recruitment and (2) strategies for retention. Strategies for recruitment are those that involve enlarging the pool of people, increasing the numbers of people who are ably trained so we can compete with other fields (law, business, and others) to get our fair share of people who have the right skills. Retention strategies are a big part of our problem because once we get the people into the pool, we are not keeping them and they are not graduating. So we are still losing people even though they have gotten through the first sets of hurdles.

I want to introduce another concept to you: the idea of readiness and the pre-educational pipeline issue, what those kinds of things those people need at the front end before they ever hit the school door. I want to quote a famous Texan, Ray Marshall, who said, "The trouble with you—"and this was told to him, he said—"is that you don't understand all you know." I think that in many cases it is our trouble that we do not understand all that we know. We have a lot of knowledge in this room and among the people who run programs to try to increase participation of Blacks in the scientific and technical fields. However, we have to translate that knowledge and apply it very differently to move beyond our program that serves a hundred kids or a thousand kids to one that can serve and reach a hundred thousand or five hundred thousand children.

If we puzzle over the problem of minority underparticipation in science and engineering, we come to appreciate how much we do know but how little we really understand about what we know and where the road to understanding may lie. Why are there so few Blacks? We get a lot of explanation from many directions, and we have to deal with all of them. We hear the whole issue of "nature" and "nurture."

***"We are fast reaching a point when we are likely to have people without jobs at the same time that we have jobs without people."***

We have to talk about genetics, what genetics says and what genetics does not say. The genetic inferiority arguments are there, and let's just face them. Let's run "at" them rather than away from them. They have been articulated publicly with regard to minorities and women. We hear people talking about mathematics genes and all of these kinds of issues. Where do those ideas rest? They rest on the fact that we as a country really believe that science and mathematics performance are driven by ability. We really believe that, and we behave as if we believe it. If you do not believe it, think about the way our schools are structured. You talk about how the media responded to the article by Benbow and Stanley on the mathematics performance of males and females. You look at the way our schools are structured in terms of tracks and groups. We believe that mathematics performance is ability-driven. It is interesting that another *Science* article, some years after Benbow and Stanley, talks about a study in which Japanese and American mothers were asked what contributes to success in mathematics, the American mothers said, "ability." The Japanese mothers said, "effort." If you believe that it is ability rather than effort that in fact is responsible for strong performance in mathematics, you will behave that way. You will think that your kid is in this class because he is dumb or he can't hack it or he just isn't good in mathematics. That's understandable, you say, because you weren't good in mathematics. The sins of the mother or the father are visited upon the child. If in fact you believe that it is effort, then when you don't do well, you try harder.

The tracks are not parallel; you can get from one to the other. In our situation, I dare you to get from one track to the other or to get your kid from one track to the other. You will come up against such jargon as you have never encountered before in your life, and everybody in this room has the same story. I was just talking to Saundra McGuire this morning, and she was telling me about a situation with her daughter. Then I was telling Ken and Diana Beane about a problem I had with my daughter in trying to get her tested to go into a different mathematics class. There are all kinds of barriers because we, as a society, really believe that mathematics performance is ability-driven. We practice educational triage very differently. We take those who are most likely to succeed and give them the most help. It is a manifestation of something in sociology of science called the Matthew Principle, so named for the biblical reference, "To those who have, it shall be given even more in abundance." This is an effect of cumulative advantage, while our children are being affected by cumulative disadvantage.

The other side of the genetics issue is the environmental issue. There are those who believe that the environment created the low levels of minority participation that we see. This goes all the way back to looking at the prenatal environment and improper nutrition during pregnancy among the poor. We know that the following have an effect on minority participation:

- Improper prenatal health care.
- Increased exposure to the environmental hazards we find in our inner cities, the bad air.
- The lead that is still in the paint of some of the old buildings.
- Substance abuse, drugs, and alcohol.
- The age of the mother (with very young mothers, we are going to have problems; we are going to have low-birth-weight babies).

I think that is one of the reasons I was so enthusiastic about Wilhelmina Delco's remarks because we have to make sure that we understand the larger societal and social environment in which this effort to increase minority participation in science, engineering, and technology is embedded. It is not just a matter of getting the right things to our kids; we must get the right things to their mothers. We must keep them from the wrong things. There is a larger context in which we must operate. Is there a high incidence of learning disability? Is it real because of all these health and environmental problems, or is it a matter of misdiagnosis? Is it a matter of simply taking the path of least resistance, since we do not want to deal with these children and we just pass them off as learning disabled, making no attempt to treat them?

> *"Japanese and American mothers were asked what contributes to success in mathematics, the American mothers said, 'ability.' The Japanese mothers said, 'effort.'"*

I think that these are issues which we are going to have to confront and deal with for ages 0 to 3. Does the lack of education of many of our mothers lead to failure to thrive, failure to provide proper health care, failure to provide early stimulation, to talk to them, to read to them, to sing to them, to interact with them? The research suggests that where parenting skills are taught, where there is person-to-person follow-up, where there is contact with those young mothers, even with those young teen mothers, we get better results. We do not have the problems with low birth weight. We tend to have better readiness. We are going to have to start looking outside. We need to conduct our own research at the upper levels about what it takes to make these positive things happen and start looking at the research that is in other areas.

We know from the work of Wiekert that, at least for the Perry High Scope project, early intervention, such as through Head Start, has long-term positive effects on attitude toward schooling, tendency to complete high school, employment history, salary earned, tendency to delay pregnancy (in teens), and tendency to refrain from criminal activity. The measured cognitive gains of Head Start which supposedly had disappeared in elementary school, had somehow been translated into affective and outcome measures as young adults. This is what we know. Now, what do we understand from this? When I look at the Head Start data, one of the things these data say to me is, what do we do to those children? This whole issue of readiness—what do we do for them? Do we give them a belief that education is something to be valued? I think so. Do we give them an opportunity to be in a child-centered educational setting? I think so. Do we make them, to a certain extent, goofproof? That is what we try to do, and many of our interventions have focused on fixing the child or making the child resistant to problems he or she may encounter in the pipeline.

But the real challenge, I think, is in fixing the system. Somebody said to me that there is nothing wrong with the children, it is those adults who are wrong. I am starting to believe that it is all of us—I am not saying it is just the teachers—there are teachers, parents, administrators, policy makers, business people, anyone who does not take the responsibility for what it is children need to get.

Let us talk about how we fix the system. What are our goals for education? What do we want people to leave school knowing and being able to do? I do not know that we *know* that. We talk about

competency, and we in fact take the information and the knowledge and parse them into discrete pieces that we can test, but we never put them back together so they make sense, so that we have some sense what it is we want people to know and what we want them to be able to do. I have heard people say that a goal for their science education in high schools is to get students ready to take science in college.

What about the people who do not go on to college? What about the people for whom that is the last science they are going to take? What about reasons that relate to being a good parent? A good citizen, to make decisions of guilt and innocence as members of juries, people who are being called upon to look at sophisticated kinds of information (like DNA fingerprinting, and fiber analysis)? We do not have clear goals. That is where the problem starts.

In this compassless voyage through our schools, we do not have clear goals. We just want to test people and find out where they are, even though it does not really matter where they are, because we do not know where they are going. We find that the schools that serve our Black children have less equipment, less time for learning, and lesser expectations and aspirations. The teachers have less experience, less belief that the children can learn, and less belief that science, mathematics, and technology are for these children. Often, they do not have a fundamental grasp of, and comfort and liking of, the subject matter itself. We have programs that we hope will make up the difference, but these tend to be pull-out programs that are focused on basic skills. I always wonder what is happening in the regular classroom, to the children who are not pulled out; that is something they are not getting.

We have systems that are beset by problems, in schools where order is often more prized than learning, rather than viewed as a requisite condition for the ultimate educational goal. Now, I recite the list of problems only to remind us that there is a system of problems. Interventions and research suggest directions, if we understand what they say (early intervention). It is easier to repair the problems of the short term than to let these accumulate over time—we know this. Therefore, we find that we need the following:

- **Clear Educational Goals:** We need them; if we do not know where we are going, it is hard to get there.

- **Long-Term Contact:** Educational risk is minimized by sustained involvement with students.

- **Engagement Opportunities:** These must be provided for involvement with the stuff of science, mathematics, and technology, not taught from books but taught the way that scientists and mathematicians actually use their knowledge.

- **Doing Science, Not Reading About Science:** I want you to read about science, too, but after you have done it.

- **Parental and Community Support:** Students are affected by multiple stimuli from their environment. Schools are better off in doing their job if they have powerful allies and partners.

- **Curriculum:** Teaching less and better, not trying to cram a whole bunch of ideas that are disconnected (just words, they are just out there); drawing on the lives and experiences of the students, their world, and their interests, to help them understand scientific concepts.

- **Well-Prepared Staff:** Rethinking the way that teachers are educated initially, given in-services subsequently, renewed regularly, given authority to make professional judgments, and held accountable for their students' performance. We show teachers failed models, for the most part. I would like to see a science teacher prepared, for example, by a combination of in-school experiences and actual experiences with kids. In their freshman year in college, I would like to see them trained to engage in one-on-one tutoring—in their second year, where they work with small groups of students, in tutoring kinds of settings; in their third year, where they are faculty for some of these intervention programs. You know how to engage the kids and keep them, and only after they are convinced that the kids can learn, we put them into classrooms where the models are not always as good as those that are presented outside our classrooms.

- **People:** We have to have minority teachers. That is the first line of defense; those are the first role models. The research tells us that the presence of a Black teacher in a school does affect what happens in that school, and that as the proportion of Black teachers in those schools goes up, the rate of expulsions, suspensions, and referrals to special education go down. There have to be people who can translate between cultures, and we do not have those people; and we are losing the ones we have from the system in droves.

- **Role Models:** People have to be able to see what they can be.

- **Fixing the System:** We have a lot of fixing to do; not all of it costs a lot of money.

I just want to share something with you, and then I will finish up here. If we look at 9-year-old performance on the science assessment of the National Assessment of Education Progress, we find that Black and Hispanic children are already behind. They catch up on knowing everyday science facts as they go along. But it is in the category, "Applies Basic Scientific Information," in this problem-solving and application part, that our young people fall behind. Then we start to understand some of why that is the case.

> ***"In this compassless voyage through our schools, we do not have clear goals. We just want to test people and find out where they are, even though it does not really matter where they are, because we don't know where they are going."***

Early exposure to simple kinds of equipment, stuff you can buy at the hardware store—our kids do not have it. We do not tell parents that instead of going out and buying a Walkman, go out and buy children a yardstick, thermometer, a barometer, weather station, so they can become familiar with some basic kinds of equipment and tools. We need to start saying this; we need to start making explicit some of these kinds of things. Now you will see that we are talking about simple things: What is this scale, this magnifying glass? There is not as much difference in exposure to things that you are likely to encounter in school.

The interesting thing is that the male-female differences start to increase. The minority difference in exposure to equipment that is there is actually due to the fact that kids in the same classroom do not have the same experience. We have target groups of students to whom the attention and the time of the teacher is directed, and we know that those target groups tend largely to be male and Anglo. The attention that Black males get is mostly disciplinary. For the most part, with the Black females and the Anglo females, if they are acting okay, nobody is going to say a word to them because you might "stir them up." We find that as we go further in the schooling process, again, looking at sophisticated equipment, there is still this difference in exposure and this is related to in-class differences in the way that students are treated. We are talking about students not having the opportunity to learn. These are things we are really going to have to address.

Now, you say, "You are at the end of your talk, and you have not even talked about college and you have not talked about graduate school." College is important. Retention programs are important. Getting people to graduate school is a problem of getting them the right information at the right time and having the money to support them. This is more difficult because this means turning on its head a total system which is in its very nature resistant to change. Education is supposed to be a stabilizing aspect of our environment, and that is the reason it is resistant to change. And we want it to be resistant to change—we do not want every fad that comes down the pike to be flipping and flopping our children around. But when we need it to change and be systematic in fundamental ways, making that happen is more difficult. This is what we need at this point, and it is going to take a restructuring.

One of the things I advocated in one place was to close down every school, redraw the boundary lines, reshuffle the teachers, and put in the same building totally different sets of people. Now, you say, that is

absolute insanity, but coming from an animal behaviorist, that is to be expected; because we know that if we can disturb the dominance relationships, we have a chance of fixing the system while people are trying to figure out who is going to peck whom. I say that in jest, but restructuring is going to take something almost that dramatic in order to accomplish it. Rochester is in fact doing it in different ways. This whole thing to establish magnets and different things is an effort to restructure, to create a certain amount of agitation in the system so you will have a chance, in essence, to fix it while all these other things are shaking out.

Your children teach you a lot, and mine are no exception. They taught me something that is fundamental. I asked my daughter to draw me some pictures. (We do a lot of work with parent programs in AAAS.) I asked my daughter to draw me a picture of good and bad ways to study. Kids know what is a good way, an effective way of studying; they know what is a bad way to study, and they draw it. They show that you should not have the dog in the room and that you should not be trying to eat and watch TV and listen to the radio all at the same time. So when my daughter finished those pictures, I said, "Oh, the pictures are wonderful." My staff all wanted copies of them, and they felt very proud and asked her whether she could draw anything else (this was Kelly, my older daughter; I have two girls, 8 and 10). This was the 10-year-old, and she said, "Can I draw anything else?" I said, "Yes, why don't you do me a favor? I want you to draw me fun science and boring science." She looked at me and she said, "But Mommy, there is no such thing as boring science."

Now, our school system's science program has been totally revamped. We threw out all our old elementary curriculum (it was determined to be beyond saving), and we threw it out because it was text-based. We went to a totally hands-on approach. We had goals, and they built equity in from the beginning. They decided they were going to teach a whole lot of technology and physical science because that is what the kids were least likely to be exposed to unless they made a conscious effort. The teachers are comfortable with the life sciences, and they will teach those; but they made a conscious effort to get some of these other fields. I just want to share with you Kelly's idea of fun science because I think it is very instructive to remind us of what we already know. This is her idea; there was no coaching here, no parental involvement. You can see this is a kid's picture. The teacher is actually doing stuff. There is a segment here on plant life; the teacher has seeds in one hand, a pitcher of water, and a little tray. She has on a lab coat and gloves. The children are doing things, too; the children are talking to each other—they are interacting. We know how to make science fun *and* meaningful to children. We do not need to go in and reinvent this, and we do not need to rediscover it; we just need to apply it. We know how children love mathematics when they first get in school, and then, the further they go, the "behinder" they get and the more turned off they become. We know from our programs that it does not have to be that way; people flock to Family Math at Shiloh Baptist Church in Washington. Family Math—we know that that can make a difference. We have to believe that we have to make a difference in order to really turn the system on its head and fix it, instead of always trying to fix the child.

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# BLACK AMERICANS AND SCIENTIFIC INQUIRY

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*At the age of 27, Kenneth Manning had received not only his bachelor's and master's degrees from Harvard University, but also his Ph.D. He has been the recipient of numerous awards and grants, including the Henry J. Kaiser Family Fund Grant and the Josiah Macy Jr. Foundation Grant, each in excess of $130,000. He currently serves as Professor of History of Science at Massachusetts Institute of Technology, and director of the writing program. He is a member of the History of Science Society, Sigma Xi, and the American Association for the Advancement of Science. In 1984, he was inducted into the South Carolina Hall of Science and Technology and was a finalist for the Pulitzer Prize in biography for his book about Ernest Everett Just, Black Apollo of Science. He has lectured and published extensively.*

Thank you very much, and let me say how delighted I am to be here today.

I want to begin my few remarks by telling you how I got interested in the whole question of the role of Blacks in American science and technology. I do that because I think there is some point to the story.

When I was in grade school in a little town in South Carolina called Dillon, I remember my teacher putting up pictures of famous Blacks on the wall during February, because it was Black History Month and we had to have pictures of people who had made significant accomplishments. And during this month I remember seeing a picture of Ernest Everett Just, who was a Black scientist. We did not know that much about him, but it was an intriguing picture. I felt that I wanted to know more about him, and, more generally, about Blacks in science and technology.

I was an undergraduate at Harvard during the years 1966-1970. You will remember that those were the turbulent years in this country, and people were very, very determined that you should work outside—rather than in—the field of Black Studies. The field of Black Studies was just emerging. If you were a serious scholar you were supposed to be interested, not in things Black, but in things Classical, so to speak. Since I was a student, I was following what my instructors, my professors, put before me. My interest was in mathematics, and in the history of science, so I went on to get my undergraduate degree in the History of Mathematics.

I remember very well, though, as a sophomore, reading Gunnar Myrdal's *An American Dilemma*. And in that book, in the second volume, there is a little footnote that said Ernest Everett Just is a fine example of "the American dilemma." Not much was said, and that was puzzling to me. So my interest in the role of Blacks in American science and technology was nourished even further. But I went on to graduate school with the same professors I had had as an undergraduate, and if they did not like Black Studies in the 1960s, they certainly would not have liked Black Studies in the 1970s. So, again, I was in some sense directed away from my interest in the history of Blacks in American science because of my determination

to go through the system, get a degree, and so forth. So I ended up with a dissertation entitled *The Weierstrassian Approach to Complex Analysis*.

But that was in 1974, and I took my first job at MIT. And it was at that time that I thought very carefully about what my next research project would be. Now, when one thinks at a juncture, as that was, one thinks about a career path—about an assistant professor being promoted from assistant to associate, getting tenured and then being promoted to full professor. And the same kinds of considerations that I had confronted during my undergraduate years and graduate years were still there, and had in some senses intensified. But there comes a time in everybody's life when he or she just really has to make a decision about what he or she wants to do. And it was at that time that I decided I wanted to study the whole question of the roles of Blacks in American science and technology. I did not care what the professional or career risks involved in that would be, and the chips would have to fall where they would. And that was the decision I made. So I turned my attention to studying the role of Blacks in science and technology.

Before I go on and talk a little bit about the particular subject I chose at that time, Ernest Everett Just, I am going to give you an overview of some other Black scientists who have made contributions to the enterprise in this country. I will also say something about the whole need for an historical approach, and hope that this conference will not forget that. It is true that our focus here is on increasing the number of Blacks going into science and technology in today's population, but we must engage in that effort with an understanding of the past, because only in that way can we make progress. That is why I really do stress the importance of history, and the importance of taking account of what has happened.

Let me say right away that few scientists of any color have made breakthrough discoveries, though many, both Black and Anglo, have made important contributions. The world really cannot expect to produce an Einstein or a Newton more than once or twice a century. Unfortunately, most people have a certain conception of scientists. You ask them if they know a scientist, and of course they do; they know Einstein. They know Newton. But they do not know the many men and women who contribute to science. Science is based, to be sure, on the fundamental discoveries of one or two great minds, but also in the day-to-day activities of hundreds of hard-working, and sometimes little-known, men and women. And the contributions of Blacks in this group have been underplayed, neglected, or totally ignored. The fact of the matter is that Blacks in America have made important contributions since the 18th century, when the history books would have us believe that the best in American science was represented by Thomas Jefferson's naturalist writings and Benjamin Franklin's clever inventions.

One of the first Black scientists of note was Benjamin Banneker. He was a mathematician, an astronomer, an architect and an engineer. Born a free Black in 1731, right outside of Baltimore, Banneker attended the community school with local Whites. But his scientific genius developed through reading in his spare time. It was the Quaker neighbors who soon detected Banneker's talent for mathematics and encouraged him. Among other things, they discussed geometry and went through Newton's *Principia*. At age 20, Banneker devised mathematical calculations with various parts of a clock, using only a compass and ruler as tools of measurement. This clock was finished in 1753, and it was the first really accurate one built in America. Later, around 1780, Banneker took up astronomy in a serious way. He published a series of astronomical almanacs, and for several years produced these almanacs regularly. He predicted solar and lunar eclipses as well as producing tide tables and weather forecasts of remarkable accuracy (unlike the weather forecasts we have today).

Now, about this man. When the first issue of the almanac was published, Banneker challenged a statement Thomas Jefferson had made that Blacks are inferior to Whites in the endowments of the body and mind. In a letter to Jefferson he mentioned how oppressed American Blacks were and attempted to highlight the hypocrisy of Jefferson's proverb about the equality of all men. Ironically, Banneker was later appointed by Jefferson to the team of architects designing the new capital city, Washington. He applied his mathematical skills to the complicated plans for laying out the streets and buildings. In the end it was Banneker who had to finish the project himself, because the head of the team, Major Pierre L'Enfant, returned to France in a huff, taking all the notes and plans with him. In effect, the layout of Washington, DC, really is a monument to Banneker's genius. These are things we need to tell our children, very early on.

There are other 18th-century Blacks worthy of mention. Not much is known about them. Onesimus belonged to Cotton Mather, the clergyman and sometime scientist who has been credited with introducing

smallpox inoculations into America. Now, there is reason to believe, judging from the statements made by a Dr. Livingstone of medical missionary fame, that Mather may have learned about smallpox preventive measures from Onesimus. You will find a lot about Onesimus documented in journals such as *The Massachusetts Magazine*. In 1792 the journal carried a column dealing with several of Caesar's pharmaceutical concoctions, all of which have proven effective in battling fevers of various kinds. Caesar's most publicized remedies were for poisons, especially rattlesnake bites. Caesar was a South Carolina slave.

Blacks have gone on to leave their mark on modern medicine as well, from the open-heart surgery of Daniel Hale Williams, to the syphilis research of William A. Hinton and blood plasma work of Charles Richard Drew. I go around the country and I call the names of these people, horrified that people in the audience have no notion of whom I am talking about. And these are not Anglo audiences, either—these are Black audiences, and these are medical school students, and they have not heard of the Hinton test, and they know nothing about Charles Drew. Yet they are pursuing medicine avidly. They have not thought about where they are going to practice, what the circumstances of their careers will be. Daniel Hale Williams, a very famous early surgeon, who really did pioneering work on heart surgery, these people want to know about. Drew, whose work on blood plasma is legendary—these people, our students, should know about in great detail.

***"The patent office did not give official recognition to a device invented by a slave."***

Now, while some Blacks pursued medical careers, some found outlets for their scientific talents in other directions. Invention was one such area. There have been literally hundreds, perhaps thousands, of Black inventors from the early 19th century on. The historical reasons for this, I think, are clear: invention requires no extensive educational training, as such, simply a clever mind. Now that is not totally true, but I think I want to contrast this with science, which I am going to talk about later in different terms.

In broad terms, American science has always had an aspect of tinkering about it. And I think people often confuse invention and science. They point to the work of Thomas Edison in science, and most of us would call that invention—that is not to undermine it at all, that is just to make a distinction. Now, Blacks who took up invention were usually following the intellectual tradition of the nation. Social courses had an impact. In the antebellum South, Blacks had the burden of work, mechanical as well as agricultural, on their shoulders. They served as skilled artisans, not only as field laborers. Almost from necessity they developed their own tradition of invention, one that carried over in Black communities long after slavery. Now, it is difficult to determine whether or not some early mechanical devices were invented by Blacks. The patent office did not give official recognition to a device invented by a slave. So, some inventions have perhaps been falsely attributed to slave owners, who registered them in their name but really had nothing to do with them. At one time there was a strong story to the effect that Eli Whitney, inventor of the cotton gin, had gotten the idea from one of his slaves. We have no proof of this as such yet, but I think it is important to raise the question. On the other hand, it has been well documented that another slave, Joe Anderson, was instrumental in helping Cyrus McCormick invent the grain harvester in 1831, even though he received no official credit for the invention. The only invention registered—the only one I found—in a Black's name prior to the Civil War, was the multiple vacuum pan evaporator, something that revolutionized the sugar industry. And the inventor was Norbert Rillieux, a free Black from New Orleans educated in Paris at L'Ecole Centrale. In 1843 he obtained a patent for the evaporator. His method of refining sugar greatly reduced the amount of fuel and the physical labor involved, and it has since been used extensively in the soap, gelatin, glue and condensed milk industry.

A peak period of Black inventors was the late 19th century. There was Lewis H. Latimer, who was a member of the so-called Edison pioneers, the group that built the electric industry in its initial stages. There was Elijah McCoy, the inventor of automatic lubrication; he developed a method whereby it was no longer necessary to shut down machines and locomotives for lubrication from time to time. The whole

process could go on continuously with the cylinders operating nonstop. No machine was considered complete unless it had been modified with McCoy's system, and this is how we get the phrase "the real McCoy," a metaphor for perfection. So, the late 19th century saw Blacks putting out hundreds of useful devices, everything from gas burners and window cleaners to nailing machines and fertilizer distributors.

But inventiveness declined in the 20th century as other professional opportunities began to open up. Still, the inventive tradition did not completely die out. We have the work of Garrett Augustus Morgan, who patented his gas mask in 1912, and F.M. Jones who patented useful devices such as ticket dispensing machines, air conditioning units, and thermostat systems.

Now let us go from the whole question of invention to that of say, pure science—physics, chemistry, biology and mathematics. That is not to say that science does not have practical effects. It does, but the primary emphasis is not that. Now, the fact is that pure science takes years; or, the results of pure science take years, even decades, to come out clearly. And pure scientists must spend much of their lives locked up in laboratories, out of view of the world, in some instances. In many cases they have the lowest profile of all. Sometimes they are admired from afar, but their work, for the most part, is out of the reach of the ordinary person.

George Washington Carver, who is perhaps one of the most famous Black scientists was a pure scientist who really saw applications for his work; his works sort of fall in both categories. From the beginning he searched for the means to make his knowledge immediately applicable in a practical sense. He was invited by Booker T. Washington to develop an agricultural program at the newly formed Tuskegee Normal Industrial Institute, and there he introduced the crop rotation system that significantly improved yields on peanut and cotton plantations. In his laboratory he began experimenting with peanuts, and in a very short time he discovered over two dozen marketable uses. Over the course of the next several years, he used chemical techniques to develop products of all kinds—more than 100 products from the sweet potato, 75 from pecans, scores of products from cotton, and so on. In my book *Black Apollo of Science*, one of the things I do is contrast Just's lack of visibility in some senses, with Carver's high visibility. And I think that White America really felt much more comfortable, in part, with the kind of scientist that was portrayed through Carver, than with the kind of scientist portrayed through Just. The pictures of Carver always are pictures of someone in a white haze, looking as if he is praying for divine inspiration from the Heavenly Father, without a brain in his head, it is all sort of inspirational and God-given; and Just, on the other hand, is someone who is dressed up in a very elegant suit, giving papers at scientific conferences. And people do not feel that comfortable with that. They have an image of what they think a scientist is.

Then there are other scientists like Percy Julian, who was a chemist at Howard University, and he went into industry. He extracted a protein useful in textile sizing in cold water tanks, synthesized the male and female hormones, developed cortisone; he made a lot of very important discoveries, and was the first Black in the National Academy of Sciences. In mathematics, there are people like David Blackwell, who is currently in the National Academy of Sciences. William Schiefflin Claytor, who died in 1941, and Dudley Woodward. Physics has Herman Branson, and Shirley Jackson, the first Black woman to graduate with a Ph.D. from Temple University. And a number of others, and biology is the same. There is a wonderful exhibition at the Chicago Museum of Science and Industry that really profiles a number of Black contributors in science and technology. I actually was a consultant on that project, and one of the most difficult things about working on that project was deciding who to profile. Because that kind of selection is purely arbitrary, and there are a very large number of people doing interesting work.

Now, having said that, let me say that the numbers are dismal. When in 1974 I was looking at this whole project, the role of Blacks in American science and technology, what I had to do was educate myself. So I looked for literature on this subject, and there is fine little book called *Negroes in Science* by James Jay. And if you look through it, you see columns, and years, and degree areas, and you see degrees, and you see zeros in most of those columns. How many Blacks graduated in 1924 with a Ph.D. in physics? Zero. And faced with that kind of data, I said, I am not going to make very much progress in this field, because I am not able to put together trends and patterns. I immediately said, well, I had better find another way of studying this problem, rather than taking a sociological approach. If I really wanted to understand what was going on, I decided, I had better study a few case studies as a way of getting at the experiences of Blacks in American science and technology. And to that end I set up four people I wanted to look at, and I will not bore you with who they were, but the long and short of the matter is that within

six months my mind was focused on Ernest Everett Just. His life was fascinating; it opened up in ways I never could have imagined, he dealt with all of the questions I wanted to deal with, and I think that you probably want to deal with in this conference. First of all I wanted, myself, to elucidate many issues in the history of science and American social history and Black history. Many of these issues have not been much dealt with before. And I will tell you what these issues are.

First I wanted to look at the whole question of motivation. What are the motivations for the choice of a career in science? It is difficult, why would anyone want to go into it in the first place? It is rather presumptuous for us to think that this is just something someone is going to pick up.

Then I wanted to examine the whole question of the role of education in a scientific career. Now that seems a very basic and simple objective, but I invite you to examine it and conclude with me that it is not. People forget the whole importance of the role of education, and it goes back to the thing about invention. In America, people confuse science and invention. They have sort of an Horatio Alger attitude about science: if you are smart enough, you will pull yourself up by your scientific bootstraps and you will make grand and great discoveries. And they never stop to think beyond that. What I wanted to do was to show that people who had, in fact, done well in science were people who had a long cumulative tradition of education behind them. Beginning at the very earliest stages, science is a cumulative field, and one has to feel step by step. Then, when you see those zeros in those columns in the number of Ph.D.s, that question focuses, then, not on the question of whether or not Blacks have pulled themselves up by their scientific bootstraps, but on, rather, what have been the educational opportunities for Blacks? So you shift the question from one of innate ability to one that is really about opportunity.

*"What are the motivations for the choice of a career in science? ..... It is rather presumptuous for us to think that this is just something someone is going to pick up."*

And one has to understand the importance of education. It was a third issue,, namely, the opportunity in America for the professional development of Black intellectuals. That was very important to me, because all of the literature you read on race relations is usually about nonprofessionals of middle- or lower-class status. And that is fine, I am not against that; I think it is important to have the experience of life revealed in many ways. But there is so much you can read about the legends, the greats, you know, that the impact becomes blurred after a while. We know very little about Black professionals, in general, in part because people have not studied them. Also, in part, because Black professionals themselves are very reluctant to talk about their own struggles and problems. They made it, in some sense, and they do not want to remember how they made it. So that is another problem.

Another issue was the financial support for Black academicians. I thought that one had to realize there was a financial dimension here, and I wanted to see how that worked itself out around science and in the Black community—the importance of institutions in scientific communities in the development of a career in science. We talk about students getting into the scientific fields, without talking about the institutions that offer them the advantages. What is life like in these institutions? What is life like in the laboratory? What is there? Somehow we have to focus on these things as well.

Another issue was the one of patronage and its importance in science. The whole question of patronage is one that is understood in art, in music; if you talk about Langston Hughes, people will talk about his patrons and so forth, and that is accepted. But somehow we do not think about science in that way; I suppose because science is supposed to be objective and pure and uses an approach anyone can follow, that people, therefore, think that scientists are objective and pure and so forth. But, you know, that does not follow.

Then there was the explicit question of racism in the world of science, both in America and in Europe. I wanted to look at that. But that was not going to be my primary focus, but I wanted to extract it and to look at it because, somehow, when we talk about getting more Blacks in science and engineering over the

course of this conference, unless we face the problem of racism in this society, I think we are just nibbling at the question. Because it is a fundamental question that has to be dealt with.

The last issue I wanted to look at was the effects of a scientific career on the personal life of a Black man. Now, that was important to me. We all join the hype of getting more Blacks into science and getting more Blacks into the professional world. And I am all for that. But, at the same time, we have to consider what the risks are and what some of the particular problems are that people will encounter, especially before or up until the point where there becomes a critical mass of Blacks in the professions. If we overlook the personal costs that can accrue, I think we are not being as responsible as we should. Now, obviously, I like telling stories, and I like the personal approach, because I think it is very revealing. I like biography; I think that looking at the individual lives of people can tell you a lot. I think it will have as much influence on social policy as grand sociological studies. I mean, if you look at great philanthropists, people like Julius Rosenwald in this country, these people were moved by the individual stories of certain Blacks or other peoples in this society. So I do think that there is room for biography, a way of penetrating and getting at the real, personal issues that impinge on science. And it is very important, I feel, that we do this—very important that we bear witness to what has gone before, because if we do not tell the story of the Black accomplishments, the Black struggles, the Black problems, who will? It will be lost to history.

I made a decision that I did not want to be involved in writing history, and I make a distinction between *writing* history and *making* history. A person who writes history is a person who writes yet another volume on the life of F.D.R. Well, we have enough of those. A person who makes history is a person who is interested in preserving the lives and stories of many common and unknown people who have important struggles, whose struggles and experiences will certainly be lost to history if these stories are not preserved by our children and grandchildren. And as I said, I am interested in making history. And more than that, I am interested in looking at problems that go beyond science and technology.

That came out in a beautiful way in this morning's discussion. There was a question someone asked, What about Blacks who really do have the technical ability, but who are using it to build databases on drug systems, and so forth, within the community. My dear friend Shirley did not answer that question—the way I would answer that question is this: When we are telling children to go into science and engineering, we have to realize that science and engineering do not necessarily bring with them any kind of good value judgement. You can have people who will use databases for good things, you can have people who will use it for bad things. That is independent of having the skill to do it. So, in our effort to get Blacks to go into science and engineering, I think there does need to be an overlay of ethics, and a morality, about what we are doing. One of the biggest mistakes Vannevar Bush made as science advisor was assuming that the Russians could not come up with atomic weapons; he said they could not come up with atomic weapons because they were not Protestant. He just could not conceive of a Communist being able to do that. When you bring to your notions of science that kind of limited view, you are going to fail. Now, it is true that we can talk about Blacks becoming proficient in technical manipulation or technical exercises, and they could use these things to carry on a lot of social problems that we want to end. Getting them into science and engineering is not, per se, going to address that problem. That is an additional problem I think we all have to deal with.

I am interested in looking at science as a way of looking at the human condition because my real interest is in the human condition. All of those kinds of things, like love and hate, good and evil, God, religion—those things are very important to me, and to see how they manifest themselves in a scientific area is one reason that makes me look at the lives of people, and to carry on in that way.

Thank you very much.

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# CONCEIVE IT! BELIEVE IT! ACHIEVE IT! INSTITUTIONALIZING MINORITY PROGRAMS

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*Conceive it! Believe it! Achieve it!* I have borrowed this phrase because it accurately describes how the University of Michigan's College of Engineering Minority Engineering Program Office evolved.

I have been asked to discuss "Institutionalizing Minority Programs," and the best way I know to do this is to tell you about my own experiences at the University of Michigan. My normal presentation method is not from a prepared speech but from an outline, so this will be a different experience for me.

Before I start, I would like to refer you to two handouts I have made available. They are brief articles from Michigan newspapers that highlight one of the primary ingredients for *institutionalizing* anything: strong leadership and support from the top.

- *Ann Arbor News*, Tuesday, October 4, 1988, "Question of Racism Not Funny to Bo," by John Beckett.
- *Detroit Free Press*, Tuesday, October 4, 1988, "Duderstadt: U-M Must Lead in Expanding Minority Role," by Stephen Jones.

These articles clearly depict, from two prominent and respected people both on and off our campus, the depth of feeling and commitment they have to the issues of pluralism and a multicultural and multiethnic society.

## DEFINITIONS

I also like to be sure that I am on the same wavelength as the people with whom I am conversing, so I have provided definitions from *Webster's Ninth New Collegiate Dictionary* (1985) of the following words:

**Institution 2 a**: a significant practice, relationship, or organization in a society or culture (the *institution* of marriage).

**Institutionalize 1**: to make into or give the character of an institution to... especially, to incorporate into a structured and often highly formalized system (*institutionalized* values).

**Minority 3 a**: a part of a population differing from others in some characteristics and often subjected to differential treatment. **b**: a member of a minority group.

**Multicultural**: [of or relating to many cultures]
*multi-* **1 a**: many, multiple. *cultural* 1: of or relating to culture. *culture* **5 a**: the customary beliefs, social forms, and material traits of a racial, religious, or social group.

**Multiethnic**: [of or relating to many ethnic groups]
*ethnic* **2 a**: of or relating to large groups of people classed according to common, racial, national, tribal, religious, linguistic, or cultural origin or background.

**Pluralism 4 a**: a state of society in which members of diverse ethnic, racial, religious, or social groups maintain an autonomous participation in and development of their traditional culture or special interest within the confines of a common civilization. **b**: a concept, doctrine, or policy advocating this state.

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***"If we do not create a nation that mobilizes the talents of all our citizens, we are destined for a diminished role in the global community, increased social turbulence and, most tragically, we will have failed to fulfill the promise of democracy upon which this nation was founded."***

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## ESTABLISHMENT OF THE MINORITY ENGINEERING PROGRAM OFFICE

In 1969, through the efforts of Gordon Van Wylen (the Dean at that time), Joe G. Eisley (Professor of Aerospace Engineering), and Keith W. Cooley (first Program Director, then a graduate student in Nuclear Engineering), the Minority Engineering Program Office (MEPO) was established at the University of Michigan's College of Engineering. The office started on a relatively small scale and concentrated, in its early years, on recruiting and establishing an internal network. In 1970, 19 Black engineering students founded the National Society of Black Engineers on Michigan's campus. (I was looking at the list of those alumni just before I left Ann Arbor, and am pleased to say that more than half of them still actively support the office.)

Each of the succeeding Engineering Deans, Dave Ragone (former President of Case Western Reserve University and current Visiting Professor at the Massachusetts Institute of Technology), Jim Duderstadt (former Provost and current President of the University of Michigan), and Chuck Vest (current Dean of the College of Engineering), have actively and personally supported MEPO. Through their demonstrated leadership and personal involvement, the university community has seen the significance of MEPO's effort for students at all levels, for faculty and staff, and for external groups. There has also been an active corps of engineering professors who have been deeply involved with MEPO over the years. We have an extremely active group of alumni—well over 300 Black alumni since 1973 (344 at all degree levels, excluding

1987-1988)—who donate time, money, and expertise to MEPO. As our alumni move into industry, stronger ties are developed in support of MEPO with industry.

To review, some basic ingredients are evident in this goal of institutionalizing minority programs:

1. Initially, for MEPO, strong commitment and support from the dean, some faculty, and of course the students.

2. Monetary support from the College of Engineering and from industry.

3. A strong recruiting effort.

4. Establishment of a student organization.

5. Evolution to a retention program; that is, tutoring, organized study groups, scholarship programs, guidance and counseling.

6. Founding a graduate minority consortium dedicated to increasing the numbers of graduates at the master's level who belong to underrepresented minority groups.

7. Initiation of comprehensive precollege programs.

8. Movement of deans to other areas within the institution and other institutions and continuation of their initial commitment.

Through this, the idea has spread throughout the University of Michigan. This fall, President Duderstadt presented his *Michigan Mandate*, which establishes three broadly based goals:

- To recognize that diversity and excellence are complementary.

- To increase minority representation on campus.

- To foster an environment in which different ethnic and racial groups can pursue academic endeavors in harmony.

An Office of Minority Affairs (OMA), centrally administered, was created in 1987, and on June 1, 1987, a Vice-Provost for Minority Affairs was named (Charles D. Moody, Sr., Professor of Education). At about the same time, the State of Michigan initiated the Martin Luther King/Cesar Chavez/Rosa Parks Program, which provides funding for minority programs at four-year institutions in Michigan. These programs involve students from the precollege through the graduate levels and include postdoctoral fellowships and visiting professorships. It is an opportunity for Michigan colleges and universities to move ahead and to prepare for the 21st century.
To quote from President Duderstadt's State of the University address delivered on Monday, October 3, 1988:

> If we do not create a nation that mobilizes the talents of all our citizens, we are destined for a diminished role in the global community, increased social turbulence and, most tragically, we will have failed to fulfill the promise of democracy upon which this nation was founded. ...Our

challenge is not to make one group from many... but to build from many varying cultural, racial and ethnic groups a truly multicultural community in which we are bound together by a common core of values and beliefs... My personal commitment to meeting this challenge is both intense and unwavering.

As an institution, the University of Michigan cannot be asked more than that commitment—a personal commitment from its chief executive officer.

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# RESEARCHING THE STATUS OF BLACK AMERICANS IN SET AREAS

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*Dr. Nettles recently accepted a position as Vice President for Assessment, University of Tennessee, Knoxville. At the time of the Black Symposium, he was a Senior Research Scientist in the Educational Testing Service (ETS) Division of Education Policy Research and Services. He earned his Ph.D. in Higher Education with emphasis on policy analysis and research, and holds master's degrees in political science and in higher education. For six years, he was on the staff of the Tennessee Higher Education Commission as Assistant Director for Academic Affairs. Subjects of studies he conducted during this period include the financing of higher education, admissions, professional school supply and demand, educational television, student loan and scholarship programs, and equality of educational opportunity. The findings of one three-year study, supported by the Ford Foundation and the Southern Education Foundation and covering colleges and universities in ten states, are presented in his report, The Causes and Consequences of College Students' Performance: A Focus on Black and White Students' Attrition Rates, Progression Rates and Grade Point Averages, published by the Tennessee Higher Education Commission, Nashville, Tennessee. While at ETS, he conducted studies comparing the experiences and performance of minority doctoral students with those of majority doctoral students, and the impact of financial assistance, financial indebtedness, and other factors upon the decisions of GRE examinees to attend graduate school.*

I am going to talk a few minutes about several research projects. Two of these projects were published recently by the National Academy of Sciences in *Minorities in Science and Engineering* (1988). Another publication is a book I recently edited, called *Toward Black Undergraduate Student Equality in American Higher Education*, published by Greenwood Press in 1988. The book includes ten chapters about the trends in participation and performance of minority students, and one chapter focuses upon the preparation of Black scientists and their contribution to the scientific profession in the United States. The chapter is written by Willie Pearson, a professor of sociology and science at Wake Forest University.

## PREPARATION AND THE PIPELINE

The *pipeline* is an important problem facing Blacks and other minority groups in the United States in preparation for every profession, but it is not nearly as severe in other professions as it is in science and engineering. If you follow the trends of vital statistics in this country, you will find that, if it is an indicator of success, minorities usually fall low on the totem pole. If it is an indicator of failure or something negative in society, then we fall pretty much at the upper end of any measures you might use. Education is no exception, and it is true in all the professions. For example, 10 percent of the professional workforce—not just in science and engineering, but the professional workforce—is Black. But Blacks represent 2.4 percent of engineers, 5.4 percent of mathematicians and computer scientists, 3.2 percent of natural scientists, 5 percent of physicians, and less than one percent of dentists in the United States.

Much of this goes back to the pipeline. Willie Pearson has found that the average person makes the decision to major in science at the age of 16. The necessary preparation, however, occurs at a much younger age, for people pursue the academic track in their high school years. Yet only one-third of Black students are enrolled in the academic track of their high school, compared to about one-half, or a little bit over one-half, of Anglo students in high school.

> ***"In some states policies have been changed so that the schools are not able to call this course-taking pattern tracking. But, regardless of how they choose to refer to it, the important point is that Black students are not receiving adequate preparation for college."***

In preparing this presentation, I decided to go back and take a look at the course-taking patterns in high school. What I found striking is that not every minority group in this country is underrepresented. Asian Americans, for example, are overrepresented for their population in their high school science and mathematics courses, in college attendance rates, and in the science professional fields. About 20 percent, for example, of Asian high school students take calculus courses, compared to the about 2-2.4 percent they represent of the population in the United States. Asians are also generally overrepresented in algebra courses in the high schools they attend. That 20 percent of Asians who take calculus courses compares to about 8 percent of Anglos and 4 percent of Blacks and Hispanics who take calculus courses. The trends are the same in other college-preparatory courses. I have data outlining the geometry-, calculus- and algebra-taking patterns of high school students, but it is no different in these courses.

Tracking is another form of segregation within schools that are desegregated. Even when Blacks and Anglos are attending the same school, very often they take different courses within those high schools. You can walk through many high schools in this country and find that Black students, who represent only 10 percent or 12 percent of the population in their school, occupy almost 80 percent or 90 percent of some of the vocational and general courses. Segregation within desegregated schools occurs very often, and that is not typical of just high schools; it happens also in the colleges and universities.

In some states, because of the attention drawn to tracking over the past several years, policies have been changed so the schools are not able to call this course-taking pattern *tracking*. But, regardless of how they choose to refer to it, the important point is that Black students are not receiving adequate preparation for college.

Despite numerous court orders beginning with *Brown v. the Board of Education*, most Black Americans attend schools where they make up the majority racial group. That is not bad as long as these schools are equal, receive equal financial support, and are able to attract teachers who are equally prepared to advance these students, but that is generally not the case. In the area of resources, the pool of teachers trained in mathematics and science curricula have long been in high demand but such low supply that they very often

do not get distributed into the urban areas where many Black students are attending school. They have the choice to teach in schools where students are more likely to be interested in science.

A recent National Assessment of Educational Progress, for example, showed that 30 percent of Black 9-year-olds, 39 percent of Black 13-year-olds, and 47 percent of Black 17-year-olds attended schools that were predominantly Anglo. That means that the majority of each of these age groups attends schools where they are in the racial/ethnic majority. It is even more often true in the northern states than it is in the southern states. It is interesting that Willie Pearson, for example, documents that two-thirds of Black scientists and engineers grew up in the South. Many of those, in the pool from which Pearson drew his data, came from historically Black colleges. That is just the opposite for Anglo scientists in this country. About two-thirds of the Anglo scientists (scientific and engineering pool professionals) in this country come from outside the South, from states that are not located among the 19 southern states.

## FINANCE AND FINANCIAL AID VARIABLES

Shirley Malcom raised some other issues that are very important and that are included in this presentation. One of those issues deals with the differences in the effect of socioeconomic status. This issue is very often overplayed, and we have to be careful how we use *socioeconomic status*. For example, socioeconomic status has little effect on some measures of school achievement, such as grades students earn in college. Students coming from low socioeconomic status backgrounds perform as well as students from high socioeconomic status backgrounds, regardless of their race, as long as they have good schools, good teachers, and they work at being good students. In college they perform as well, as long as they had equal preparation in high school and elementary school.

> ***"Tracking is another form of segregation within schools that are desegregated. Even when Blacks and Anglos are attending the same school, very often they take different courses within those high schools."***

A few court cases have emerged recently in which school finance policies have been challenged. The first case, *Abbot v. Burke*, in which a group advocates changing the way state finances are distributed so those with the greatest need can qualify for more, has been underway in the State of New Jersey. Others are likely to follow.

At the college level, Black enrollment since 1980 has declined. We would be unwise if we did not look at the accomplishments of Black Americans over the past three decades. For example, Gail Thomas discovered from data provided by the National Center for Statistics and other sources that, in 1960, there were actually 184,000 Black undergraduates between the ages of 18 and 24 in the United States. By 1975, that number had increased to over 650,000 Black undergraduates, so there were gains in college attendance among Blacks during the 1960s and the early part of the 1970s. Between 1975 and 1980 we saw stability in the college-going rates of Blacks; but during the period just preceding that, Black enrollment grew at the undergraduate level at three times the rate of Anglo enrollment.

We also observed that during that period financial aid policies were such that federal grants, Black Education Opportunity Grants and loans emerged under the higher education acts and continued to increase throughout the early part of the 1970s. There has been a decline of 30,000 Black students in higher education between 1980 and 1986 attending undergraduate institutions. The rates of the rest of the population—other races or ethnic groups—remain constant. It is interesting to note that at the same time—although we cannot directly correlate these two variables—there was a redistribution in financial aid and a change in financial aid policies at the federal level. In 1980, for example, grants represented about

82 percent of federal financial aid provided to college students, while loans represented only 17 percent. By 1986, that had changed to 50 percent grants and 50 percent loans.

It is interesting also to observe that the neediest students are lacking in financial aid. We hear often about the brain drain, for example: a reference to the shift of Black students from predominantly Black colleges to predominantly Anglo institutions. There is also a shift in the socioeconomic status of students, such that the higher socioeconomic students have tended to move away from predominantly Black institutions. I have heard that this trend may be reversing, but we are waiting for data on that. It is interesting that between 1980 and 1986, historically Black colleges accounted for about 90 percent of the decline in undergraduate enrollment. It is even more interesting when you look at that decline together with the declines in federal grants—not only in the amount of grants but also the number of grants awarded at the level in which students have to qualify for grant aid.

The research I am doing on graduate students is for two studies. One study is the relationship of financial aid to minority participation in graduate school (the paper is available through the Graduate Record Examination Board). Then there is a more extensive study in which I have taken a sample of the GRE test takers for 1986. We are going to follow them up for at least two years to examine whether students go into graduate school the first year after taking the test, and what influence scholarship offers or other types of aid have on their decision to continue working or to go into graduate school and to persist in graduate school. We will look at other factors as well.

I also have a study that is in technical review and that is supported by the Federal Government's Office for Educational Research and Improvement (OERI). For this study, I sampled doctoral students attending Florida State University, Ohio State University, Rutgers University, and the University of Maryland who had been in graduate school for at least one year, examined their experiences and their backgrounds, tried to relate their backgrounds to the success they were having in their doctoral programs, and looked at the paths they took to their doctoral programs.

> *"Counterintuitive result: ...the more debt people have in undergraduate school, the more likely they are to go to graduate school..."*

On the financial aid front, for example, for the first time we are finding a counterintuitive result: that the accumulation of debt has a positive relationship to people's attendance of graduate school. What I am saying is that the more debt people have in undergraduate school, the more likely they are to go to graduate school, and sooner, after completing undergraduate school. I did not expect this finding. In fact, we are finding that pattern not only in my research but also in the research of other colleagues. Students' attitudes seem to be that if they are going on to graduate school, they had better do it before they start paying back their loans.

It seems clear that the policy at the graduate school level should be to provide incentives for these students, with, for example, loan forgiveness upon completing a graduate program. If you are recruiting faculty, you might try to supplement their salaries by the amount they (former students) have to pay back. The loan is an incentive for getting them to join the faculty at your institution. That way, students will not be deterred from graduate school or faculty careers by an accumulation of debt.

In this research, I also found a difference between Blacks, Hispanics, and Anglos. Blacks and Hispanics who are in doctoral programs are quite different from Anglos. Hispanics are more likely to be more selective in choosing or less likely to choose graduate schools than Blacks. It seems that Hispanic students (and this population does not include Mexican-Americans and Chicanos; it is mostly South Americans and Puerto Rican students) are likely to have attended highly selective undergraduate institutions. In fact, they are likely to have attended more selective undergraduate institutions than the Anglo students. If they perform very well in undergraduate school and they wind up in doctoral programs, they do just as well as their Anglo counterparts. Their socioeconomic status backgrounds are lower than those of the Anglo students but higher than those of the Black students.

The three groups are not different in their rate of debt accumulation, in either the amount or their tendency to accumulate debt for undergraduate school. The Blacks, by and large, take more time off between undergraduate and graduate school and are more likely to be part-time students and significantly less likely to have graduate teaching or research assistantships in their doctoral programs. Of Hispanics, on the other hand, 70 percent are graduate teaching or research assistants, as compared to 38 percent of Blacks and 54 percent of the Anglos.

We find also that the Anglo students tend to have higher grades in their graduate programs, but the Blacks tend to be more satisfied with their graduate programs than either of the other two groups. The Hispanics tend to be more satisfied than the Anglos with their graduate program.

I want to end at this point and entertain any questions about these findings or any other questions that may have occurred to you during my presentation. Thank you.

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# SAY *YES* TO A YOUNGSTER'S FUTURE: LOCAL HOOK-UPS FOR NATIONAL EFFORTS

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*Ms. Beane has served as Director of Education for the National Urban Coalition (NUC) since January, 1986. Through NUC's education program, Say YES To a Youngster's Future, she continues a long-time commitment to increasing minority student participation in science and mathematics. Her 15 years as a classroom science teacher in Washington, DC, Chicago, and New Brunswick and Plainfield, New Jersey, were complemented by a variety of community organizing activities, including service on the local Boards of Education. Prior to joining the NUC staff, she was senior program officer for the Mid-Atlantic Center for Race Equity at the American University. In that position, she planned and executed equity-related technical assistance to meet requests from school districts in Maryland, Virginia, West Virginia, and the District of Columbia. Among the materials she developed to help educators in increasing minority student interest in and access to mathematics and science programs are Mathematics and Science: Critical Filters for the Future of Minority Students (1985) and "They Used Science" (1984), an interactive classroom poster featuring six American minority contributors to science and health. She holds a Master of Education degree from Rutgers University and the Bachelor of Science in zoology from Howard University.*

## A CIRCLE OF PARTNERS

I am here today to talk to you about two subjects:

- *"Say YES to a Youngster's Future"*, the National Urban Coalition's response to the problem of America's growing underclass and their gross underrepresentation in the fields of mathematics, science, and technology; and

- *Circle of Partners*, which, along with the National Urban Coalition, has formed a community of caring around many of the "at risk" Black, Hispanic, and American Indian children who need our care.

The mission of the National Urban Coalition, at both the local and the national levels, is to create a new reality: to weld the strongest possible alliance of forces to free up the economic and social potential of the people who live in our cities, towns, and communities. This has been the Coalition's overriding purpose since its inception in 1967, and it remains the core of its work today.

The major priority of the Coalition's education program, Say *YES* to a Youngster's Future, is to increase the number of female and of Black, Hispanic, and American Indian students interested in, and prepared for, the advanced mathematics and science courses that grant access to careers in science and technology.

The Say *YES* to a Youngster's Future (Say *YES*) program is based on several assumptions that are supported by research and experience:

- All children can achieve.
- Achievement is closely linked to teacher and parent expectations and student academic self-esteem.
- Mathematics and science can provide the kinds of activity-based experiences that stimulate the development of reading, language, and logic skills.
- Preparation for advanced levels of high school mathematics and science must begin before grade 5, ideally during the preschool years.
- Improved classroom instruction and regular out-of-school science and mathematics experiences are essential for nurturing and maintaining interest.
- Minority parents and community members can play key roles in influencing children's participation in mathematics, science, and technology.
- Girls, minority boys, and the parents of these children benefit from interacting with role models, persons who are successful in mathematics, science, and technology.

***"Accomplishment of goals based on these assumptions requires the talents and commitments of many partners, especially for building national models for intervention that must be implemented at the local level."***

Accomplishment of goals based on these assumptions requires the talents and commitments of many partners, especially for building national models for intervention that must be implemented at the local level. For this reason, the Circle of Partners was organized.

This circle includes an interesting quilt of people of many colors, backgrounds, and perspectives. It includes parents, students, educators, business executives, government officials, social leaders, civic leaders, politicians, youth, clergy, members of fraternal and professional organizations, scientists, astronauts, and many others who had committed themselves to "saying yes to a youngster's future" by working to reverse the inequity of minorities who are being undereducated in the elementary and secondary school grades in science and who are, therefore, underrepresented in the pursuit of high-technology fields in college as well as in the workplace.

The National Urban Coalition's collaboration with its partners has two main thrusts, the first being a mobilization of partners and the second being the implementation of programmatic strategies. The Coalition sees a need to mobilize its partners in the majority and minority communities who will serve as information collectors, disseminators, and public awareness advocates and strategists who can bring the equity issues about the underrepresentation of minorities in mathematics and science to light in their communities. This partnership of mobilization includes groups like the Carnegie Corporation of New York, the Shell Oil Company Foundation, the National Alliance of Business, the National Black Leadership Roundtable, the Association of Science and Technology Centers, and Apple Computer, Inc., as well as special interest publishers and the local mass media agencies. These organizations are the *key communicators* which often control the flow and content of the information the public receives and acts upon.

Working with key communicators like the National Science Teachers Association, the Triangle Coalition, state departments of education and the chief state school officers, and others, we have seized opportunities to inform the majority education community. The National Coalition of Chapter I/Title I Parents, the National Black Child Development Institute, the National Council of Negro Women, and the National Association of Neighborhoods are examples of key communicator partners with total or sizable Black constituencies. These various national-level partners are in a position to communicate information on the mathematics/science issue to their constituents, often transmitting this information down to the local level. In the case of the loosely organized network of National Urban Coalition affiliates, the Say *YES* staff has acted as the key communicator. When we first surveyed the National Urban Coalition affiliates in January 1986 to determine which affiliates had education programs, 30 percent reported having education-related programs. No affiliate's response, however, reflected a mathematics, science, or technology education focus. The National Urban Coalition's newsletter, the *Urban Exchange*, became a vehicle for disseminating information to its affiliates and others on the underrepresentation issue. Our articles emphasized the importance of starting early with appropriate intervention efforts.

A long-term challenge is the Coalition's mobilization work with the National Black Leadership Roundtable, which was organized by the Congressional Black Caucus and which is composed of more than 300 national organizations, most having local affiliates. The initiation of the process of infusing mathematics/science underrepresentation issues into the consciousness of this body has been painfully slow. House of Representatives Delegate Walter Fauntroy [District of Columbia], after meeting with us, however, asked us to prepare a videotape that could be used to present the issue to Black churches and community groups. This video, *The New ABCs: Preparing Black Children for the 21st Century*, is narrated by Colonel Frederick Gregory, a Black astronaut, and was produced with the cooperation of the National Aeronautics and Space Administration. The video has been used by several of the National Black Leadership Roundtable organizations and other groups that first became aware of it at some national conference or other mobilization activity in which Say *YES* or its partners participated. The video, which suggests intervention steps local groups can take, seems to be an effective vehicle for raising awareness and interest at the local level. Its use in the Black community appears to be quite diverse: businesses, hospitals, colleges, state and federal government agencies, utility companies, churches, social organizations, professional science and engineering associations, intervention programs, television stations, school systems, and individuals.

Our communicator's partnership with the Shell Oil Company Foundation, based in Houston, Texas, made possible the production of a television public service announcement in which Whitney Houston urges children and adults to "say yes to math and science." One of the Coalition's change agent partners, an American Indian woman in Minnesota, stated that she felt so good every time Whitney Houston's announcement came on television because it made her feel like part of an upward movement. Her reaction supports our long-held theory that media support is crucial to developing new attitudes and establishing a climate for change. Numerous Black children and adults have made a point of letting me know they saw Whitney Houston on television talking about the importance of mathematics and science.

Vital throughout this entire mobilization effort has been the Coalition's linkage with the Office of Opportunities in Science of the American Association for the Advancement of Science (AAAS).

The second thrust of the Say *YES* project is programmatic. The circle of program partners are the *change agents* and the *inheritors*. The change agents, like many of us here today, develop and implement the intervention programs or provide the human and/or financial resources for us to work with in communities across the country. The most important component in the Circle of Partners is the inheritors—the children, their families, and, in many cases, the teachers whose lives have been enriched by the program.

Now let's take a look at how these Say *YES* partnerships, under the direction of the National Urban Coalition, are facilitating the development of local Say *YES* programs.

From the earliest days of the Say *YES* program, it was quite clear that, as we made our audiences aware of serious underrepresentation of Blacks in science-related careers, they were most often struck by the fact that mathematics is the critical filter granting access to the advanced science courses required for college majors leading to careers in science and technology. Furthermore, few appeared to have been conscious of either Black student mathematics and science enrollment patterns in their local high schools or of

national trends. We found that from every audience came the question, "What can we do?" In many cases, those asking for the next step were persons already providing direct services to children or families. So what they were requesting was specific *programmatic* strategies rather than advocacy activities. The National Black Leadership Roundtable mentioned earlier, however, is an example of an organization focusing on the development of an information dissemination/advocacy program.

***"...Media support is crucial to developing new attitudes and establishing a climate for change."***

Since most requests for programmatic assistance came from those wanting to establish some form of intervention at the local level, the National Urban Coalition selected the *Family Math* program developed by EQUALS of the Lawrence Hall of Science at the University of California at Berkeley. To provide an example of what the Coalition looks for in a program, let's look at why the Family Math program was selected. First, the Coalition felt that the Family Math program can empower on multiple levels. Through the three-day Say *YES* Family Math training, classroom teachers become more skilled in using manipulatives to enhance problem-solving skills in mathematics. Teachers and schools gain a positive, non-threatening strategy for involving minority parents in the mathematics education of their children through the two-hour classes held for families one night a week for four to six weeks. Community-based organizations, once trained, can offer a specific, low-cost, enjoyable educational program to their constituents. Parents and students, through career awareness activities, have opportunities to learn about the importance of enrolling in mathematics courses throughout high school. Parents report that their families actually talk about mathematics as they take their math challenges home with them. Students often exude a new confidence about their mathematics abilities.

Consequently, the Say *YES* program menu began with a determination to make the Family Math program available to local minority sites, either by offering training directly or by referring them to EQUALS for training. We felt, however, that all programs developed or disseminated by Say *YES* should include a component that helps make the connections between the participants and the fields of mathematics and science. Since it was the developer of Family Math, EQUALS is a major change agent in our circle of partners. EQUALS has been most supportive of our efforts to supplement the Family Math curriculum with our cultural connections, and a couple of local sites have expanded on our initial work in that area.

The Whitney Houston Say *YES* television public service announcement is intended not only to arouse interest in pursuing mathematics and science studies but also to help our local Say *YES* site feel connected to a national program—part of a national network. For that same reason, we offer to list in our national newsletter the names of all families completing a *Say YES Through Family Math* course. This list is being expanded to include those completing *Say YES Through Family Science and Family Computering*, once the program is implemented.

Although several of our affiliates over the past year and a half have initiated math/science components in their programs, our partnership with Apple Computer, Inc., has added significantly to the thrust of our program at the local level. Our affiliates and other local, community-based organizations like the churches in our Say *YES* network were invited to apply to the Coalition for Apple computers for use to establish local computer learning centers with multifaceted programs. Such programs are currently being established in Washington, DC; Baltimore, Maryland; Houston, Texas; East Palo Alto, California; Minneapolis, Minnesota; and Boston, Massachusetts. The Minneapolis Urban Coalition has developed a Say *YES* consortium of local community organizations that can share resources, talent, and expertise as they establish their Say *YES* computer learning center programs. The addition of this computer component to the Say *YES* Family Learning Center at Shiloh Baptist Church in Washington, DC, has served to generate new enthusiasm and support from the congregation and the community.

We find that our affiliate partnerships usually need to be tailored to their specific needs, but this need sometimes forces us to expand our program offerings. For example, the Columbus Metropolitan Area Community Action Organization (CMACAO), our Columbus, Ohio, affiliate, operates 11 of the 15 Head Start centers in Franklin County. Since becoming aware of the importance of exposing children early to good problem-solving mathematics and science experiences, this affiliate has worked with us to organize an ongoing training program for its staff of 100 and has involved Head Start staffs from neighboring communities. This newly formed partnership with its local science and technology center has been cemented by the science and technology center's representation on the CMACAO Head Start program's board of directors.

Several examples have been cited of how Say *YES* moves from the national to the local level, in each case working outside the public school system assisting community-based organizations to capture our vision and to implement intervention programs. However, one of the most exciting and challenging Say *YES* components is the Say *YES* Demonstration School Project, which is in its second year in the initial pilot cities of Houston and Washington, DC. The Shell Oil Company Foundation, this time functioning as change agent partner, is sponsoring the Say *YES* program in ten schools in Houston and nine in Washington, DC. For the past two summers in these two cities, the Coalition has convened teams of elementary teachers for intensive institutes designed to meet local instructional needs. At the institutes, teachers participated in activity-based mathematics and science education courses designed to improve their content and presentation skills. They identified resources, designed and assembled manipulative mathematics materials and science teaching kits, and developed lesson plans they are expected to implement during the school year.

Initially, the Coalition worked with each school district to determine needs in elementary mathematics and science. We developed a model that incorporated the traditional intervention of teacher training, stressing a hands-on approach, but we also included a parent involvement component: a Saturday Family Math and Science Program. During the summer institutes, we provided Family Math training to expose the Say *YES* teachers to a good model of informal education for families. This model comprises cooperative involvement in problem-solving activities that can be continued at home. This Saturday program is in actuality a parent training model in a laboratory setting, since parents are working with their children while they are learning how to stimulate and maintain children's interest in mathematics and science.

The Saturday program has been an excellent vehicle for involving most of the members of the Circle of Partners. The families take field trips, meet Black and Hispanic persons who use mathematics and science in their work, and cooperate with media representatives. Say *YES* school team members have learned to reach out to their community businesses for help with refreshments and door prizes. In the case of Houston, our local affiliate, the Association for the Advancement of Mexican-Americans (AAMA) has served as the National Urban Coalition's Say *YES* representative working to bridge the gap between school and community.

Participating teachers are using an activity-based approach in the classroom and are pilot-testing the Saturday Family Science and Mathematics Program in their schools. Activities that are the most successful with families in this Saturday program will be incorporated into a *Say YES Through Family Science* model. The principals and the guidance counselors who work with these teachers also have participated in special workshops focusing on their leadership and support roles in the project. All target schools are overwhelmingly Black and/or Hispanic. Preliminary findings point to a positive relationship between participation in the Say *YES* project and improvement in student achievement.

We still have much to learn about transforming a national program into a local reality, but I can summarize with a few generalizations from our experiences thus far.

1. Incentives are essential! We need (a) incentives for local sponsors (for example, increased visibility in the community and an expanded pool of well-prepared students moving into the work force); (b) incentives for community-based organizations, including school systems (increased material and human resources, increased parental involvement, and improved student academic performance); and (c) incentives for the inheritors, the children and their families whose lives we hope to enrich with new dreams and with the skills that will make those dreams accessible. Incentives may require a

variety of stimuli, but none can be more important than a sensitive, well-designed, well-organized program that facilitates their total involvement in mathematics and science activities. The opportunity to be with their peers and to receive recognition for participation are also essential. Parents and, probably to a lesser extent, children need to feel participation will help the children in school. We must also acknowledge the role of widgets (folders, buttons, T-shirts) in building a sense of pride in participation.

2. A second generalization is that, to sustain a local program, the development of resources at the local level is imperative—the human resources required for committed leadership and the material resources required to pay the bills.

3. A third generalization is that every national program needs a system to facilitate the flow of information between the national and the local levels. Such a communications mechanism has great value, especially in documenting pilot phases of local programs, in maintaining follow-up data, and in evaluating.

4. The media, when a program or an issue can attract its attention, can be extremely helpful. A new set of values can be communicated when parents and children see the pictures or film clips and become interested in being part of the program. Potential sponsors become aware of the program's activities.

5. Most importantly, since local residents know their communities best, local persons must work with the national staff to develop strategies for adapting the national program to that community while still maintaining the original intent and integrity of the national program.

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# JOURNEYS TO SET STUDIES AND CAREERS

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**Laurel, MD 20207**

*Theodore Habarth may best be described as a man of vision. After graduating from Notre Dame University, he traveled to South America where he earned his master's degree from Catholic University in Santiago, Chile. While there, he served as the director of the Bi-National Center of the United States Information Agency (USIA) in Antofagasta, coordinating all radio, television, and press relations throughout the entire northern zone of the country. Habarth returned to the United States in 1967, where he began his career at the Applied Physics Laboratory of The Johns Hopkins University, working in personnel administration and as Director of the Lab's Affirmative Action program. He initiated the effort which led to the establishment of the GEM program in 1976, a consortium now consisting of 63 corporations and research centers and 55 universities. The GEM program has produced nearly 700 minority engineering master's degree recipients and several Ph.D. recipients, since its founding. He served as GEM's vice president from 1976 to 1981 when he was elected President and Chairman of the Board of Directors. Always looking to the future, Ted Habarth stepped down from the presidency in 1987 in order to direct Project Journey, which he had proposed in 1985 as a means of motivating and providing career guidance to secondary students of all races and nationalities around the country. He is currently the project's primary fundraiser and oversees the production and distribution of a second Journey series designed for commercial broadcasting. Habarth's commitment to service is further evident in his volunteer efforts. He was the only representative from private industry on President Jimmy Carter's Civil Rights Reorganization Project. He has served as president of the Washington, DC, Technical Personnel Forum and has worked with the National Alliance of Business and with the Maryland United Way.*

*Journey* is a project dedicated to developing a powerful motivational and career guidance videotape-driven curriculum for middle, junior high, and senior high school students. A product of the National Consortium for Graduate Degrees for Minorities in Engineering, Inc. (the GEM program), Journey is designed, produced, and implemented by a team representing GEM, the John Hopkins University, the University of Michigan, and N.A.K. Production Associates.

Since the conception of this project in 1985, educational experts, teachers, school administrators, parents, and more than 9,000 students throughout the United States have contributed ideas, reactions, and suggestions toward the development of this unique 13-part videotape series designed for use in schools.

Journey is designed to help *motivate* teenage students. It leaves them with concepts and goals to plan for their future and builds self-confidence, showing students that, "Oh, yes, I can." Journey exposes students

to the experiences of others who have successfully made the transition from high school to careers. Each step of this transition is unveiled through the stories of actual, not fictitious, people.

Journey provides its viewers with the opportunity to see what other teenagers are experiencing, sharing in their difficulties and triumphs. It paints personalized portraits of several careers critical in today's technological society while demystifying the process of entering any specific career field. This aspect is particularly helpful for students being encouraged toward, or who are already interested in, mathematics-based fields requiring hard work with often difficult and abstract course content. Each episode shows how courses studied today have an impact on career choices later in life.

Journey also reflects the multiethnic and multiracial personality of our society today. It recognizes the diversity of the talent pool from which this country must draw to meet the challenges facing us, as we move into a new century of escalating international technological competition.

Above all, Journey provides teachers and counselors with models and examples that can be used to help guide students with decisions and choices that will have an impact on their future. It encourages teachers to share their own choices as teams of students discuss with them the choices and decisions of those featured in the various Journey videotape segments.

## A LIVING PROJECT

Journey is *not* just another textbook in videotape format. It is an evolving project starting with an initial series of 13 episodes. It forms a stand-alone career guidance curriculum for teenagers. It is linked, in its messages, to a second Journey series that will be offered to commercial television stations around the country on an incremental basis. The Journey television shows will present their themes through musical entertainment and celebrity interviews and will reflect current issues and events of interest to teenagers.

Since the features of the Journey school series are based on the lives of real people living in the context of the events taking place at the time of filming, changes in their lives as well as in issues of the day allow teachers to illustrate the messages of this series with updated examples.

Journey also has a built-in research evaluation component, administered through the School of Education at the University of Michigan. This component provides the authors *and* users of Journey with scientific feedback on the effectiveness of the various methodologies used in this program and with suggestions for improvements.

## THE MANUAL

A Journey manual accompanies each videotape episode and outlines a discussion and exercise format covering six class periods. Each manual has been designed to be a self-contained motivational and career guidance aid for secondary school teachers, guidance counselors, and other discussion leaders working with teenagers. The manual contains the following:

1. The episode videotape (VHS or 3/4-inch format)
2. Teacher's guide
3. Student journal
4. Information materials for parents of students in Journey sessions
5. Journey *Mailbox*

## WHERE DOES JOURNEY FIT IN?

Journey is designed for full-class or small-group instruction. In some cases, it will be integrated into an existing course sequence, such as algebra or chemistry or social studies. In other cases, schools may choose to institute an elective Journey career guidance course to supplement an often overburdened guidance program. Still others will place Journey into the program outlines of special before- or after-school career orientation clubs or projects. The authors believe, however, that the "fitting" of Journey is best left to the discretion of local school officials and teachers.

## GENERAL APPROACH IN USING EACH JOURNEY TAPE

The Journey *Teacher's Guide* provides *one approach* for the use of these videotapes with teenagers. It outlines suggested key issues for discussion, a set of objectives, pre- and post-viewing activities, vocabulary suggestions, and other possible student activities for each lesson. These Journey videotapes are rich in messages related to each major theme. Teachers, therefore, are asked to adjust the emphasis of each class lesson to their particular situation, needs, and student group.

## THE MAILBOX

Since Journey is new and developing, the users of Journey are asked to share with others unique applications and the strategies they have found most effective in their particular situation. To facilitate this interchange of ideas, we have included in this guide and all subsequent ones a Journey Mailbox. All letters received for sharing ideas, information, and suggestions for other users of this guidance program will be reproduced in full. Also reproduced in this Mailbox will be letters from educators, students, parents, and professionals who have taken an interest in this project and who wish to provide suggestions and information to Journey discussion leaders.

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# BLACK ASTRONAUTS AT THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

**Joseph D. Atkinson, Jr., Ph.D.**

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**Houston TX 77058**

*Dr. Atkinson has been with the NASA Johnson Space Center since 1964 and has served as Manager of the Equal Opportunity Programs Office since 1974. As a member of every astronaut selection board since 1977, he has had extensive involvement with all aspects of astronaut recruitment and selection. He earned his bachelor's degree from Morehouse College, his master's degree in public administration from the University of Houston, and his doctorate in public administration from the University of Colorado. He is responsible for research grants for historically Black colleges and universities (HBCUs), and for grants to nonminority universities with a significant number of minorities. He has published a number of technical papers and contributed to the publication of several books, to include the Encyclopedia of Public Administration, The MBA's Dictionary, and The Facts on File Dictionary of Public Administration. Most significantly, he is the author of The Real Stuff, a fascinating history of NASA's Astronaut Recruitment and Selection Program. He has received many special honors and awards in recognition of his organization and community contributions. He is married to the former Beatrice Williams of San Antonio, Texas.*

## MINORITIES: THE EARLY NASA DAYS

The first seven astronauts selected in 1959 were all male, all protestant, and all Anglo. It was not until 19 years later, in 1978, that the first Blacks were selected, even though there had been earlier attempts to select Blacks.

Two years after the selection of the original seven astronauts, Edward R. Murrow, Director of the U.S. Information Agency, sent the following letter to James E. Webb, the Administrator of NASA (September 21, 1961; reproduced on the next page).

Webb responded to Murrow on October 18, 1961, pointing out that he could understand the value Murrow saw in the proposed flight. He thought, however, he should also point out that NASA had a large number of suggestions for adding to the present group of astronauts. Webb went on to say that the present seven astronauts were all that were needed for the Mercury program and that extension of the program was under consideration. In connection with the Apollo program, the selection of astronauts was still considerably far in the future. In a telephone interview (March 19, 1982; Washington, DC), Webb said:

> The entire Mercury program had been planned and conducted to provide the types of scientific and technical information that would permit them to improve and develop their apparatus, their tracking network, and the man-machine relationship involved. In view of the eminence of their orbital flight and the fact that they were carefully selecting the teams for both the first and second flights and the long lead time necessary, he did not see now how they could adopt Murrow's suggestion. However, he could certainly keep it in mind.

Webb further stated in that interview, "Murrow's letter is an example of the many suggestions that NASA received from all quarters. Murrow was saying that the United States could gain in a propaganda way around the world if we did this." Webb indicated that while he acknowledged receipt, his reply "did not give any encouragement to the idea because the suggestion was inconsistent with our agency's policies."

Dr. Robert B. Voas, Human Factors Assistant to the Director of the Manned Spacecraft Center (now NASA/Johnson Space Center), in an August 28, 1963, memorandum to Robert R. Gilruth, Director of NASA, provides a more explicit description of the climate prevailing in the space program:

> ...It was recognized from the beginning that there might be political and public relations requirements that should be considered in selecting the candidates. After thorough discussion by management, it was decided that technical requirements of the program would have to be entirely controlling. The application and the selection for the pilot's position would be handled like all government employment procedures... It would be based on only technical qualifications in relationship to the specific requirements of the Mercury flight program. As a result, no consideration was given to any special minority or political groups and, in general, the selection team, which was formed to review the records and interview the individuals, was unaware of the religious affiliation, national origin, or race of the applicants. It later turned out that all of the seven candidates were Protestants, but this was a fortuitous circumstance since the selection committee was unaware of their religious affiliations. No women were considered in the program since none were graduates of the test pilot schools. There were no Negroes or foreign-born among the candidates who went through the final selection procedures. Whether there were any among those whose military records were reviewed is unknown to the committee since this information was not part of the record.

Voas' observation was in the wake of the Dwight episode.

## THE FIRST BLACK POTENTIAL NASA ASTRONAUT

In March 1963, Captain Edward J. Dwight, Jr., a Black Air Force experimental test pilot, was one of 136 applicants nationwide and one of 26 recommended to NASA by the Air Force. In a preliminary evaluation, 102 of these applicants were eliminated. Of the 34 left, only 14 were finally selected for astronaut training, but Dwight was not among the ones selected. In early 1962, President John F. Kennedy had requested General Curtis Lemay, in his dual capacity as head of the Joint Chiefs of Staff and Chief of the Air Force, to take steps to integrate racially the Test Pilot School at Edwards Air Force Base, California. Dwight was the Black pilot who met the criteria. In 1961, he was a 26-year-old Air Force officer from Kansas City, Kansas. Commissioned in 1955, he was a B-57 pilot for two years with more than 2,000 hours of high-performance jet aircraft flying time to his credit. He had a degree in aeronautical engineering from Arizona State University and was rated as an outstanding pilot for three consecutive years. Although he was fully qualified for admission to test pilot school, Dwight said "he was generally viewed as one who had been admitted as a result of presidential influence" (telephone interview, September 17, 1982, Denver, CO). The prevailing belief was that Dwight might get selected but would never fly for NASA. He was enrolled in Phase I of experimental test piloting at Edwards Air Force Base in August 1962 and was graduated the following April. Subsequently, he was one of 14 admitted to Phase II, the Aerospace Research Pilots Course. Those pilots, usually recommended to NASA by the Air Force, were generally selected from the pilots who followed the curriculum.

FIGURE 1



UNITED STATES INFORMATION AGENCY
WASHINGTON

DIRECTOR

September 21, 1961

Dear Jim,

Why don't we put the first non-white man in space?

If your boys were to enroll and train a qualified Negro and then fly him in whatever vehicle is available, we could retell our whole space effort to the whole non-white world, which is most of it.

As ever,

Yours,

Edward R. Murrow

The Honorable
James Webb
Administrator
National Aeronautics and
Space Administration

Dwight applied for astronaut training, and his flying record and classroom grades placed him eighth in his class, all of whom were recommended "without qualifications" to the NASA astronaut selection board. Although Dwight was not among those selected by NASA, two of his classmates were accepted for NASA training. One was Theodore C. Freeman of Haverford, Pennsylvania, killed in a crash of a T-38 jet at Ellington Air Force Base near Houston in October 1964. The other was Dave R. Scott, who flew Gemini and Apollo missions and was the seventh man to walk on the moon; he became Director of NASA Dryden Flight Research Center at Edwards, California, before he resigned in October 1977.

Thomas U. McElmurry was the Deputy Commandant of the Aerospace Research Pilots School. When Dwight was a student there, McElmurry, who flew with him, told me in an interview (September 9, 1982, Houston, TX):

> Dwight was perfectly capable of being a good astronaut on his own merits. He was perfectly capable of doing it. He would not have been number one, but if it was important enough to this country to have a minority early in space, then the logical guy was Dwight. But it wasn't important enough for somebody in this country at that stage of the game to do it, so they just chose not to do it. Dwight was not incompetent. He graduated number eight in his test pilot class of 16. You mustn't say he was mediocre. You didn't graduate unless you were pretty doggone good. Every man who graduated could have been a test pilot, or he would not have been graduated. We were ethical from that standpoint.

## ALLEGED INIQUITIES

Dwight said in a personal interview (September 17, 1982) he had no quarrel with NASA for not selecting him. He was, however, disconsolate over his subsequent Air Force assignment at Wright Patterson Air Force Base. This assignment was considered by aerospace school graduates as "the worst possible one a guy can get." In a 15-page report to the U.S. Department of Defense, he charged that he had been subjected to severe discrimination in the Air Force during and after his aerospace course and that "discrimination—as contrasted with the aid and encouragement given his 15 Anglo classmates—had been a great mental strain and handicap." In that connection, the Pentagon said:

> In order to effectively utilize the training acquired by Captain Dwight and his contemporaries at the aerospace research pilot school, those officers who were not selected by NASA were given assignments in the Air Force System Command. Each has duties related to experimental test flying in research aircraft.

Dwight requested a different assignment from the one he had received, but the Air Force response was, "He is very capable, and he can make a significant contribution to our research and development objectives." The Air Force and NASA denied any discrimination charges. An anonymous Department of Defense source said, "Dwight bucked the system by complaining about discrimination. The military takes a lot of pride in its policy of no racial bias. When a guy bucks the system, he's not going to find many people willing to carry the ball for him." (Committee of Science and Technology, 1981)

## NASA RESPONSE

When interviewed about the Dwight case at NASA by Jerome S. Cahill of the Washington Bureau of the Philadelphia Inquirer, Julian Scheer, Assistant Administrator for Public Affairs at NASA, replied:

To my knowledge, the Air Force never recommended anybody. And one other thing, it was my impression, speaking off the top of my head, that Dwight never finished his training at Edwards.

When he was read pertinent paragraphs of the Air Force letters to Congressmen Robert N. C. Nix and Richard S. Schweiker, Scheer promised to look into the matter. He said, "I don't want to sound defensive, but NASA has a perfectly good record on the question of equal opportunity." Later, NASA's public information office reported that, of the agency's 32,852 employees, 816 were Negroes—about 2.5 percent.

In Washington, official silence still clouds much of what is known in some quarters as "The Dwight Case."

***"Astronauts hold in their hands something far more costly and precious than the millions of dollars' worth of equipment in their capsule; they hold the prestige and the honor of their country. They are the symbol of their nation's way of life. Possibly, it is this that is so important to the minorities who are seeking to become a part of the American vanguard in space."***

## CONGRESSIONAL INVOLVEMENT

Among those interested in the case were Representative Richard S. Schweiker (Republican, Pennsylvania) and Representative Robert N. C. Nix (Democrat, Pennsylvania). Schweiker, pursuing the allegation, then wrote to President Johnson. The reply, however, came from the Air Force, assuring that Dwight had been accorded "the same rights, privileges, and treatment" as other students. Nix pressed Air Force and civilian space officials for a "full explanation" of the 31-year-old officer's status. "I'm not satisfied with the answers I've been getting," Nix said.

## MEDIA AND SOVIET UNION REACTION

*Ebony Magazine*, the *Washington Post*, the *Indianapolis Star*, and the *Philadelphia Inquirer* gave comprehensive coverage to the Dwight rejection. On June 8, 1963, the Soviet Union congratulated the United States on the success of the Gemini IV space flight. As part of the same congratulatory message, however, the praise was tempered by Soviet charges that racial prejudice had crept into the American space program. Tass revived the week-old charge against the Air Force by Edward J. Dwight, Jr., "that he was rejected for astronaut duty because he is a Negro." Regarding the Dwight story, H. L. Nieburg, in his comprehensive analysis of the interrelationship between science and the space effort, said that such regrettable news items "reflect other aspects of society and dull even the brightest moments of our national program... and may have more powerfully affected the American image at home and abroad than the Gemini flight that occurred the same week."

## COMMUNITY IMAGE

In 1963, during the time Dwight was at Edwards Air Force Base, Dr. Charles Lang of Los Angeles produced a film strip on Dwight's training activities. This film was widely used by Roscoe Monroe of the NASA Spacemobile Educational Program, who noted:

I know what I saw in the reaction of Black youngsters who looked at Captain Dwight and how they reacted to his message—it did a lot of good. He was the closest person to an astronaut our group could identify with.

In programming a wide array of NASA appearances to women's groups, minority groups, communities, and conventions, Monroe found it necessary to use persons who were either Anglo astronauts or other NASA employees. He said many surrogates were used in the absence of women and minority astronauts.

## THE SECOND BLACK POTENTIAL NASA ASTRONAUT

During these earlier years, the Air Force and NASA had separate space programs. The Dyna Soar X-20 and later the Manned Orbiting Laboratory (MOL) programs were Air Force projects. The Mercury and the Gemini programs were NASA projects. The Air Force training program paralleled but was not coordinated with the NASA spaceflight program.

The MOL was to be equipped to accommodate two men in orbit for 30 days. The Department of Defense selected 17 astronauts for its program. All the men selected for MOL were military test pilots and graduates of Aerospace Research Pilot School at Edwards Air Force Base. They were selected in three groups:

**TABLE 1**

| Group | Date | Number of Pilots Selected |
|---|---|---|
| I | November 12, 1965 | 8 |
| II | June 17, 1966 | 4 |
| III | June 30, 1967 | 4 |

Note: The total consisted of 13 Air Force, 3 Navy, and 1 Marine personnel.

Robert H. Lawrence was the first Black test pilot to be selected to train for MOL in the Air Force Space Program. He had a Ph.D. in nuclear chemistry from Ohio State University. In addition, he was a senior test pilot with more than 2,000 hours of high-performance jet aircraft time and a graduate of the Aerospace Research Pilot School at Edwards Air Force Base. On December 8, 1967, he was killed when his F-104 Star Fighter aircraft crashed on the runway during a routine training flight. He was the ninth U.S. astronaut to die on the ground.

The Department of Defense canceled the MOL program on June 10, 1969, as a result of a budget cut. To assure useful application of a significant portion of the investment in MOL, the Department of Defense transferred seven of the MOL astronauts to NASA: Major Karol Bobko, Lt. Commander Robert L. Crippen, Major Charles G. Fullerton, Major Henry W. Hartsfield, Major Robert F. Overmyer, Major Donald H. Peterson, and Lt. Commander Richard H. Truly.

## SUMMARY

Both minorities and women had attempted to become NASA astronauts for almost two decades before they were selected in 1978. In the Soviet Union, the first woman cosmonaut flew in 1963, and the first

Intercommunicate minority (Cuban male) flew in 1976. In the U.S. program, some noteworthy activities took place. Jerri Cobb, an internationally recognized pilot, was appointed in 1961 as a consultant to the NASA administrator. Her task was to advise him on developing qualification guidelines and programs for women astronauts. Cobb was succeeded by Jacqueline Cochran, who served seven years in the position. The appointment of these women as consultants did more to enhance NASA's image among the female population than it did to bring women into the program during the first seven selections.

The first Black potential NASA astronaut, Edward Dwight, Jr., an outstanding experimental test pilot, was among those recommended by the Air Force to become an astronaut candidate, but he was not among those finally selected by NASA. A second Black potential NASA astronaut, Robert H. Lawrence, a test pilot with the Air Force MOL Program, was killed in a training flight in 1969 before he could be transferred to NASA. Neither Dwight nor Lawrence ever served with NASA. Presently, Dwight is a successful sculptor and artist of the first magnitude. He and his family live in Denver, where he maintains his studio. Dwight has been commissioned to do life-size statues of Martin Luther King, Jr., for Morehouse College, and Hank Aaron for the Braves baseball team in Atlanta. His art has been exhibited by many major art galleries nationwide.

The astronauts of today are among the world's most prestigious popular idols. Although there are many reasons why Blacks have wanted to become astronauts, I believe the following explanation to be true: Astronauts hold in their hands something far more costly and precious than the millions of dollars' worth of equipment in their capsule; they hold the prestige and the honor of their country. They are the symbol of their nation's way of life. Possibly, it is this that is so important to the minorities who are seeking to become a part of the American vanguard in space.

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# EFFECTIVE INTERVENTIONS: TWENTY-FIVE YEARS OF DEVELOPMENT

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**Executive Director**
**Elementary Institute of Science**
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*Ms. Anderson has spent all of her professional life in education, from public school settings to the corporate sector. A graduate of Fisk University in Nashville, Tennessee, she started her professional career as Junior Historian at the Vanderbilt-Roosevelt National Historical Site in Hyde Park, New York. She has taught school and developed training programs for a major insurance company. Despite a busy schedule, she has found time to volunteer her services as a Docent for the Museum of Natural History in San Diego, as a member of the San Diego Energy Education Committee and the Reuben H. Fleet Community Science Task Force, and as president of the San Diego Chapter of Jack and Jill of America, Inc.*

It is an honor to be here today to participate in the First Annual Black Symposium on Science, Engineering and Technology, for no question is more important to America's future than the future of its youth.

At the heart of any successful program, large or small, is a person capable of providing not only the organizational expertise but often also the energy and enthusiasm needed to give the program life and purpose. The Elementary Institute of Science was established by Mr. Thomas Watts in the back of a classroom at Kennedy Elementary School in 1964. Mr. Watts, a soft-spoken native San Diegan, was the son of a Navy family. He was educated in San Diego city schools and studied at the University of Redlands, at Claremont Graduate School and San Diego State University. He is married to Doris Watts, also involved in the success of the Institute.

After about five years of teaching, it was obvious to Mr. Watts that bright children were not performing well in the traditional educational program. In trying to find ways to motivate them, he discovered virtually all of them were fascinated by electronics and the natural sciences. This gave him the idea for the Institute, which was an almost instant success.

Mr. Watts began teaching at Kennedy in 1959. The friends he made there—Cathy Lane, James Johnson, Irene Greiner, Charles McCartney, all volunteers—were the mainstay of the Institute's staff.

A year was spent in preparing a curriculum and gathering equipment before the Institute was put into operation. It began with 15 students, but by the end of the first school year the group had grown to 38, with 20 on a waiting list.

Mr. Watts directed the Institute until the 1967-1968 school year, when 70 children were enrolled. After the worth of the program had been proven, the Institute was moved in 1968 to its present location, a modest split-level dwelling abandoned by the city. Outside, the dwelling seems no different from any of its neighbors. Inside, however, its kitchen is a chemistry laboratory, its front bedroom is a library, and its

back bedroom is an electronics laboratory. The lower level has a geology lab and a photography lab with darkroom.

Funding consisted of a $25 gift from the Wholesale Furniture Club and a pledge of $18 a month to the program from one woman.

The Elementary Institute of Science was established to serve the children in the low-income area of southeast San Diego. The results of the program prove children can achieve in scientific areas regardless of cultural, ethnic, or social background and with little relationship to previous academic achievements or failures. The median education for the adults in the southeast area (according to the 1960 census) barely exceeded the eighth-grade level, and in some instances 7 percent of those over 25 years of age had never attended school.

Children living today in areas of poverty in this country will be forced to compete tomorrow in a world faced with a shortage of scientists and trained technicians. We seem determined to let them just get by with a minimum educational preparation, which will not serve them when they enter the labor market.

The Elementary Institute of Science approaches the problem by offering an intensified after-school and Saturday science enrichment program to the youngsters. The children are provided with the background, facilities, and equipment necessary to explore the many areas of science.

Mr. Watts realized early that there is a vast and virtually untapped reservoir of future scientists within the minority neighborhoods and these children must be exposed to science before they lose their natural childhood curiosity and enthusiasm. Without an adequate background in science in the elementary years, they would not be properly prepared or motivated to pursue science in junior high or high school.

It has been well documented that the earlier the intervention, the greater the likelihood achievement differences between racial/ethnic groups can be lessened. Middle school, therefore, is a particularly opportune time for science intervention. Too many youngsters, especially those from disadvantaged neighborhoods, spend their high school years relearning fifth- and sixth-grade mathematics rather than higher mathematics, science, and the more powerful reasoning skills that could serve them in the future.

Two distinguishing features of our program are its comprehensiveness and that it is community-based and directed. This allows us to rely on our own history and preferences in designing and implementing projects best suited for our needs. Although the program of the Elementary Institute of Science was initiated for children bypassed by our society, the Institute's concepts can be applied in other programs targeted to different groups in the community.

Our policy is to locate the institute in a minority neighborhood and to admit all children regardless of race, creed, or economic condition. It is very rewarding for a minority community to have a program of such value that the majority community seeks the opportunity to come into the minority neighborhood to participate. Such has been the case at the Institute. For too long, it has been the other way around: minority parents have been forced to send their children into the majority community to participate in the "good life."

## PROGRAM OBJECTIVES

The Elementary Institute of Science provides children aged 6-13 with an intensified experience in scientific inquiry in an attempt to prepare and motivate them to pursue studies leading to careers in science and technology. The specific objectives of the Institute are threefold:

- To establish and maintain a science center where elementary-age children of southeast San Diego can have full access to the "things of science" and where they can pursue studies in the various areas of science.

- To provide the scientific community of San Diego with an opportunity to become better acquainted with the children of southeast San Diego and with the talent potential there.

- To broaden the "life space" of the child through field trips to various locations throughout the county and through repeated contacts with college campuses, museums, lecture halls, and scientific laboratories.

Over the years, the Institute has served more than 5,000 young people in this community, half of whom have gone on to higher education.

The National Science Teachers Association recently reaffirmed the idea that acquiring science process skills and developing scientific attitudes require the use of activity-oriented investigative teaching methods. If, indeed, we want our children to understand science, we must give them many opportunities to observe, to experiment, to wonder, and to inquire, "What if?" If they never wonder, they will never know science. But given the freedom to act, the student is transformed from an observer of the teaching process to a participant in the learning process.

## PROGRAM REVIEW

The Institute's program is successful because:

1. *It is informative, educational, and entertaining* as a result of discussions, lectures, seminars, workshops, films, book reviews, field trips, parents' nights, and career planning.

2. *It provides opportunities for investigative research* through student projects, science fair competitions, microscope studies, pond studies, and chemical experiments.

3. *It provides school and community service* through workshops for students doing science fair projects and instruction of younger students in laboratory and experimentation safety.

## PROBLEMS

The Elementary Institute of Science is faced with primary problems:

- *Membership.* Programs in underrepresented areas face interest and membership problems. It is sometimes difficult trying to attract students not particularly interested in becoming involved with the academics of science or research.

- *Funding.* The Institute requires special funding from external organizations to provide opportunities involving expenses to members who might not be able to pay.

## TRENDS

The trends in drug abuse, the economy, and education in San Diego County are of great concern to the Elementary Institute of Science, for they will have a direct impact on the existence of the Institute.

## DRUG ABUSE

Residents of San Diego County are at higher risk for drug abuse than residents of many other comparable cities because of a unique combination of demographic and geographic factors. The demographic factors include (1) the presence of several major military installations with over 60,000 males under the age of 25 on active duty; (2) a large, somewhat transient population of students and young adults; and (3) a 16-36 percent high school dropout rate. Geographic factors contributing to drug abuse include

the major port located in San Diego, an international airport and several local airports, access to remote agricultural areas well suited to growing high-quality marijuana, and the three international border crossings and long unprotected border with Mexico. These factors add up to produce a large population at high risk for drug abuse, with relatively easy access to drugs. The community as a whole needs to be concerned about alcohol and drug abuse prevention. The Institute *is* concerned, too, because its facility sits right in the heart of daily drug and gang activities.

Although juvenile crime is declining, serious juvenile crime points to the need for more programs to deal with high youth unemployment and to provide after-school activities.

## ECONOMIC TRENDS

The San Diego area economy is expected to be on a "dual track." A large sector of the community will face prosperity, but a segment of the population will be adversely affected by the high cost of housing, health care, and changes in the job market.

The unemployment rate is expected to fluctuate somewhat. In 1985, the unemployment rate was significantly lower than in 1980. Between 1997 and 2005, the unemployment rate is forecast to average around 8 percent, before declining rapidly to reach less than 7 percent in 2010. By the year 2010, the number of unemployed persons is expected to reach 108,000. The unemployment rate for all minority groups tends to be above that for the Anglo population, with Blacks experiencing the highest rate at 9.3 percent, Hispanics next at 7.0 percent, Asian Americans/Others at 5.8 percent, and Anglos at 4.7 percent.

The population in need of assistance is concentrated in geographic impact areas that are removed from the rapidly growing employment centers. The locations of future jobs are not expected to coincide with the areas of high unemployment levels.

The statistics indicate unemployment has a differential impact on persons from minority racial/ethnic populations. This contributes to poverty for minority racial/ethnic populations, for both youth and adults.

## EDUCATIONAL TRENDS

In 1985, the median level of education in San Diego increased slightly, to 13.9 years. The median education level in the United States for 1985 was 12.7 years. Thirty-four percent of the population is better educated than 19 years ago. The number of persons with less than eight years of schooling has decreased from 16.5 percent to 10.7 percent.

In the State of California, it is estimated that the dropout rate is 37 percent. Dropout rates in San Diego County range between 16 percent and 36 percent. The dropout rate for Blacks is 41 percent.

It is estimated that 400,000 San Diego County residents are considered functionally illiterate (reading comprehension at or below a fourth-grade level).

The school systems need the support of the community to improve educational attainment and to reduce the dropout rates, especially for minority populations. Additional solutions are needed to decrease the dropout rate, including more community visibility for successful minority professionals.

## UNIVERSITY OF CALIFORNIA'S TASK FORCE ON BLACK STUDENT ELIGIBILITY

The Elementary Institute of Science is preparing to participate in the University of California Task Force on Black Student Eligibility. The task force will study community-based intervention strategies for increasing the college eligibility rates of Black high school students. Our program has been identified as having elements that could be replicated by other communities wishing to address this problem. The following organizations in California have been identified for possible study:

- The Young Black Scholars Program, Los Angeles
- The Santa Fe June Moses Study Hall, Vallejo
- Project Interface, East Oakland
- The Elementary Institute of Science, San Diego

The Task Force on Black Student Eligibility was established in January 1986 by University of California President David P. Gardner. The group will advise Gardner and the Board of Regents on ways to discover and understand the factors that influence the academic preparation and college eligibility rates of Black high school students.

Dr. Edmund Keller, Professor of Political Science at the University of California at Los Angeles, will codirect the study. Task force members will identify, investigate, and report on a variety of strategies that have been used to encourage Black high school students to undertake a rigorous academic curriculum in high school. The Elementary Institute of Science continues to stress this goal, to better prepare students for college.

## CONCLUSION

Of course, not every youngster exposed to the Elementary Institute of Science will become a professional scientist. But involvement in the concepts, the discipline, and above all the logical thought processes will make for wonderfully aware citizens, ready to participate in the tough technical and scientific decisions ahead.

We must do everything possible to make science attractive to young people, by emphasizing the roles science could and does play in solving the fundamental problems of our nation and our world. We must appeal especially to the largest group, disadvantaged minority youth.

## APPENDIX

### The Dream Fulfilled

For three years (1976, 1977 and 1978), the Consortium for Black Professional Development has awarded a Grand Prize Trophy to the outstanding exhibitor at their National Science Fair. For each of those years, winning in competition with top science students from throughout the United States, that talented young person has been a representative of the Elementary Institute of Science.

First came **Geoffrey Holman**, now a student at the Massachusetts Institute of Technology, who won the following honors and awards:

1. Grand Prize Trophy, National Consortium, 1976
2. First Place (category and division), National Consortium, 1976
3. NASA Awards—Consortium and Greater San Diego Science and Engineering Fair (GSDSEF), 1976
4. Second Place, Senior Engineering, GSDSEF, 1976
5. American Institute of Aeronautics and Astronautics Award, GSDSEF, 1976
6. Fred H. Rohr Science Award, GSDSEF, 1976

Geoffrey was followed by his younger brother, **Jonathan Holman**, who earned his Bachelor of Science in Chemical Engineering in June, 1982, from the California Institute of Technology, Pasadena. Special Skills: familiar with computer languages Fortran, Basic, Pascal, Cobol, C, and various machine languages. The following are his honors and awards:

1. Grand Prize Trophy, National Consortium, 1977
2. First Place (category and division), Consortium, 1977
3. NASA Award, Consortium, 1977
4. First Place, Senior Medicine, GSDSEF, 1977
5. U.S. Army Award, Medicine and Health, GSDSEF, 1977
6. U.S. Air Force Award, Medicine and Health, GSDSEF, 1977

Next came **Foster Carr**, now a Freshman at Harvard. His awards include:

1. Grand Prize Trophy, National Consortium, 1978
2. Senior Sweepstakes, GSDSEF, 1977
3. 3rd Runner-Up Senior, Sweepstakes, GSDSEF, 1978
4. Sweepstakes, California, State Science Fair, 1977
5. Second Place, Consortium, 1977
6. Third Place, International Science and Engineering Fair
7. Air Force Award, GSDSEF, 1977
8. Army Award, GSDSEF, 1977

Other top Institute students include:

**Ronald Grey** (Now at U.S.C. School of Engineering)

1. Finalist, Grand Prize Trophy, National Consortium, 1976
2. First Place (Category and Division), Consortium, 1976
3. NASA Award, Consortium, 1976
4. U.S. Army Top Prize, GSDSEF, 1976
5. U.S. Army Engineering Award, GSDSEF, 1976

**Brian Sanders** (Computer Science Magnet)

1. Third Place, Consortium, 1978
2. Second Place, Zoology, GSDSEF, 1978
3. Top Prize, Gompers Science Fair, 1978

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# MATHEMATICS AND COMPUTER SCIENCE ENRICHMENT PROGRAM FOR SECONDARY SCHOOL STUDENTS: The How, When, What and Why

**Henry L. Hardy, Ph.D.**

**Director and Instructor**
**Mathematics/Computer Science Summer Institute**
**Cheyney University of Pennsylvania**
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*Although Dr. Hardy holds the position of Professor and Chairperson of the Mathematics/Computer Science Department at Cheyney University of Pennsylvania, he finds time to serve as Director and Instructor for its Mathematics/Computer Science Summer Institute, and as Adjunct Professor of Mathematics at Pennsylvania State University (Penn State). In addition, he produces a steady flow of publications, which includes six standardized examination booklets in mathematics and computer science he developed. He received his Ph.D. in Mathematics Education from Temple University after completing his bachelor's degree at Southern University, his master's degree at Central Connecticut State College, and a sixth year at the University of Hartford. He has received many awards in recognition of his outstanding achievement and performance at Cheyney University and in the William Penn School District. He is a member of the Executive Board of the Pennsylvania Association of Computer and Information Science Educators and of the American Mathematics Society and the National Association of Mathematics.*

I thank Dr. Nina Kay and her colleagues for inviting me as a guest speaker for the First Annual Black Symposium. I am Dr. Hardy, Professor and Chairperson of the Mathematics and Computer Science Department at Cheyney University of Pennsylvania. However, I was invited to speak at this symposium because I am the founder and only director for the Cheyney Mathematics and Computer Science Summer Program for Secondary School Students.

I had a little problem writing my speech for today, but that has happened to me before. Each time that happens, I drift back to my childhood days and my Southern upbringing. I remember my days in a Southern Baptist church. I remember preachers like the Reverend Snowden, the Reverend Smothers, the Reverend Grimes, and most definitely the Reverend Isiah Warner. I remember times when the Rev. Warner would be at the pulpit and it seemed like he was just fumbling around, like he did not know what he was saying nor what he was talking about. I later found out he was not fumbling around, he was just getting himself together. When he got himself together, he was good. I remember the Rev. Warner saying something like, "If you're going to be a speaker, to be effective, you must first make yourself comfortable." He said that, to make yourself comfortable, talk about something you know. He said, when you do that, the words just seem to flow. So that is what I will do today.

## HOW I STARTED THIS PROGRAM

In 1976, I wrote a proposal and submitted it to the National Science Foundation. The program was critiqued and reviewed, and my proposal was returned with a letter that said it was not funded.

I felt rejected. I went into something of a cocoon—you know we all do that. With summer passing, I took out the proposal and read the review. I have been told in the past I am a persistent person and somewhat stubborn. I decided to revise this proposal and submit it again, but I thought I would take a different route. Why not visit the National Science Foundation and meet some people down there, talk with them to see what I have to do? So I did that.

I went to the National Science Foundation. When I got there I went into the building, and I was going from the second floor to the sixth floor, back and forth. The National Science Foundation building had all of these color codes, green for something, yellow for something, purple for something, red for something else. Finally a custodian, who happened to be a Black man, saw me. I could just picture what he saw: someone who was scared, tired, frustrated, disgusted, and irritated.

He came up to me and said, "Young brother, it seems like you're lost."

I said, "Yes sir, I am."

He said, "What seems to be the problem?" I told him what I was there for. He said, "Brother, you need to talk with Dr. Shirley McBay."

I did not know Dr. Shirley McBay from the Man in the Moon, so I asked him, "Who is Dr. Shirley McBay?"

He said, "She's the Director of MISIP."

I did not know a MISIP, so I asked him, "What's a MISIP?"

He did not tell me, but he said, "Come on, Brother, follow me." I did not know what to do. We went down to some room. It was the janitor's room, I guess. He said, "I'll call Dr. Shirley McBay for you." We got there and he made this phone call. He talked with somebody and gave the phone to me, and sure enough, there was somebody named Dr. Shirley McBay. So I talked with this person named Dr. Shirley McBay. She then gave the phone to someone else, and I talked with someone named Dr. Rodriguez. I think his first name was Paul. Talking to him for a while, he asked me to give the phone back to the janitor, I still did not know his name. I did, and he talked for a while.

He hung up and said, "Young Brother, follow me," and I did. I was on a roll. I did not know what to do, so I thought I would see it through to the end. He took me downstairs and called a taxi. I got in this taxi and he told the driver where to take me. He told me the taxi driver was going to put me out on a particular corner, and Dr. Rodriguez would be there waiting for me.

Hey, what did I have to lose? So I went. Sure enough, the taxi driver took me across town, I paid him, and got out on the corner. There was somebody waiting by the name of Dr. Rodriguez. He took me into the MISIP Building. Sure enough, there was somebody named Dr. Shirley McBay. I met this person, Dr. Shirley McBay, and we talked about my proposal. She and Dr. Rodriguez told me what I had to do, and one thing led to another.

I left and went back to Cheyney. I made the changes and resubmitted the proposal to NSF-MISIP. Well, several weeks later, I received a phone call. The secretary said, "Professor Hardy, there is a phone call from NSF-MISIP, Dr. Shirley Malcom."

I said, "You must mean Dr. Shirley McBay."

She said, "No, this is from Dr. Shirley Malcom."

I thought, well, okay, I will go along with this, too, I am still on a roll. Sure enough, there was somebody named Dr. Shirley Malcom. I got on the phone, she said, "Professor Hardy," blah, blah, blah, "and let's discuss this budget."

Well, I went along with that, too. She told me I had some changes to make, some revisions and this, that, and the other.

So later, I got a letter saying, "Congratulations, you have been awarded a National Science Foundation MISIP Grant in the sum of $252,000 for an institutional grant for curriculum development, publication, and a summer enrichment program for post-secondary school students."

That is actually how this program started. I have gone back to the National Science Foundation looking for that man, but I have not found him yet. As a matter of fact, I really do not remember what he looks like. I wish I could find him, though, because I owe him something. I went back hoping I could buy him dinner, take him out to the finest restaurant, any meal he wanted, or anything he wanted to drink. I just think I owe him something.

## THE WHEN

We started in the summer of 1979. This past summer of 1988, we completed our tenth consecutive summer. This is something of which I am extremely proud.

## THE WHAT

What did we do with these students over the past ten years? In the first summer of our six-week residential program, there were 14 students, two instructors, and four supporting staff members.

The mathematics consisted of elementary functions and calculus. Computer science consisted of Basic and Fortran. The student's daily schedule was such that they had one class from 8:30 until 10:00, a 10:00 to 10:30 break, a second class from 10:30 to 12:00, and lunch from 12:00 to 1:00. They had labs from 1:00 until 4:30, and dinner was from 4:30 to 6:00. From 6:00 until roughly 9:30 at night, they had recreational activities: swimming, tennis, basketball, baseball, badminton or just lounging around with the other students on campus. This was five days a week and then there were labs for four hours on Saturdays.

This schedule remained for the entire six weeks. All 14 of the students in the summer program enrolled in Cheyney University's academic year program. We had developed a dual degree program. By coming in during the summer, these students had more advanced training than the average student with a mathematics and computer science major at Cheyney. The academic year schedule for the first semester consisted of Natural Science I, Social Science I, Communications I, Calculus I, Calculus II and Fortran. The second semester they had Natural Science II, Social Science II, Communication II, Calculus III, Differential Equations, and Cobol.

At the end of the first summer I recruited 18 students for the second summer. These 18 students basically went through the same program the 14 had gone through the previous summer.

I also had to have a program in the second summer for the first-year group. I had heard of a summer program in computer application at Goddard Space Center. I visited Goddard Space Center and met Mr. Mundy and Mr. Chapman. I also met Dr. Carl Kirksey, who is director of the program and a professor at Bowie State College. All 14 of our second-summer students were accepted at Goddard for its ten-week computer applications program. Students attended classes for four weeks and were assigned to a full-time employee at Goddard for six weeks. The students received 4 semester credit hours from Bowie State College that were transferred to Cheyney University.

I recruited 24 students for the third-year summer program. These 24 students went through the same program we had had the previous two summers. I now had 32 students to place during the third summer. Students were placed at Goddard Space Center, Computer Science Corporation, Bell Labs, Philadelphia Navy Yard, Pennsylvania Army Depot, General Electric, Burroughs Corporation, and other places.

I recruited 32 students for the fourth summer and 54 students for the fifth summer. During these five summers and four academic years, all students went through the same summer program and academic year program.

Earlier I told you I had funds for three years, so you may ask how I funded the summer programs for five summers. I persuaded Dr. Wilson, our president, to let me use the indirect funds from the grant as well as the monies I did not use by not hiring a faculty person. I persuaded the Vice President of Student Affairs to let the students live in the dormitories at no cost. I persuaded the food service to let me pay them a lump sum so all students could eat. I got books for the students for the fourth and fifth year from students attending the first three years.

The sixth year brought major changes. I had exhausted all funds, but wanted to continue the program. I submitted my proposal to the William Penn Foundation. The William Penn Foundation was not interested in funding the program for postsecondary students, but would consider a six-week summer program for secondary school students. I revised my proposal for secondary school students and received a $94,000 grant for a mathematics and computer science residential summer enrichment program for participants from grades 8-11.

I received over 700 applications for the sixth summer. I knew I could not accept 700 students, so I developed a selection process based on six criteria: standard examinations, complete application, medical form, school academic record, a letter of recommendation from a counselor, and an interview with the parent and student. I accepted 122 students during this sixth year, which was in 1984. There were six instructors and ten student assistants. The ten student assistants were mathematics and computer science majors who had gone through our summer and academic year programs. Mathematics courses were arithmetic, algebra and elementary functions. The computer science courses were Basic and Fortran. Each student had a 1-1/2-hour mathematics class, computer science class, mathematics lab, and computer science lab. The student schedule was 8:30 to 10:00 class or lab, a 10:00 to 10:30 break, 10:30-12:00 class or lab, 12:00-1:00 lunch, 1:00-2:30 class or lab, 2:30-3:00 break, 3:00-4:30 class or lab, 4:30-6:00 dinner, and 6:00-9:30 recreation which included basketball, softball, swimming, tennis, badminton and what-have-you. By 9:30, they had to be back in their dormitories.

We are talking about eighth- to eleventh-grade students. This was the first time some of the youngsters had been away from home in any type of program. We could not let them wander out at night without any supervision, so I decided they should be back in their dormitories by 9:30. The evening activities also included workshops and preparing for the SAT and ACT. It was not all just academics. We also had movies, rehearsals for our talent show, etc., and other activities, such as a Fourth of July picnic, and two field trips. Field trips included the Great Adventure, Goddard Space Center, and the Black History Museum in Washington, DC. We also had birthday parties, pool parties, and a talent night.

In 1985, the seventh year, I submitted my proposal to Cheyney University's Enhancement Program. It was funded for $76,000. I accepted 92 students and duplicated our (sixth-summer) program for secondary school students.

In 1986, the eighth year, I again submitted my proposal to the William Penn Foundation. The eighth year was funded by the William Penn Foundation in the amount of $132,000. The eighth year also brought several changes. The language arts component was included and each participant received a $40.00 per week stipend. The staff included two mathematics instructors, two computer science instructors, two language arts instructors, and ten student assistants. Three of the six instructors were secondary school teachers.

In the eighth year I accepted 96 students, using the same selection process as for the sixth and seventh summers. The courses now included arithmetic and algebra, elementary functions, Basic, Fortran, Pascal, and language arts. It was also during the eighth summer we first gave awards for the highest honors in each section of each course. Here the daily schedule was a little different from the previous two summers. The students had breakfast from 7:30 to 8:30, the first class was from 8:30 to 10:00, 10:00-10:30 break, the second class was from 10:30 to 12:00, 12:00-1:00 lunch, third class from 1:00 to 2:30, 2:30-3:00 break, lab 3:00-4:30, dinner from 4:30 until 6:00, and 6:00 to 9:30 for recreational activities. At 9:30, they must be in the dormitories. We still had the field trips, pool party, talent show, Fourth of July picnic, workshops, and what-have-you.

In 1987, the ninth year, we were funded by the William Penn Foundation in the amount of $142,000. The number of instructors remained at six and student assistants at ten. Student stipends went from $40.00 to $45.00 per week.

In 1987 the student enrollment was 86. The class schedule remained the same as 1986. Highest honors were again presented, but the concept was expanded to recognize those students who had most improved during the six-week period.

In 1988 we were again funded by the William Penn Foundation in the amount of $142,000. The student enrollment was 96. The 1988 program was basically a carbon copy of the 1987 program.

## THE WHY

Why did I start this program, and why do I continue to solicit funds and stay with this program?

I used to live in Hartford, CT and, at that time, I taught in a high school in Hartford, Weaver High School. While teaching at Weaver, I applied for admission to Central Connecticut State College for the master's degree program in mathematics. I was accepted at Central Connecticut State and I met the chairperson of the Mathematics Department, Dr. Cook. Dr. Cook explained the programs offered there. There was Program A and Program B. Program A included 27 hours and a thesis. Program B included 33 hours and a comprehensive. I chose Program A. I was given the program.

Dr. Cook also assigned me an advisor, Dr. Palzere. I started taking courses without the assistance of Dr. Palzere, because he would not meet with me.

I was attending part-time, taking three courses, which was 9 hours. After the first 9 hours, I went back to Dr. Cook. I said, "Dr. Cook, I need some help. Dr. Palzere won't meet with me."

He said, "Well, come with me, I'll take you to meet Dr. Palzere." Dr. Cook took me to Dr. Palzere's office. Dr. Palzere was at his desk. He told us to come in and have a seat. We did.

So I asked, "Dr. Palzere, why won't you meet with me?"

He said, "Henry, you don't need an advisor."

I said, "Why would you say that?"

He said, "Well, you're not going to make it."

I said, "Well, why would you say that? I've taken three courses. I have two *A*s and one *B*."

He said, "That doesn't matter—Blacks don't achieve in the sciences, mathematics, biology, chemistry and physics."

***"He said, 'That doesn't matter—Blacks don't achieve in the sciences, mathematics, biology, chemistry and physics.'"***

I got two *C*s in my master's program, both from Dr. Palzere.

I remember taking mathematics, statistics and research with Dr. Palzere, and nothing I did was right. He had me going from New Britain, Connecticut to Hartford, Connecticut; from New Haven, Connecticut, and Bridgeport, Connecticut, to Springfield, Massachusetts collecting data. When I asked him something, he said I should know it. When I did something on my own, he said I should have come to him. I did not know what to do. While there, I became so frustrated I enrolled in another program at the University of Hartford. Dr. Palzere had my mind so messed up that, if someone walked up to me and asked, "Hardy, what is the product of 5 x 6?", I would slowly say, "30," and I would probably scratch my head and say, "I think." Actually I really was not sure 5 x 6 was 30.

Well, there is an old saying we have down South: "The Lord moves in mysterious ways and wonders to perform." Somehow a wonder was performed with Dr. Palzere. He went on sabbatical.

While Dr. Palzere was on sabbatical, I went back to Dr. Cook and put in a request to transfer from Program A to Program B. Dr. Cook honored my request. I enrolled in two additional courses and applied for the comprehensive. I passed one class with an *A*, the other with a *B*, and passed the comprehensive on the first try.

When Dr. Palzere returned for commencement that semester, I was marching. I want you to know I did not give Dr. Palzere the high five, but I did give him the low finger.

I left Hartford in 1972 and came to Cheyney. But, I could never get Dr. Palzere out of my mind. I used to think he was a super racist. But, I like to give every man the benefit of the doubt. I thought maybe Dr. Palzere is not a racist. Maybe he just did not know any better. Coming from New England, he just had not seen any Blacks in the sciences.

And, I do not think that is fair. I do not think they, the Palzeres—and there are a lot of them—should have to go through life not seeing Blacks in the sciences.

So what would I do? I would develop a program that would mass-produce young Black folks to go out there and succeed in mathematics and the sciences. I am not sure how far I have come, or how much I have accomplished, but I feel good about the strides I have made.

Again, I thank Dr. Nina W. Kay and her colleagues for inviting me to speak today. Thank you.

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# ASSESSING YEAR-ROUND MATHEMATICS AND SCIENCE PROGRAMS

**Nellouise D. Watkins, Ph.D.**

**Director**
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**900 E. Washington St., Greensboro NC 27401**

*Dr. Watkins has an extensive background in the sciences and mathematics. She is a graduate of Fisk University and Wilberforce University and earned her doctorate in computer science. In addition to her position as Director of the Computer Center at Bennett College in Greensboro, North Carolina, she also serves as Director of the Saturday Academy, sponsored by Bennett College and North Carolina A & T State University, as Director of the Intensive Summer Science Program, and as Director of the Mid-Atlantic Conference on Educational Computing. Despite the expanded role she has assumed professionally, she manages to find time for professional organizations and community service. She serves on the United Way Budget Committee and on the Board of Directors of Greensboro National Bank and is a member of The Links, Inc. She belongs to the Beta Kappa Chi National Honor Society in Science, Alpha Kappa Alpha Sorority, and the Kappa Delta Pi National Honor Society in Education. As testimony to her fortitude and versatility, she was selected Greensboro Mother of the Year in 1971. She has contributed to several professional journals and co-authored several publications, most recently Issues in Educational Computing at Minority Institutions (1986) and The Saturday Academy Process for Accessing Mathematics-Based Careers (1987).*

## ACCESSING MATHEMATICS-BASED CAREERS

This morning, we propose to take a thesis, articulate some assumptions and derive a conclusion for your critique.

*Thesis*: The current system of education used to prepare students for the mathematics-based professions—that is, engineers, scientists, mathematicians, computer scientists—has failed minority and female students when measured by the number from this group successfully practicing these professions.

*Assumption*: Adequate studies support the assumption that: 1) there are no inherent barriers to the successful participation of minority and women in the mathematics-based professions; 2) when they are provided early, excellent and sustained instruction in mathematics and the sciences, they pursue these professions, and; 3) when instruction is targeted to identifiable educational access problems, the achievement levels attained by minorities and women parallel those of any other student population.

*To Prove*: The magnitude and complexity of the problem does not preclude that this large sector in today's technological society—minorities and women—must remain educationally "at risk."

Many intervention programs funded by foundations such as NSF, industries such as Exxon, and states such as the North Carolina School of Science and Mathematics all provide positive significant data that appropriate stimuli produce the required results. The program I will describe is one of those targeted interventions aimed at producing American Indian, Black and women scientists and engineers. Originally funded by the Ford Foundation and currently funded by General Electric Information Systems, *Access to Mathematics-Based Careers* (AM-BC) is a pilot study on the effects of cultural differences on learning styles to determine an effective teaching style for selected groups. The AM-BC program is directed toward two intervention levels: fourth through eighth grades, in what we call the Saturday Academy, and ninth through twelfth grades, in an Intensive Summer Science Program (ISSP).

The four discipline areas—mathematics, science, communications, and computer science—constitute the format for both the Saturday Academy and ISSP. The Saturday Academy, as the name implies, meets each Saturday morning from 9:00-12:00 for 12 weeks, with two sessions offered each school year. The ISSP is a college-resident program for four weeks during the summer.

The highlights of the Saturday Academy are as follows:

- Parents are required to attend two workshops during the 12-week session.
- Class enrollment is maintained at 15-20 students.
- Students are placed based on their score on the Competency Test of Basic Skills.
- Faculty are highly trained and committed role models. The same teachers handle both programs, and all professors are teaching in their area of specialty. A person from IBM teaches two of the programming classes.
- Space and equipment donated by the university and college are made available each Saturday morning.
- Short-term evaluation, based upon pre- and posttesting, shows significant improvement in mathematics performance. Improvement in the regular school session is frequently documented. Continuation beyond one Saturday Academy session is the rule rather than the exception.
- Scientists, engineers, and/or community leaders act as visiting presenters during each 12-week session. Field trips are also arranged.
- The use of computer technology is interwoven throughout the morning activities. Students learn to program in Logo and Basic. Software for skills building, often in game format, is a part of mathematics and communications classes.
- The laboratory experiences are hands-on simple experiments in electricity, heat transfer, mechanics, the pendulum, laser, robots, etc. Because students continue beyond one session, new experiments are presented each session.
- Discipline and respect are emphasized in the midmorning "donut and drinks" break during which local community organizations present silver dollars to students who have shown the greatest improvement for the week.
- The strong support and commitment of the leaders of the two consortium institutions is reemphasized at the closing parent workshop awards luncheon when the Chancellor and President personally hand out certificates to each student.

- The mathematics courses place primary emphasis on application problem solving. Examples are (purposefully) culturally and sexually biased.

- The communications course involves reading, writing, and oral creative expression. For example, groups research the life of George Washington Carver or Madame Curie, then write and act out a skit.

The Intensive Summer Science Program has the same format and emphasis, but directed at higher grade levels. Several additional benefits are enjoyed by the students.

- Early experiences in social and academic responsibility and having to get along with other people.

- Exposure to what college life is all about.

- Unlimited access to computers to program, to drill, to play games.

- Learning to put primitive computers together.

- *Doing* science and mathematics from an everyday application perspective.

- Accepting the diagnosis of deficiencies, because of an atmosphere of caring demonstrated when faculty, tutors, and the computer are available for help from 8:00 am to 10:30 at night.

- Special group interaction sessions to help students focus on, "Where you are," "Who you are," "Where you are going," and "How you are going to get there."

- Use of software developed for the particular problems that face minority students by minority "master teachers" of many years' experience.

- Group competition in the IQ Bowl makes learning fun when SAT preparation questions were projected on a big screen.

- Biweekly sessions on preparing for the SAT using actual questions.

- Being taught in the electronic classroom where the teacher becomes a guide to the learning. Here, the software provides the concept while a teacher assistant keys in the answer the student gives. The large screen monitor shows the concept, the student answer, and a tutorial for the total class to discuss.

If the courses are the same as the students take at school, and students come on their day off (Saturday) or during their summer vacation, this is contradictory to the perennial excuse—the lack of motivation! What seems to make the difference? We have asked this question of students, faculty, staff, outside evaluators, parents and teachers. The responses included a significant number of intangibles:

1. Highly qualified faculty—teachers who know not only content but methods—can use a variety of relevant illustrations in teaching application-oriented and problem solving materials.

2. Classes that promote learning without penalty, laughter but also discipline.

3. The technique to assist ego building with an emphasis on calling students by name. For example, each Saturday morning every student wears a brightly colored name tag.

4. The philosophy of the program that every student is a part of the inner circle, and no one is a part of the periphery.

5. The requirement for every faculty member to call on each student by name at least once in every class.

6. A prearranged plan to prevent students from laughing at another student's response to a question.

7. Although fragile egos and insecurity are natural companions to deficiencies in performance, rigorous academic preparation in the skills must constantly be stressed. Students are less sensitive if the teacher is a model who "made it."

8. Improvement in skills building and acquisition of facts are more rapid using computer-assisted instruction (CAI) materials. Privacy and immediate feedback, particularly praise, increase confidence and reduce embarrassment, which are often mental blocks to learning.

***"If the courses are the same as the students take at school, and students come on their day off (Saturday) or during their summer vacation, this is contradictory to the perennial excuse—the lack of motivation!"***

Some barriers to pursuing a career in a mathematics-based profession like engineering are common to minorities and women, and some are unique to one particular group. Among the commonalities to circumvent the barriers are the needs to: 1) strengthen problem solving and analytical thinking; 2) reduce other deficiencies in mathematical performance; 3) "do" more science to concretize the scientific method; 4) develop a sense of the utility of mathematics and science; 5) improve career guidance; 6) pursue different teaching styles; 7) hire better trained teachers, and; 8) increase the number of minority and woman role models.

Perhaps the most critical need unique to women in engineering and related fields is the negation of the societal dogma that these are not appropriate fields for women.

Permit me in closing to give a two-minute scenario:

Three years ago Congress approved funds to cover operational costs for Saturday Academies and ISSP type programs to be conducted through three-year grants to colleges and universities. This initiative was implemented as a stop-gap measure while the massive teacher training programs are in process, and will be reviewed for continuity after two cycles. The academies have become observation laboratories for the teacher training programs. Now that the first funding cycle is complete, the quantitative portion of the California Achievement Test, ninth-grade level, indicates that numbers of minorities, females and Anglo males show no significant difference in performance.

At 12 consortium centers funded under the initiative, Intensive Summer Science Programs have been in operation for the past two summers. Four hundred minority and female students have been served at each college campus. The dropout rate has been exceptionally low, while the percentage of students continuing for both summers has been very high. One trend is apparent over the two summers evaluated: better than 60 percent of the attendees are on the track to complete the calculus course before graduation at their home school. This is expected when almost 5,000 students are participating in an intervention preparing them for admission to a school of engineering.

The idea of a special endowed chair for minority faculty to teach in the ISSP programs has attracted many outstanding engineers, scientists and mathematicians. Several centers had engineers elect to take their vacation from industry in this way.

Provisions of the program for the university sponsors to receive funds to provide supplies, dormitories, food, security and recreation while donating the use of their facilities and equipment is an excellent proof of commitment. As you would expect, there is a center at every women's college (all nine of them).

The evaluation team composed of representatives from the national societies of mathematics, engineering, computer science and the various sciences are doing a tremendous job in guiding and monitoring the programs.

> ***"One trend is apparent over the two summers evaluated: better than 60% of the attendees are on the track to complete the calculus course before graduation at their home school."***

The procedures manuals, including suggested methodologies, a wide selection of experiments, and tested CAI software collected by earlier programs, have certainly prevented "reinventing the wheel."

Clearly these experienced institutions' estimates of costs to conduct the Saturday Academies and the summer programs were strong factors in getting the national project approved. The in-kind contributors and leadership given by the universities and colleges was the basis for the cost-effective estimate of $150 per child per year for the Saturday Academy and $600 per student at a summer program.

Proof by logic and illustrative examples are necessary but certainly not sufficient to say *Quod Erat Demonstratum* to the thesis stated at the beginning. But the probability of significantly increasing the pool of females and minorities in engineering and mathematics-based careers as illustrated is clearly high.

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# THE DETROIT AREA PRE-COLLEGE ENGINEERING PROGRAM (DAPCEP)

**Kenneth Hill**

**Executive Director**
**Detroit Area Pre-College Engineering Program, Inc.**
**60 Farnsworth, Room 110, Detroit MI 48202**

*Kenneth Hill is the Executive Director of the Detroit Area Pre-College Engineering Program, Inc. (DAPCEP). He has held this position since the inception of the program in 1976. Hill has lived in Detroit since 1966 except for the two years he spent in Zambia, Central Africa. He received his undergraduate degree from Howard University and his master's degree from Wayne State University.*

The Detroit Area Pre-College Engineering Program, Inc. (DAPCEP) is a nonprofit organization founded in 1976 with a grant provided by the Sloan Foundation. DAPCEP is governed by an 18-member board of directors who represent the Detroit Board of Education, local universities, corporations, foundations and parents. The National Science Foundation, the Detroit Board of Education and 18 corporations and foundations provide funds and in-kind services to the program. DAPCEP is the largest pre-engineering program in Michigan.

The purpose of DAPCEP is to motivate and prepare minority students to successfully pursue baccalaureate degrees in science or engineering. DAPCEP has designed an intervention curriculum for students in grades 7 through 12. The curriculum provides both middle and high school students with the opportunity to learn about careers in science and engineering by interacting with practitioners in the college classroom, in the laboratory, and in the field.

## THE GOALS OF DAPCEP

The purpose of this project is to provide a precollege engineering enrichment program for students in grades 7 through 12. The goals of the precollege engineering enrichment courses are to:

a. Provide students with the opportunity to explore career options within the fields of science and engineering through hands-on experiments;

b. Allow students to interact with science practitioners;

c. Promote academic preparedness; and

d. Allow students to develop an appreciation of the role of the scientist in society.

## IDENTIFICATION OF THE TARGET POPULATION

The DAPCEP Enrichment Program is open to students living in Detroit. Students in the counties of Wayne, Oakland, Washtenaw and Macomb also participate.

Currently, there are 1,780 middle and high school students enrolled in DAPCEP. There are 120 students who participate in the Summer Enrichment Program and 700 students who participate in the Saturday Morning Program. Also, there are 1,080 middle school students in the In-School program held in Detroit public school classrooms.

## ADMISSION CRITERIA

DAPCEP offers a spectrum of activities for the purpose of increasing the number of minority students in science and engineering careers. Each DAPCEP activity contains elements to motivate, instruct, and enrich the participants, with some efforts concentrated more on one of these aspects. Therefore, the prerequisites for each of the DAPCEP programs differ. For some (Science Fair, engineering classes, tutorial), there are no prerequisites. For others (advanced summer program), a prior DAPCEP program is required. Typically, there are three times as many applicants as there is available space.

*"Seventy percent of current DAPCEP alumni in college are pursuing engineering, mathematics or science majors. Seventy-four percent of DAPCEP college graduates pursued majors in engineering, mathematics and science."*

The guidelines for participation in a DAPCEP program are:

- Current enrollment in a high school college preparatory curriculum.
- *C* average in the subject areas of English, mathematics and science.
- Interest in a career in engineering or science.
- Satisfactory recommendation by a teacher or counselor.
- Commitment to attend all sessions of the program.
- Participation in a previous DAPCEP activity given special admission consideration.

## PROJECT DESIGN

DAPCEP courses are designed for students in grades 7 through 12. The pre-engineering classes and Saturday morning enrichment courses are conducted during the academic year, September through June. The five-week on-campus programs are conducted during the summer. DAPCEP courses are conducted in the Detroit public schools, on the college campuses of participating universities and at three industrial sites. There are six universities that actively participate: the University of Detroit, University of

Michigan-Ann Arbor, University of Michigan-Dearborn, Michigan State University, Oakland University, and Wayne State University.

The instructors for these programs are: (1) university professors and instructors; (2) certified Detroit public school teachers; (3) computer science instructors, engineers and scientists from industry.

## PROJECT OUTCOMES

### Survey Methodology

DAPCEP recently completed a survey of enrollees from 1976 to 1987. From a population of 3,170, the data below were derived from the answers of 699 respondents. Every attempt was made to contact former enrollees, including mailing surveys, contacting by telephone, circulating surveys at Open Houses and in classrooms, and accepting call-ins to our new WATS line. One thousand surveys mailed to former enrollees were returned undeliverable.

### Survey results

Seventy percent of current DAPCEP alumni in college are pursuing engineering, mathematics or science majors. Seventy-four percent of DAPCEP college graduates pursued majors in engineering, mathematics and science.

| | Total | Engineering | Computer Science | Science | Math | Liberal Arts | Other |
|---|---|---|---|---|---|---|---|
| College Graduates | 128 | 71 | 9 | 13 | 2 | 16 | 2 |
| College Enrollees | 571 | 267 | 36 | 80 | 14 | 155 | 19 |

98 scholarships awarded to DAPCEP students
698 Science Fair gold ribbon winners

DAPCEP graduates are employed at the following places: NASA, Ford Motor Company, General Motors, EDS, TRW, Dow Chemical, General Electric, Detroit Edison, Bell Laboratories, Highland Park School District, Detroit Public Schools, Peace Corps/Irrigation/Guatemala, U.S. Air Force, Applicon/Schlumberger, Craine Naval Base Research.

## PROGRAM EVALUATION

The following criteria are used to measure the effectiveness of our precollege engineering enrichment programs:

The number of middle school students who elect a college preparatory curriculum when entering high school and who elect to take science and mathematics.
The number of high school students who elect a college preparatory curriculum and who elect to take science and mathematics courses.

The number of students who pursue a bachelor's degree in engineering, mathematics or science.

The number of college students who choose careers in engineering, mathematics or science.

This information can be obtained from students' school records and from surveys.

## THE DAPCEP BOARD OF DIRECTORS

*Mr. Harry G. Greenleaf*
*President, Ford Motor Company*

*Mrs. Sharon R. Burch*
*Vice President, Univeristy of Michigan*

*Mrs. Delois McCorvey*
*Secretary, Parent Advisory Committee*

*Mrs. Mary E. Blackmon*
*Michigan Bell Telephone Company*

*Mr. Smallwood Holoman, Jr.*
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*Mr. Walter J. Roman*
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*Dr. Paul Hovsepian*
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*University of Michigan (Dearborn)*

*Mr. Ronald L. Spears*
*Parent Advisory Committee*

*Mrs. Donna Thornwell*
*Detroit Public Schools*

## THE DAPCEP STAFF

The DAPCEP staff consists of an Executive Director, Mr. Kenneth Hill; an Assistant Director, Mrs. Velma Ward; an Assistant Director for Development, Mrs. Carol Upshaw-Anderson; and a support staff of four. The DAPCEP staff coordinates the operations of all DAPCEP course offerings and supervises the fundraising activity.

The DAPCEP office is located at 60 Farnsworth, Rooms 110 and 111. The office space in Room 110 is provided at no cost by the University of Michigan; the office space in Room 111 is rented.

## THE 1988 DAPCEP PROGRAM BUDGET

This budget details the administrative and program costs.

| | |
|---|---|
| Administrative Costs | $111,745.00 |
| On Campus Summer Programs | 83,500.00 |
| On Campus Saturday Enrichment Courses | 63,200.00 |
| Science Fair | 8,000.00 |
| After School Tutorial Program | 7,000.00 |
| In-kind Services | 303,750.00 |
| Total | $577,195.00 |

## DAPCEP PRE-COLLEGE ENGINEERING ENRICHMENT COURSES

| GRADES 7-8 | GRADES 9-10 | GRADES 11-12 |
|---|---|---|
| **Pre-Engineering Classes**<br><br>Field trips<br>Technical Speakers (Minority role models included)<br>Science Fair Activities<br>Engineering Projects<br>Engineering Contests<br>Research on Minority Scientists and Engineers<br>Overview of major Engineering disciplines, and films. | **Pre-Engineering Classes**<br>(9th Grade Only)<br><br>Same description as grades 7-8, with more advanced content. | |
| | **Saturday Morning Enrichment Courses**<br><br>Introduction to Computers<br>Electronic Data Systems<br>Algebra<br>Introduction to Chemical Engineering<br>Technical Writing<br>Laboratory Science<br>Computer Science<br>Fundamentals for General Computer Users—Hewlett Packard | **Saturday Morning Enrichment Courses**<br><br>Fundamentals for General Computer Users—Hewlett-Packard<br>Computer Concepts—Unisys Corporation<br>Computer Science and Engineering Design<br>Introduction to Civil Engineering<br>Introduction to Mechanical Engineering<br>Introduction to Electrical Engineering<br>Introduction to Plastics & Polymers<br>Introduction to Computer Science<br>Chemistry<br>Physics Laboratory Experiments<br>Calculus<br>Trigonometry |
| | **Summer Programs**<br><br>Introductory Pre-College Engineering Programs (3) | **Summer Programs**<br><br>Summer Advanced Pre-College Engineering Program |
| **After School Tutorial Program**<br><br>Students commute to Wayne State for tutorial assistance from former DAPCEP students enrolled in engineering. | **After School Tutorial Program** | **After School Tutorial Program** |

## DAPCEP CAREER AWARENESS ACTIVITIES

All of the DAPCEP courses have career awareness components. The courses dealing with Introduction to Civil, Electrical, Mechanical and Manufacturing Engineering cover career opportunities in depth. There are two unique programs, however, that provide students with opportunity to interact with engineering and science practitioners: The DAPCEP Summer Bridge Program and the DAPCEP Mentoring Program.

### The DAPCEP Summer Bridge Program

This program is designed to identify and assist minority students who have shown an aptitude in science and engineering. The program provides summer jobs for students entering college. These jobs provide an opportunity for the student to gain work experience in the fields of science and engineering.

### DAPCEP Mentoring Program

This facilitates the opportunity for an effective one-to-one relationship between high school students and science and engineering professionals by linking educational and corporate institutions. The primary commitment is to enrich the education of the participating students.

### The Detroit Science Fair

Students are assisted by their science instructors when preparing exhibits for the Science Fair. DAPCEP has developed a video that provides students with information on how to participate in the Science Fair.

## DAPCEP CONTRIBUTORS

*The National Science Foundation*
*Ford Motor Company*
*General Electric*
*E.I. DuPont*
*Herrick Foundation*
*MichCon*
*De Vlieg Foundation*
*Dow Chemical Company Foundation*
*3M*
*National Steel*
*Whirlpool Foundation*
*Gerstacker Foundation*
*Westinghouse*
*Alcoa Foundation*
*Holley Carburetor Division*
*Barrow, Aldridge, & Company*
*Eaton Corporation*
*General Motors Corporation*
*Chrysler Corporation*
*Black United Fund*
*Burroughs Corporation*
*Michigan Bell Telephone Company*
*Detroit Edison*
*Dow Corning Corporation*
*Monsanto Fund*
*ANR*
*Rockwell International*
*G.T.E.*
*Detroit Board of Education*
*Alcoa Laboratories*
*American Motors Corporation*
*Himmel Foundation*
*Addison Wesley Publishing Company*
*The McGregor Foundation*

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# MENTORING AS AN INTERVENTION

**Rufus H. Cox**

**Professor of Chemistry**
**Community College of Philadelphia**

*At the time of the Black Symposium on Science, Engineering, and Technology Careers, Rufus H. Cox was Professor of Chemistry at the Community College of Philadelphia. He received his Bachelor of Arts degree from Temple University and his Master of Science degree in chemistry from Drexel University. In 1980, he was honored by the Chemical Manufacturers' Association, for excellence in chemistry teaching in two-year colleges. Professor Cox was a research chemist at Frankford Arsenal in Philadelphia before he began his teaching career. His interests included membership on the Energy Education Advisory Council to the Philadelphia Electric Company and serving as District Commissioner and Merit Badge Counselor for the Boy Scouts of America. He especially enjoyed performing chemical demonstrations for children of all ages. Professor Cox died suddenly in October 1988. He will be remembered for his commitment and dedication to his profession and to his community.*

This is a report on intervention by mentoring. This intervention is a part of the Minority Initiatives Program in progress at the Community College of Philadelphia (CCP).

The program was organized at the request of Dr. Judith Eaton, President of the Community College of Philadelphia, because she was not happy with the decline in enrollment of and the low retention rates of minority students at the Community College of Philadelphia. The Vice President of Student Affairs, Dr. Preston Pulliam, heads the project. Many faculty administrators and staff members, including myself, assist him with the project.

The Mentoring Intervention Project will be described at the end of the report. First, a profile of the class that entered the Community College of Philadelphia in September 1983, and measures of the academic progress the Fall 1983 class had made by the end of the Summer 1987 term, will be presented.

A mathematics intervention program that promises to encourage and enable more minority students to enroll in the calculus course sequence early in their college careers will be described briefly. Dean Judith Toman and some mathematics faculty members of the Mathematics, Physical Science and Engineering Technology Division hope to obtain financial support for the Mathematics Intervention Project.

The decline in the numbers of chemistry students and in the numbers of first-time enrollments in CCP from the Spring 1984 term, a year of maximum enrollments, to the Spring 1986 term, will be shown.

For the Fall 1983 term, 3,480 first-time students enrolled in the Community College of Philadelphia. An additional 2,628 students were in CCP already. Of the first-time students, 852 needed remediation (see Table 1) and probably would not have been able to gain access to higher education through admission, as college-ready, to most of the four-year baccalaureate colleges and universities in the Philadelphia area. Roughly half of the students who attend CCP are under age 21 and recently graduated from high school. The other half are adults who have been out of high school longer. Many of our full-time students are householders and work to support families.

TABLE 1

**Distribution of Age, Sex, Race Exiting Curriculum, and College Readiness at Admission for the Entering Class of Fall 1983**

| | Number of Students | Percent |
|---|---|---|
| **AGE** | | |
| 16 to 21 | 1871 | 55.0% |
| 22 and over | 1529 | 45.0% |
| **SEX** | | |
| Male | 1398 | 40.2% |
| Female | 2076 | 59.8% |
| **RACE/ETHNICITY** | | |
| Black | 168 | 48.3% |
| Anglo | 1150 | 33.0% |
| Asian | 188 | 5.4% |
| Hispanic | 181 | 5.2% |
| Other/Unknown | 280 | 8.0% |
| **EXITING CURRICULUM** | | |
| General Studies | 1727 | 49.7% |
| Allied Health | 108 | 3.1% |
| Transfer | 183 | 5.3% |
| Business | 1070 | 30.8% |
| Other | 387 | 11.1% |
| **ACADEMIC PREPAREDNESS** | | |
| P2 A, B, C, ACT 101 | 349 | 10.0% |
| ASK; All rem., no proj. | 194 | 5.6% |
| Some rem., no proj. | 309 | 8.9% |
| College Ready | 2628 | 75.5% |
| Total | 3480 | |

Of the 3,480 entering students in the Fall 1983 class, 1,681 were Black, 188 were Asian [-American], 181 were Hispanic, 1,150 were Anglo, and the racial/ethnic origin of 280 students was unknown.

The diversity in previous academic preparation, ethnic origins, career goals, economic status and other uncertainties of the urban setting is reflected in the measures of institutional effectiveness. Of the 3,480

entering students of the Fall 1983 class, 27 percent completed 24 or more academic credits to achieve sophomore status before leaving CCP. By racial/ethnic origin, 26 percent of Black students, 24 percent of Hispanic students, 31 percent of Asian students and 32 percent of Anglo students had achieved sophomore status by the end of the Summer II 1987 term (see Table 2).

**TABLE 2**

**Fall 1983 Entering Students Who Achieved Sophomore Status by Racial/Ethnic Background**

| | Black | Anglo | Asian | Hispanic | Other | Total |
|---|---|---|---|---|---|---|
| **ENTERING** | 1681 | 1150 | 188 | 181 | 280 | 3480 |
| % of total | 48.3% | 33.0% | 5.4% | 5.2% | 8.0% | 100% |
| **ACHIEVED SOPHOMORE STATUS*** | 431 | 367 | 58 | 43 | 45 | 944 |
| % of total | 45.7% | 38.9% | 6.1% | 4.6% | 4.8% | 100% |
| Percent of racial/ethnic group | 25.6% | 31.9% | 30.9% | 23.8% | 16.1% | 27.1% |
| Relative Over- or Under-Representation in Sophomore Class | 0.9 | 1.2 | 1.1 | 0.9 | 0.6 | |

* As of 8/87. Sophomore status defined as having successfully completed 24 credits.

**TABLE 3**

**Graduates by Race and Age (Students Entering in Fall 1983)**

| | Black | Anglo | Asian | Hispanic | American Indian | Other/ Unknown |
|---|---|---|---|---|---|---|
| **Associate Degree** | 133 | 135 | 12 | 16 | 1 | 11 |
| | 43.2% | 43.8% | 3.9% | 5.2% | 0.3% | 3.6% |
| **Certificate** | 15 | 11 | 3 | 1 | 1 | 2 |
| | 45.5% | 33.3% | 9.1% | 3.0% | 3.0% | 6.1% |

* as of August 1987

Of the 3480 entering students of the Fall 1983 class, 308 or 8.8 percent graduated with an associate's degree. Of 1681 Black students, 133 or 7.9 percent graduated with an associate's degree. And, of 181 Hispanic students, 16 or 8.8 percent graduated with an associate's degree (see Table 3).

The results are not yet complete for the Class of 1983. Some students *stop out* for a period of time and then return to continue their academic work. Also, some students transfer to four-year colleges and universities at the end of their first year at Community College of Philadelphia.

The Chemistry Department program audit shows enrollments in chemistry were at a maximum in the Spring 1984 term, with 1,039 students. There has been a steady decline from 1,039 students in Spring 1984, to 795 in Spring 1986.

During the period of the chemistry department program audit, college-wide full-time-equivalent enrollment (FTE) at the main campus dropped from 8,100 in the Fall of 1983 to 7,400 in the Spring 1986 term. We can speculate that two main causes for the decline in enrollments are students' money problems and students' asking themselves how important a college education is to their future success.

Staff and faculty of CCP are conducting several programs directed toward the recruitment and retention of more minority students. The Director of Admissions makes strong continuing contacts with community groups such as church groups, business groups, etc., asking them to assist CCP in getting information out to families of prospective students. He also reaches out to middle school pupils to be sure they know about opportunities for post-high school education at the Community College of Philadelphia.

Mathematics faculty and the Dean of the Division of Science, Mathematics and Engineering Technologies are starting a mathematics intervention program for minority students. The CCP students will be able to complete a newly designed two-course differential calculus sequence in one semester less than is normally required. Students who have sufficient skill in algebra to take the new calculus sequence will be identified with appropriate screening tests. It is expected this program will route more students into the calculus sequence track early in their college careers. It will improve their mathematics skills. Also, it will provide an early opportunity to influence more minority students to consider science or engineering as a life's work.

We speculate that the low percentage of minority students of the 1983 entering class who had graduated by the end of the 1987 summer term is in large part caused by the students' money problems, by the many distractions of living in the urban setting, and by uncertainty about their chances of academic success.

The mentoring program matches each of 40 interested faculty, counselors, and other staff members with no more than five students each. Each group of five students was selected from students who were on academic probation at the end of the 1988 spring term.

So far, mentors have agreed to engage the student(s) assigned to them and to get to know them beyond the professional role each of them normally presents to students. Each mentor in his or her role can become an advocate for and hopefully a friend to the student. Mentors have agreed that they will encourage the student, as appropriate, to make use of all the professional services and people available to help, such as teachers, counselors, academic and financial advisors.

At present, mentors see that their main job is to put their academic, career and life's experiences to work for the student to assist the student in coping with academic, adjustment, bureaucratic and, at times, even money problems. There will be periodic opportunities for all mentors to meet for the purpose of comparing the experiences they have had and the progress they have made with their assigned students.

We found during the 1987-1988 school year that it was not easy to engage students and to persuade them to "buy into" the mentoring program. For the 1988-1989 school year, the group of students on academic probation was selected, for two reasons. It is hoped that the student on probation will see a mentor as being sincerely interested in him or her as an individual. And, working with students on academic probation, to retain more of them and assist them in formulating and achieving their career goals, presents the mentors with a real challenge.

As of October 1, 1988, mentors have been assigned to the selected students. At the end of the Spring 1989 term, there will be measures of what the mentors—and their students—have accomplished.

**APPENDIX**

## Minority Education Initiative Program, 1988-1989

### Community College of Philadelphia

I. **Goals and Objectives**
The goals and objectives of the Minority Education Initiative Program are:

A. To *develop appropriate strategies* with participation throughout the College community for the purpose of increasing the enrollment and retention of minority students;

B. To establish a *minority recruitment and retention program* addressing the academic, financial, student activities, and support service needs of minority students; and,

C. To establish *staff development activities* to sensitize faculty and staff to minority student issues and the need for their assistance in helping to increase minority enrollment and retention.

II. **Implementation of Initiatives**
The implementation of initiatives should be in four areas: academic achievement, financial aid, student activities, and recruitment.

A. **Academic Achievement**

1. Recruit a group of faculty, staff, and adult students to participate in a *minority mentoring program* to help in increasing minority student achievement.
   Target Student Population: 200 students, both traditional and adult.
   Goal: To establish mentoring matches between 200 students and 50 faculty, staff and student mentors.
   Plan of Action: The faculty coordinator and program assistant will promote this program throughout CCP and be responsible for setting up matches in the following areas: Financial Aid's Guaranteed Student Loan (GSL) program, Counseling Center, and the English Department (unaffiliated courses).
   Timetable: September 1988, matches established; December 1988, matches reviewed; May 1989, program reviewed and evaluated to determine if revisions are necessary.
2. Establish, through the Counseling Department, *career development/life planning courses*, and an *orientation experience* emphasizing minority student participation.
   Target Student Population: 100 students, both traditional and adult.
   Goal: to have 100 students enrolled in career development/life planning courses and an orientation program during the 1988-1989 academic year.
   Plan of Action: The Counseling Department will offer the career development/life planning courses and a preregistration experience for both the Fall 1988 and Spring 1989 semesters. Students will be referred and identified by the Admissions and Recruitment Departments. The Department Head of Counseling, the Dean of Student Life, and the Director of Recruitment will be responsible for implementation.
   Timetable: June, July and August 1988, the orientation will be offered; September 1988-December 1988, and January-March 1989, the career development/life planning courses will be offered; May 1989, the offerings will be evaluated and revised as appropriate.
3. *Recruit minority students to assist freshmen minority students* in becoming acclimated to CCP.
   Target Student Population: 100 students, both traditional and adult.

Goal: To assist 100 students in becoming acclimated to CCP through meeting and working with a host of student groups.
Plan of Action: The administrative assistant will recruit and organize ten Black and Hispanic student hosts. This group will meet with and recruit minority students to provide an overview of the college and tour of facilities and share with the students their personal perspective of the college.
Timetable: August 1988, host group will be recruited and organized; September 1988-May 1989, host group will provide support services; May 1989, service will be evaluated and reviewed as appropriate.

4. [1]Set up *faculty and staff training workshop* to address the need for CCP's staff and faculty to establish an atmosphere in which all students, regardless of race, gender, socioeconomic background, language, disability or sexual orientation can develop their full potential.
Target Student Population: All students.
Goal: To establish a series of faculty and staff workshops for faculty and staff to address some issues particular to working with ethnic and racial minorities.
Plan of Action: An Academic Division and Student Affairs Area will sponsor four staff development sessions, beginning in November 1988, for 50 interested staff, faculty and administrators.
Timetable: September 1988, an introduction and promotion of the sessions will take place; October-December 1988, four sessions will be offered; January 1989, evaluation of the program will occur and appropriate recommendations made for additional training.
5. Develop a *high school linkage program* to increase the interaction between College faculty and minority high school students. This activity would be designed to encourage greater academic achievement for minority high school students.
Target Student Population: 75 Philadelphia high school students who are planning to attend a postsecondary institution.
Goal: To provide counseling, academic advising, and career development at an inner-city high school for students who are planning to attend college.
Plan of Action: Staff will offer the career development/life planning course recently developed by the Counseling Department at a selected high school site for high school students. The Director of Recruitment and the Vice President for Student Affairs will make necessary arrangements and contact public school officials.
Timetable: August 1988, contact made with public school system and high school selected; September 1988-December 1988, first course offered for 35-40 students; January 1989, second course offered for 30-35 students; April-May 1989, program will be reviewed and evaluated.

B. **Financial Aid**

1. Establish special *financial assistance programs* for the following student populations: students not eligible for PELL grants, campus-based aid, and subsidized Guaranteed Student Loans (GSL); and students in need of emergency grants for such expenses as transportation, child care, and textbooks.
Target Student Population: 100 students for 1988-1989 who are in need of special financial assistance because of emergencies and inability to purchase college supplies.
Goals: To provide 100 special emergency grants to students in financial need.
Plan of Action: To establish an emergency grant program for students after a need has been established by the Office of Financial Aid and/or the Counseling Department.
Timetable: August 1988, guidelines for programs developed and funding assigned; September 1988-April 1989, program will be implemented; May 1989, program will be evaluated and reviewed.

[1]Potential for outside funding

2. Establish a *student career development employment program* at CCP to enable financially-needy minority students to be hired as paraprofessionals, in order for them to develop a link with the college, gain work experience, and receive some financial support for educational expenses.
   Target Student Population: 10 students who are in need of employment and financial assistance.
   Goal: To establish a student career development employment program for 20 CCP students to provide these students with appropriate work experience and financial support.
   Plan of Action: The Office of Job Placement would implement a program that will provide career development/employment positions for college students. These students would receive a job at CCP along with training and career development.
   Timetable: August 1988, design program guidelines, approve guidelines and seek funding, promote the program and seek potential candidates; September 1988-May 1989, implement the internship program; June 1989, evaluate the program and make appropriate revisions.

C. **Student Activities**

1. Establish a *minority leadership lecture series*.
   Target Student Population: 300 students, both traditional and adult.
   Goal: To provide five lectures by minority leaders, to be attended by 300 students.
   Plan of Action: The Office of Student Activities will seek out and schedule five minority leaders with national reputations to meet, lecture and interact with the students. There will be a special emphasis to have meetings between the leader and small groups of minority students for an exchange of ideas.
   Timetable: August-September 1988, contact presenters and schedule program; October 1988-March 1989, have lecture programs; May 1989, evaluate program and plan for 1989-1990.
2. Recruit *prominent minority members of the Philadelphia community* to mentor minority student leaders.
   Target Student Population: 20 traditional students.
   Goal: To provide a mentoring relationship between outstanding minority members of the Philadelphia community to mentor student leaders within student activity clubs and other organizations. (We would like to recruit five prominent minority members of the Philadelphia community).
   Plan of Action: The Student Activities Office will identify five prominent minority leaders in Philadelphia to mentor the assigned students. The office will also recruit and supervise the matching after developing program guidelines.
   Timetable: August 1988, guidelines and program design will be completed, and mentors recruited; September 1988, matches will be made; December 1988, matches will be reviewed and revised, if necessary; April 1989, program will be reviewed and evaluated and revised where appropriate.
3. [1]Initiate *special leadership training sessions*, emphasizing minority student participation.
   Target Population: 50 traditional and adult student leaders of CCP clubs and organizations. (Target student population: traditional.)
   Goal: To have two leadership training workshops for 50 students to provide leadership training.
   Plan of Action: Office of Student Activities will provide the workshop leaders and recruit the student leaders for the two workshop sessions that will prepare students to take leadership roles in clubs, organizations and in their jobs.
   Timetable: September 1988, leaders recruited and selected; October 1988, workshops will be presented; December 1988, workshops will be reviewed and evaluated for appropriate changes.

D. **Recruitment**

1. [1]Solicit outside funds to establish a *minority high school recruitment program* supported by a college scholarship for academic performance. This program would be used to attract talented

[1]Potential for outside funding

[1]Potential for outside funding

minority high school students to CCP.
Target Student Population: 10 talented minority high school students.
Goal: To provide an academic scholarship to 10 talented minority high school students to attend CCP.
Plan of Action: Office of Recruitment will develop the guidelines for this program and actively recruit the high school students eligible for this program.
Timetable: September-October 1988, develop guidelines and requirements for the scholarship; November 1988, seek funding; December 1988-April 1989, promote the scholarship while recruiting at high schools; May 1988, award scholarship to talented students from area high schools; June 1989, review program and revise as appropriate.

2. Present *career development/life planning seminars* for minority adult students at the main campus and various community sites. These seminars would be promoted and facilitated by a College staff member interested in working with adult minorities in the community. This program could be tied in with the GED program, church and community organizations, local unions, businesses and corporations.
Target Population: 200 adult students interested in attending college.
Goal: To provide career development/life planning seminars for 200 adult students at various community sites and the main campus to provide vital information for continuing these students' education.
Plan of Action: The Recruitment Office will work with appropriate academic areas to present the career development/life planning seminars at various community sites and the main campus. These presentations will be made by members of the Counseling staff to various churches, community organizations, unions and business corporations throughout the academic year.
Timetable: September 1988, schedule the seminars on campus and in the community; October 1988-May 1989, implement and offer the seminars; June 1989, evaluate program and revise as appropriate.
3. Promote *internal recruitment* emphasizing special efforts to recruit from within CCP where there may be large groups of minorities, for example, from the West Philadelphia Regional Center.
Target Student Population: 250 students who are currently enrolled in CCP. (Targeting the West Philadelphia Regional Center.)
Goal: To recruit students who are in CCP to encourage their continued enrollment. Targeting efforts to attract adult minority students from the West Philadelphia Regional Center to the main campus.
Plan of Action: Recruitment Office will meet with the staff of Community Service Area and develop a plan for internal recruitment. The recruiters will work with the Community Service staff to implement that plan for 1988-1989 school year.
Timetable: August 1988, planning meeting with Community Service staff; September 1988, internal recruitment plan completed and implementation begun; September 1988-May 1989, internal recruitment plan carried out; June 1989, impact evaluated and appropriate revision made.
4. Develop *networking and recruitment program* with community-based agencies and minority churches, to attract minority adult students.
Target Student Population: 200 students served by area agencies and churches interested in enrolling in college, both traditional and adult.
Goal: To set up a networking program with area community agencies and churches in order to attract adult students to CCP.
Plan of Action: Office of Recruitment will develop a plan for networking with area agencies and churches, implementing the plan by contacting appropriate community members to present the educational opportunities of CCP for agencies' staff and for their clients, including working with the area church groups.
Timetable: September 1988, agencies and churches will be contacted by the Office of Recruitment; November 1988, schedule will be established for visits and contacts; November 1988-May 1989, networking will be implemented; May 1989, program will be reviewed and evaluated.

5. *Recruit adult minority role models* to assist in recruitment visits and presentations to minority adults throughout Philadelphia.
   Target Population: 200 adult residents of Philadelphia.
   Goal: To have recruitment presentations for 200 adult residents of Philadelphia by CCP staff members and area minority role models during the 1988-1989 academic year.
   Plan of Action: The Recruitment Office, the Vice President of Student Affairs, and the President will work together to secure minority role models to volunteer to work with the recruiters. These volunteers will work with recruiters to make recruitment presentations at area community sites for adult residents.
   Timetable: September-October 1988, recruit volunteer minority role models; November-December 1988, presentations will be scheduled; December-March 1988, presentations will be carried out with volunteers and members of the recruitment department.
6. Implement an aggressive *recruitment plan for the West Philadelphia Regional Center* emphasizing contacts with community agencies and schools in West Philadelphia.
   Target Student Population: 100 adult and traditional students.
   Goal: To aggressively recruit students for the West Philadelphia Regional Center by contacting and working with community agencies and schools in West Philadelphia.
   Plan of Action: To have the Recruitment Office and the Community Service staff work closely to develop and implement an aggressive recruitment plan for the West Philadelphia Regional Center.
   Timetable: September-October, 1988, the Recruitment Office and the Community Services staff develop recruitment plans for the West Philadelphia Regional Center; October 1988-April 1989, plans are implemented.

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# SOME INSTITUTIONAL COMMITMENTS NECESSARY FOR INCREASED MINORITY PARTICIPATION IN ENGINEERING, SCIENCE, AND TECHNOLOGY

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Over the past 20 years, a significant effort has evolved to increase minority (Black, Hispanic, and American Indian) participation in the science, engineering, and technology (SET) professions. This effort has been sponsored mainly by American industry and spearheaded by organizations such as the National Action Council for Minorities in Engineering, Inc. (NACME), the National Association for Minority Engineering Program Administrators, Inc. (NAMEPA), the National Association of Precollege Directors (NAPD), and the National Consortium for Graduate Degrees for Minorities in Engineering, Inc. (GEM).

In addition, many institutions throughout the nation have developed college-based minority engineering programs (MEPs). MEPs are designed to enhance the recruitment and retention of the underrepresented minorities in engineering curricula at the college level.

To increase the awareness among the middle and senior high school students of SET professions, precollege programs have been created. These precollege programs exist on the regional or state level, such as California's Mathematics, Engineering, and Science Achievement (MESA) Program and the Southeastern Consortium for Minorities in Engineering (SECME); within localities, such as the Philadelphia Introduction for Minorities in Engineering, Inc. (PRIME) and the Detroit Area Pre-College Engineering Program (DAPCEP); and on college campuses, such as the Manhattan College Pre-Engineering Comprehensive Achievement Program (PRE-CAP). A primary objective of the precollege programs has been "to support and encourage minority youth to feel that they can aspire to college or difficult subjects like mathematics and science." These organizations (DAPCEP, PRIME, SECME, MESA, PRE-CAP, NAPD, NAMEPA, NACME, GEM, and the MEPs) form the *pipeline* that identifies, guides, and prepares underrepresented minorities, from the elementary school years through graduate school, for careers in all levels of SET professions. As a consequence, Black student enrollment in freshman engineering classes increased from 2.8 percent in 1972 to approximately 6.0 percent in 1986, and Hispanic student enrollment in freshman engineering classes increased from 2.9 percent in 1973 to 4.3 percent in 1986. Disappointingly, the 1986 American Indian freshman student enrollment remained at less than 0.5 percent.

The retention of minorities in engineering curricula remains a problem. Nationally, about 30 percent

of the Black student freshman engineering class achieves the baccalaureate degree in engineering, as compared to an approximately 70 percent completion rate for the entire freshman class. The high attrition rates for minorities in engineering are evident in the fact that, as of 1986, minorities are still significantly underrepresented in the SET professions. Blacks employed in engineering and science made up 2.5 percent of the total population of all the professions, underrepresented in comparison to their 12 percent share of the U.S. population. Hispanics represented only 2 percent of the engineering and science professions, and American Indians employed in engineering and science were only a fraction of a percent of the total population employed in SET professions. Hence, the SET professions and the engineering graduating classes in the United States are predominantly populated by Anglo males, a racial/ethnic group which is at about its saturation point for producing SET professionals. The percentage of females earning bachelor's degrees in engineering rose from 2.3 percent of the class in 1975 to approximately 15 percent of a much larger class in 1985. Of females receiving bachelor's degrees in engineering in 1985, 18 percent were minority women. Since 1985, the numbers of women earning the bachelor's degree in engineering have leveled off or even decreased. So, female participation in engineering is on the decline, even though more than half of all college students are female.

There will be a decreasing pool of college-age youth in the United States over the next 20 years, and in that decreasing pool, the percentage of minority youth will increase. A 6 percent decline in the college freshman class size has already occurred between the fall of 1982 and the fall of 1987, and a further decline to a 25 percent decrease is expected by the turn of the century. Demographics predict that by the year 2020, 43 percent (23 percent Hispanic and 20 percent Black) of American school-age youth will be minority, as compared to 1982 when only 24 percent of youth ages 6-7 were Black or Hispanic. As a consequence, the United States will have an ever-increasing shortage of trained SET professionals. With current demographic trends it is predicted that by the turn of the century, excluding the occurrence of economic disaster, there will be a shortage of 450,000 science and engineering professionals in this nation.

Minority youth remains the great untapped resource for future SET professionals. The tasks associated with preparing an adequate number of minority youth in both academic and scholarly areas [see below] to enter college engineering and science curricula are very complex. These tasks are in the domain of the precollege effort and will most likely remain uncompleted in the near future. America's universities, recognizing the national need for increased minority participation in engineering and science, must make significant institutional changes and be completely committed to enhancing minority participation in engineering, science, and technology.

## MINORITY STUDENT PREPARATION FOR SET PROFESSIONS

The key to the long-term effort for increased minority participation in engineering and the sciences is to provide our youth with good academic and scholarly preparation at the precollege level. Academic preparation would include thorough and challenging courses in algebra, geometry, trigonometry, biology, chemistry, physics, and reading and writing skills throughout the middle and senior high school years. Scholarly preparation would include orientation to SET professions, motivation toward engineering and science studies, motivation to achieve excellence in the classrooms, study skills, and time management training. The two leading barriers to minority retention in SET curricula at the college level are the lack of motivation toward engineering and science studies and poor preparation in mathematics prior to matriculation. NAPD precollege programs attempt to overcome the deficiencies in secondary education of minority youth by offering academic enrichment programs such as science fairs, industry tours, advice, and counseling. In 1987, NAPD programs served more than 40,000 students enrolled in more than 1,000 schools throughout the nation. One can imagine, however, that this is only a fraction of the available student population in the nation or of those minority youth who would eventually matriculate in a science or an engineering college curriculum.

The challenge facing the university is the retention of minority students who have not been exposed to academic enrichment programs at the precollege level and who have deficiencies in secondary school

mathematics and science. Hence, the university is faced with a dilemma: to provide a significant number of minority students with access to careers in engineering and science, the admission of minority students may have to be differential with respect to the majority freshman student population. A measure of the significance of the differential may be shown by comparing the 1987 Scholastic Aptitude Test (SAT) mathematics scores by ethnic groups (see Table 1).

**TABLE 1**

**Math SAT Averages by Ethnic Groups and Average Math SAT Differentials from Anglo Testees***

| Ethnic Group | SAT Math Score | Differential (%) |
|---|---|---|
| **American Indian** | 432 | -11.7% |
| **Asian American** | 521 | 6.5% |
| **Black** | 377 | -22.2% |
| **Hispanic—Mexican American** | 424 | -13.3% |
| **Hispanic—Puerto Rican** | 400 | -18.2% |
| **Anglo** | 489 | 0.0 |

* Source: The College Board

In all cases, the average SAT mathematics scores for the underrepresented minority groups are less than those of the majority (Anglo) student population. These mathematics SAT scores for minorities do represent an increase: Black students had the largest increase between 1977 and 1987 of any ethnic group, with a 20-point gain on the average mathematics score. A mathematics SAT score is not suggested here as the only achievement factor to consider for admission to college programs in engineering and science; other achievements such as high school grade point average (GPA), extracurricular activities, community service, or interest in SET professions may be more important factors to consider in the admission of minorities to engineering and science curricula. For minority students to be competitive in the college classrooms, however, their academic and scholarly achievements will have to be somewhat comparable to the majority student population.

Comparable academic achievements, high school GPAs, and mathematics SAT scores between the majority and a significant number of the underrepresented minority groups, however, should not be expected in the near future. In the meantime, many colleges and universities must establish intensive retention programs for minorities in engineering.

## MINORITY ENGINEERING RETENTION EFFORT: THE NEEDED INSTITUTIONAL COMMITMENT

### The Minority Engineering Program (MEP)

In response to the need to recruit and retain minorities enrolled in engineering curricula, many engineering schools in the nation have established MEPs. In the NACME 1987 annual report, about 160 engineering schools with minority retention programs were supported by NACME Field Service and retention grants or incentive grants. Typically, the MEPs are based in the engineering school to provide specific comprehensive support for minority students. An effective MEP will have the following components (Landis, 1985):

- Tutoring
- Advice and counseling
- Minority engineering student organizations
- Career guidance
- Work experience and cooperative/summer internships
- Precollege summer program orientation
- Faculty involvement
- Adequate financial aid/scholarships
- Reduced academic schedule load when appropriate
- Effective recruiting/admissions policies to increase overall minority enrollment
- Minority engineering role models
- Commitment of administration
- Extensive personal contact with students

The existence of MEPs can be credited for the improvements in minority engineering retention and graduation rates that have occurred over the past 15 years.

Most of the MEPs are understaffed and undersupported by their institutions. Typically, institutional support for MEPs is less than 30 percent of the total program budget. The program is normally managed by one full- or part-time director, often with little clerical assistance. In addition, MEPs have to fight for the most precious commodity of all at a university: space. Financial resources to support staff, program services, and student scholarships of the MEPs must be obtained through external (corporate and foundation) solicitations. The MEP staff typically may spend 30 percent of its time soliciting external organizations for program support. For MEPs to be completely effective in minority recruitment and retention, these programs must be institutionalized at all engineering schools. The Office of Minority Engineering Education (OMED) at the Georgia Institute of Technology is institutionalized and enjoys the following benefits:

| *OMED Staff* | *Staff Activities* | *OMED Financial Support* | |
|---|---|---|---|
| *Full-Time Director* | *Student Services - 50%* | *Institutional/State* | *80-90%* |
| *Full-Time Assistant Director* | *Program Development - 30%* | *Industry* | *10-20%* |
| *Full-Time Clerk* | *Fund-Raising - 20%* | | |
| *Industry Loan Executive* | | | |

As a result of this institutionalized support, which includes financial assistance, use of facilities, and staffing support, Georgia Tech graduated 79 minority engineering students in 1987 as the seventh-largest producer of minority Bachelor of Science engineering graduates in the nation.

***"The existence of MEPs can be credited for the improvements in minority engineering retention and graduation rates that have occurred over the past 15 years."***

## Modified Admissions and Controls

Effective recruiting and admissions policies for minorities in engineering schools are necessary components of any MEP. Any minority admission policy must not exist solely to increase the overall minority enrollment, however. The admissions policy must be tied to the retention program. At Penn State, as with many engineering schools, minorities are admitted to engineering differentially with respect to the majority of the freshman class. In Fall 1987 more than 95,000 students were enrolled in freshman engineering classes at institutions throughout the nation. Of this number, 6,100 were Black. However, a 1987 NACME report concludes that half of the Black students with combined SAT scores greater than 1,000 are available annually to pursue engineering (Landis, 1985). This amounts to only 4,600 students (College Board, 1988). The remaining Blacks entering freshman engineering classes have combined SAT scores less than 1000, whereas the typical majority freshman student entering our top engineering schools may have a combined SAT score of 1100 or more. Hence, minority student admission policies for engineering schools must be designed to account for a possible differential in precollege academic and scholarly achievements of minority and majority students.

The most probable consequence of an uncontrolled admission of minority students in engineering programs is academic failure. Summarized in Table 2 is the distribution of SAT scores, and in Table 3 the high school GPAs, of all students and of Black students enrolled in the general chemistry course at Penn State's University Park campus in the Fall 1986 semester.

Table 2 shows that 68 percent of all students enrolled in the freshman general chemistry class had a mathematics SAT score between 600 and 800, whereas 68 percent of the Black students had a mathematics SAT score between 400 and 600. Table 3 shows that 62 percent of all students enrolled in the freshman general chemistry class had a high school GPA greater than 3.5, whereas 66 percent of the Black students had a high school GPA between 2.5 and 3.49. Listed in Table 4 is the final grade distribution in the freshman general chemistry course from Fall 1986.

Based on evaluations of Black student performance in general chemistry and calculus classes, it was concluded that differential admission of Blacks and other minorities in engineering and science at Penn State's University Park must be controlled. In addition, the existing placement tests for mathematics and chemistry are being changed and updated. A remedial chemistry course to prepare for general chemistry, available to all students, has been officially established. The proposed new admission criteria for minorities in engineering and science is:

**Table 2. Math SAT Scores***

| SAT Scores | All | Black |
|---|---|---|
| 700-800 | 16.3% | 5.9% |
| 600-699 | 52.0% | 13.7% |
| 500-599 | 26.8% | 35.3% |
| 400-499 | 4.6% | 33.3% |
| 300-399 | 0.4% | 11.8% |

**Table 3. High School Grade Point Average (GPA)***

| High School GPA | All | Black |
|---|---|---|
| 3.50-4.00 | 62.3% | 16.0% |
| 3.00-3.49 | 31.1% | 34.0% |
| 2.50-2.99 | 5.7% | 32.0% |
| 2.00-2.49 | 0.8% | 18.0% |
| 1.50-1.99 | 0.0% | 0.0% |

**Table 4. General Chemistry I Final Grades***

| Grade | All | Black |
|---|---|---|
| A | 14.7% | 2.8% |
| B | 28.6% | 16.7% |
| C | 37.3% | 33.3% |
| D | 11.2% | 22.2% |
| F | 8.2% | 25.0% |

*Tables 2-4: Students enrolled in general chemistry. Fall 1986. Penn State.

- Minority students admitted differentially in engineering and science at Penn State's University Park campus will be required, without exception, to begin in the summer session prior to the regular fall matriculation. A specially supervised program of academic preparation will be conducted for these students during the summer session. This specially supervised academic program will continue

during the fall and spring semesters of the freshman year. Participation by these students in the complete program is mandatory.

- Minority students not admitted differentially in engineering and science at Penn State's University Park campus will be encouraged to attend an academic enrichment summer program before the fall semester of the freshman year. Attendance in this program is not mandatory, however. The normal advising and counseling offered by university counselors and the MEP will be available to these students during the academic year.

These changes in admissions, testing, and counseling are necessary at Penn State so as to improve minority retention in engineering and science programs. Institutions must be strong in their commitment to the minority retention effort and be willing to change to effect progress.

### Special Training in Study Skills and Time Management

To address deficiencies in learning and study skills commonly found among many college freshmen, the College of Engineering at Penn State has established a special course: Engineering 297, Learning Skills and Time Management. It is well known in educational psychology that *learning how to learn*, via good learning strategies based upon fundamental psychological processes, will greatly improve learning. Additionally, many researchers suggest that such learning strategies should be learned in high school. Since 1985, more than 200 undergraduates have enrolled in Engineering 297, and not one student has had a prior course, lesson, or seminar on learning how to learn! This is a serious deficiency in educational policy.

*"Since 1985, more than 200 undergraduates have enrolled in Engineering 297, and not one student has had a prior course, lesson, or seminar on learning how to learn! This is a serious deficiency in educational policy."*

The Engineering 297 course was developed to address learning skills problems that could be affecting minority student retention in engineering. The course is a combination of lectures, video and film case studies, and workshops using the Ellis (1985) text. Topics covered in the 15-session course are listed in the Appendix.

## CONCLUSION

The 1973 goal of increasing minority participation in engineering and science by tenfold in ten years was not achieved. Since that time, however, both the enrollment of minorities in engineering curricula and the graduate rates of minorities in engineering and science has increased significantly. The retention of minorities in engineering, however, remains a serious problem. There is a desperate need to increase minority participation in the SET professions. For continued improvements in minority graduation rates in engineering and science to occur, a greater effort will be required at the precollege level to improve the academic and scholarly preparation of minority youth for engineering and science. This is the only long-term solution to increasing the pool of minorities available to pursue degrees in engineering and science. In the meantime, engineering schools must be fully committed to supporting special minority retention programs.

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## APPENDIX

**Engineering 297: Learning Skills and Time Management**
**Course Outline**

| | | |
|---|---|---|
| **Session 1** | (1) | Textbook and how it works |
| | (2) | Quiz files |
| | (3) | This syllabus and what you have to do and why |
| | (4) | Video—*A Step to Tomorrow* |
| | Assignment: | Chapter 1, *Master* text. "First Step," and "Study Smartly" Pack. |
| **Session 2** | (1) | Review key parts of Chapter 1 and how the *Master* text works |
| | (2) | Review Study Smartly Pack and major ideas |
| | (3) | Quiz 1—pp. 31-32 |
| | Assignment: | Chapter 2, "Time Management." |
| **Session 3** | (1) | Quiz 2, pp. 61-62 |
| | (2) | Importance of time management |
| | (3) | Time charts/scheduling |
| | (4) | Time and engineering courses and other activities |
| | Assignment: | Chapter 3. "Memory." Books will be collected for check-in on Chapters 1, 2, and 3. |
| **Session 4** | (1) | Memory strategies |
| | (2) | Improving memory |
| | (3) | Rote learning? Memory experiments |
| | (4) | Turn in texts for check-in |
| | (5) | Quiz 3, pp. 85-86 |
| | (6) | Film, *Human Memory and How It Works* |
| | Assignment: | Prepare a 1- or 2-page essay on learning problems or problem courses for class discussion. |
| **Session 5** | (1) | Chapter 4. "Reading and Reading Skills." work on text exercises in class |
| | (2) | Discussion: learning problems to date |
| | Assignment: | Complete Chapter 4 on reading. Start Chapter 5 on note taking (at least half), pp. 110-121. |

| | | |
|---|---|---|
| **Session 6** | (1) | Muscle reading—a basic strategy |
| | (2) | Why consider reading? |
| | (3) | Note taking—what the research says |
| | (4) | Complete Chapter 5 in class |
| | (5) | Quiz 4, pp. 107-108 |
| | (6) | Video, *Reading Skills and College Study* |
| **Session 7** | (1) | Quiz 5, pp. 131-132 |
| | (2) | Note-taking strategies |
| | (3) | Good note-taking approaches, Spargo's *Handbook* |
| | (4) | Video, *Reading a Lecture: Basic Note Writing Strategy* |
| | Assignment: | Chapter 6, "Test and Test Preparation." Books will be collected for check-in on Chapter 4-6. |
| **Session 8** | (1) | Testing and preparation |
| | (2) | Test anxiety (state vs. trait anxiety) |
| | (3) | Cramming—and why you should avoid it |
| | (4) | Quiz 6, pp. 157-158 |
| | (5) | Video: *Test-Taking Methods: Distribute Your Practice* |
| | (6) | Turn in text for check-in. |
| **Session 9** | (1) | Creativity and college work |
| | (2) | Chapter 7 in class on creativity |
| | (3) | Your ideas on creativity |
| | (4) | Film, *Creative Problem Solving* |
| | Assignment: | Complete Chapter 7, "Creativity," and Chapter 8, "Relationships." |
| **Session 10** | (1) | Quiz 7, pp. 181-182; Quiz 8, pp. 201-202. |
| | (2) | Chapter 9, "Health Issues and Success in College" (in class) |
| | (3) | Video. *Self-Fulfilling Prophecy—Attitude and Success* |
| | Assignment: | Prepare a one-page outline for your final project paper. |
| **Session 11** | (1) | Chapter 11, "Support Services and Available Resources." Start in class, complete exercises |
| | (2) | on your own. |
| | (3) | Review what we have learned to date. |
| | Assignment: | Turn in texts for final check, Chapters 7-9. |
| | | Final project. Complete Chapter 11. |
| **Session 12** | (1) | Quiz 9, pp. 277-278 |
| | (2) | In-class work on final projects |
| | Assignment: | Final project. |
| **Sessions 13, 14, and 15** | (1) | Presentation of final projects |
| | (2) | Related discussion at Observation Television Studio. |

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# SPECIAL PROJECTS FOR BLACK WOMEN

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Spelman College is a historically Black liberal arts college for women with an enrollment of 1700. The College is a member of the Atlanta University Center consortium of six institutions of higher learning. The student body is national in character, with 70 percent coming from states other than Georgia. The College is recognized nationally for the strength of its academic program and its success in preparing graduates for leadership positions in the professions, government, business, and community service.

The proportion of minority women scientists and engineers is well below what would be expected from demographic data. In 1986, women constituted 15 percent of employed scientists and engineers in the United States. Of this group, approximately 5 percent were Black, 3 percent were Hispanic, and less than 1 percent were American Indian. Thus, minority women constituted less than 2 percent of the Nation's science and technical labor force.

Spelman College is committed to increasing the number of qualified Black women entering science and engineering careers. Two of the special programs conducted by the college to achieve this goal are the Prefreshman Summer Science Program and the Women in Science and Engineering (WISE) Scholars Program.

## PREFRESHMAN SUMMER SCIENCE PROGRAM

The Prefreshman Summer Science Program, developed in response to the poor representation of science and mathematics majors at Spelman, has been held at the college every summer since 1972. The most recent funding sources are the National Aeronautics and Space Administration (NASA) and the Public

Health Service. There have been years, however, when funding was furnished solely by Spelman College. The program was always considered an integral part of the science program. Originally designed as both a recruitment and a retention activity, it has emerged as a retention and an advancement effort.

High-ability Black women science majors are at high risk during the freshman year. They suffer from the usual college adjustment problems and may have additional problems such as (1) ineffective study skills and habits, (2) serious background gaps in their education in science and mathematics, (3) a financial need to work, and (4) low self-esteem. The summer program alleviates the severe loss of students between entrance and the sophomore year.

The Prefreshman Summer Science Program is an eight-week residential program for approximately 40 students. The academic component of the program consists of classes taught by faculty from Spelman and other Atlanta University Center institutions. Students take biology or chemistry, mathematics, reading, and computer science, each with a laboratory. In addition, instruction is given in problem solving and test-taking skills. Classes are intensive, and the academic experience is demanding and challenging.

Small group and individual tutorials are conducted in the evenings and on Saturdays by undergraduate tutors, usually alumnae of the program. Tutors also assist in laboratories, in counseling activities, and in weekly quiz bowls in every area.

The counseling component is designed to increase awareness of science and engineering, to acquaint students with various careers, to motivate and encourage students to stay in science majors, and to provide a balance of activities for student well-being. Professional scientists and engineers, including women, are invited to give career talks such as "Opportunities in Computer Science" and "Careers in Engineering." They also give scientific presentations that provide an introduction to different fields of study. Typical topics are "Atmospheric Chemistry" and "Recombinant DNA Technology." Students participate in other activities such as a national conference on Black women's health issues, a trip to an observatory, a visit to a medical school, and a visit to the Marshall Space Flight Center.

Each student receives a certificate of award at a closing ceremony with parents present. Special awards are given to the winners of the quiz bowls.

An examination of the outcomes of participants in the 1976 and 1985 summer programs provides a measure of the program's success. Of the 47 participants in the 1976 program, 42 returned to Spelman in the fall, and more than half of them received advanced placement in mathematics. The 17 summer students who were placed into Analysis I or Calculus constituted only 17 percent of the enrollment, but they earned 89 percent of the *A* and *B* grades given at the end of the semester. Of the 32 students who graduated from Spelman, 25 earned degrees in science and engineering (see Table 1). Of these students, 11 are now physicians, 4 are dentists, 1 has a Ph.D. in mathematics, 2 are engineers, and 3 are computer scientists (see Table 2).

In the 1985 summer program, 46 of the 50 participants enrolled as freshmen, and 83 percent received advanced placement in mathematics. As of last year [1987], 41 students were still at Spelman, 34 of whom were studying science or engineering. Table 3 gives the statistics on the number of students majoring in different fields from 1985 to 1986.

Spelman College has reached a stage in which science and mathematics are highly visible on the campus and is experiencing growth problems in the science program. While maintaining emphasis on the Prefreshman Summer Science Program, the Division of Natural Sciences has begun to develop new programs to produce graduates of exceptional strength who will seek graduate degrees.

## WOMEN IN SCIENCE AND ENGINEERING (WISE) SCHOLARS PROGRAM

The WISE Scholars Program was initiated in 1987 as a cooperative venture among Spelman College, NASA, and a select group of exceptionally promising students. The program provides scientifically talented women from groups underrepresented in the scientific and technical workforce with the opportunity to pursue undergraduate studies in science and engineering in the highly motivating and supportive environment of Spelman College.

**Table 1. Degrees Received by the 1976 Summer Participants**

| Subject | Number |
|---|---|
| Biology | 13 |
| Chemistry | 1 |
| Computer Science | 2 |
| Engineering | 2 |
| Health/Natural Science | 5 |
| Mathematics | 2 |
| Social Sciences | 5 |
| Other | 2 |
| Total | 32 |

**Table 2. Occupations of the 1976 Summer Participants**

| Occupation | Number |
|---|---|
| Engineer | 2 |
| Computer scientist | 3 |
| Mathematician | 1 |
| Physician | 11 |
| Dentist | 4 |
| Total | 21 |

**Table 3. Majors of the 1985, 1986, and 1987 Summer Participants**

| Major | 1985-86 Number | 1986-87 Number | 1987-88 Number |
|---|---|---|---|
| **Science and Engineering** | 44 | 38 | 34 |
| **Other** | 2 | 5 | 7 |
| Total | 46 | 43 | 41 |

Scholars are actively recruited and are selected by a competitive process. Preference is given to students residing close to NASA centers. Selection criteria include high potential and achievement in science and mathematics as measured by college entrance examinations and grade point averages and an interest in pursuing a career in science or engineering. Scholars are selected by a committee of Spelman faculty and

staff, the NASA center's Equal Opportunity Officer, and the NASA agency-wide Federal Women's Program Officer.

The success of the Prefreshman Summer Science Program can be seen in the movement of Spelman from an institution with little emphasis on science to one with a significant number of students majoring in science and engineering (Table 4) and graduating with science and engineering degrees (Table 5).

There are 13 sophomore and 15 freshman scholars. Each scholar is sponsored by a NASA center. The chief Equal Opportunity Officer and the Federal Women's Program Officer at the NASA installation have a primary role in the development of the student. The NASA centers and the number of students are listed in Table 6.

Scholars are required to pursue majors in electrical or aerospace engineering through the Dual-Degree Engineering Program, with the other degree being in physics, mathematics, or other scientific or engineering field related to the mission of NASA and the work of the sponsoring NASA center. In the Dual-Degree Engineering Program, a student spends three years at Spelman and two at Georgia Tech, Rochester Institute of Technology, Boston University, or Auburn University and earns degrees from both Spelman and the engineering institution.

**Table 4. Science and Engineering Majors**

| Major | 1973-74 | 1980-81 | 1987-88 |
|---|---|---|---|
| Biochemistry | | | 18 |
| Biology | 120 | 198 | 216 |
| Chemistry | 15 | 27 | 65 |
| Computer Science | 7 | 76 | 136 |
| Engineering | 13 | 85 | 82 |
| Health/Natural Science | | 16 | 25 |
| Mathematics | 39 | 49 | 74 |
| Physics | | 2 | 10 |
| Total | 176 | 453 | 627 |

**Table 5. Science and Engineering Graduates**

| Major | 1973 | 1980 | 1988 |
|---|---|---|---|
| Biochemistry | | | 4 |
| Biology | 7 | 27 | 8 |
| Chemistry | 1 | 8 | 8 |
| Computer Science | | 3 | 23 |
| Engineering | | 3 | 3 |
| Health/Natural Sciences | | 4 | 17 |
| Mathematics | 10 | 15 | 18 |
| Physics | | 2 | 3 |
| Total | 18 | 62 | 84 |

**Table 6. NASA Centers and WISE Scholars**

| NASA Center | Number of Scholars |
|---|---|
| Ames Research Center | 3 |
| Goddard Spaceflight Center | 4 |
| Jet Propulsion Center | 2 |
| Johnson Space Center | 4 |
| Kennedy Space Center | 3 |
| Langley Research Center | 4 |
| Lewis Research Center | 4 |
| Marshall Spaceflight Center | 2 |
| Stennis Space Center | 2 |
| Total | 28 |

**Table 7. Grade Point Averages of 15 Scholars**

| Grade Point Average | Number of Scholars |
|---|---|
| **4.00** | 1 |
| **3.50-3.99** | 3 |
| **3.00-3.49** | 9 |
| **2.50-2.99** | 2 |
| Total | 15 |

The students take a strong sequence of science and mathematics courses leading to the specified major. The following courses are required of every participant.

- Honors Analysis I, II (calculus of one variable)
- General Chemistry I, II
- Honors English I, II
- Study Skills and Critical Thinking Seminar
- Analysis III (calculus of several variables)
- Mechanics and Heat
- Electricity and Magnetism
- Fortran or Pascal
- Independent Study/Research

Scholars are given demanding schedules. It is the philosophy of the program that early and effective support will enable students to maintain the academic excellence in the sciences with which they entered. The programs involves risk-taking. It is much more risky to build a program with participants taken at the freshman level than to support juniors who have already demonstrated that they are achievers.

Freshmen take Honors Mathematics at one of three levels and General Chemistry, Honors English, and Study Skills and Critical Thinking Seminar along with other courses that meet general or major requirements. Sophomores take mathematics, physics, and other courses within their interests and needs. Typical schedules for freshman and sophomore scholars are:

| **Freshman Scholar Majoring in Engineering/ Mathematics** (17 Hours) | **Sophomore Scholar Majoring in Chemistry, College Honors Program** (18 Hours) |
|---|---|
| Honors English I | Organic Chemistry |
| Honors Analysis I | Mechanics and Heat |
| General Chemistry | Analysis III |
| Introduction to Engineering | Honors World Civilization |
| Intermediate French I | Honors World Literature |
| Volleyball | Sophomore Assembly |
| Study Skills/Critical Thinking Seminar | |
| Freshman Orientation | |

The second component of the program is counseling and academic support. The Director serves as academic advisor during the crucial first two years and maintains close contact with the instructors in order to intervene, if necessary, to assure student success. Early identification of potential problems in science and mathematics courses is made by requesting a progress report on the students from their instructors before the midterm examinations.

Tutorials are an important part of the Academic Support Program. Tutors are provided for students in mathematics, chemistry, physics, and computer science. Tutors are graduate students or upper-level undergraduates of exceptional ability and achievement. The graduate tutor in mathematics conducts a group session for freshman students who are taking Honors Quantitative Reasoning I, Honors Quantitative Reasoning II, or Honors Analysis I. The session is designed to develop the ability of the students to work in small, productive groups. They generate their own small groups and are given problems to work. The tutor moves from one group to another offering assistance, if necessary for the group to continue working. One benefit has been the tendency for students to continue working together in the dormitory outside the formal session with the tutor. The graduate student is also available at other hours to provide additional traditional tutoring.

In Chemistry, a graduate tutor conducts a required group tutorial session for two hours. Difficult but basic topics are emphasized by the tutor, and questions are taken from the group. The tutor is available also for individual tutoring. In Physics, an undergraduate student who is now at Georgia Tech provides individual or small-group tutoring. The program is using different modes of tutorials in an attempt to determine what works best for the students. One problem that is being addressed is the failure of high-ability students to use tutorial services because of the mistaken but prevalent belief that tutorials are

designed for students of low ability. Therefore, students are required to attend some tutorial sessions and are actively encouraged to use others as a means of enhancing learning.

***"One problem that is being addressed is the failure of high-ability students to use tutorial services because of the mistaken but prevalent belief that tutorials are designed for students of low ability."***

All freshman and many sophomore scholars live in the same dormitory, the Living-Learning Center. A special residential director is available to provide counseling and to give special assistance during evenings, nights, and weekends. Students also attend several group meetings with the Director during the year for assessing progress, determining problem areas, and providing support. Each freshman scholar has a sophomore scholar who serves as her Big Sister. The students are matched by major, and the Big Sister provides advice, support, and friendship.

Freshmen attend a seminar in study skills and critical thinking. Many bright students have not developed good study skills. Topics in the seminar are introduced during the three-day orientation conference for WISE scholars at the beginning of the academic year. The noncredit course meets once a week and covers topics such as study skills, test-taking skills, time management, and techniques for studying the sciences. The seminar is taught by a college counselor and several guest lecturers. Sessions on graduate school have been held, and these efforts will be extended as students advance.

Scholars engage in a 10-week research experience at the sponsoring NASA center each summer. Each student must submit a paper upon return to Spelman and to give a presentation of her work. The following presentations were given in the Fall, 1988 semester:

*Inertial Reference Package*
*Detector Array*
*Computer Research at Stennis*
*Fuel-Rich Catalyst Combustion*
*Investigation of Space Adaptation Syndrome*
*Computer-Aided Design for Large, Advanced Space Systems*
*The Attitude Heads by Display Prototype*
*Controlling Indoor Air Pollution*
*Zirconium Ignition Test*
*Thermal Cycling Effects on Crack Densities on the Space Station*

Each semester, a woman scientist or engineer from NASA spends two days on campus as the NASA Lecturer. She gives several talks and conducts an informal session for the WISE scholars. Through the visits, a strong statement is made that women can achieve academically in science and engineering and can achieve success in technical careers.

Scholars receive scholarships that cover 80 percent to 100 percent of the direct costs of attending Spelman College. The promotion of scholarship aid that is not restricted by guidelines for financial need is important as the College seeks to encourage more talented minority students to follow successful paths in science.

Scholars are required to make successful progress toward the major and to earn a grade point average for the year of 3.0 to remain in the program.

An early evaluation based on the outcomes of the first year indicates that the program is successful. Thirteen of the original 15 scholars are still in the program. Table 7 gives the grade point average breakdown of the 15 students; the average grade point average of the returning students is 3.3.

Fourteen scholars made the honor roll at least one semester last year, and 11 made the honor roll both semesters. Two students were among the 15 Atlanta University Center Dual-Degree Engineering students of all levels who received outstanding student awards at the Annual Awards Banquet. Seven students received honor pins at the affair. There is a sense of enthusiasm and success among the sophomore

students. The program has enhanced their interest in science and engineering careers and has increased their confidence in their ability to attain such a career. The WISE scholars are mature, self-reliant, and determined young Black women who will become the scientific and technical leaders of the future.

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# TEACHER TRAINING AND IMPROVEMENT IN SCIENCE

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The shortage of United States citizens trained in areas of science, engineering, and technology is rapidly reaching alarming proportions. Research facilities and universities are finding it increasingly difficult to staff science positions with Americans. To exacerbate the problem, fewer American students are expressing an interest in pursuing degrees in quantitatively based fields, and far too many students leave the nation's elementary and middle schools with an inadequate foundation in mathematics and science (National Science Board Commission on Pre-College Education in Mathematics, Science, and Technology, 1983). This lack of preparation translates directly into a deficiency in science and mathematics when these students emerge from high school.

The problem of inadequate science and mathematics preparation is particularly acute for minority, female, and disadvantaged members of the population who are located in large urban school systems. Far fewer members of these groups take science courses than their Anglo male counterparts. However, census data predict that today's "minority" students will be in the majority in the public school systems by the year 2010. Thus, intervention programs designed to increase the interest in science by all segments of the American student population are needed urgently if the United States is to avoid the rapidly approaching

date when sensitive research positions requiring the highest levels of security clearance will have to remain unstaffed.

Whereas a number of intervention programs exist that are designed to increase interest and proficiency in science for students, few programs are targeted at improving the ability of precollege-level science teachers to teach basic science concepts in a manner that is both interesting and fun for students. The importance of working with teachers as well as students is evident when the potential impact of the intervention is considered. When 20 students participate in a program, 20 students are impacted. When 20 teachers participate in an intervention, however, each teacher can convey the excitement of science to 25-30 students every year for the remainder of her or his career. Hence, 20 teachers can impact upwards of 5,000 students over a 10-year period. Teacher improvement programs are thus quite cost-efficient and have the potential to make a significant impact on potential students of science.

*"When 20 students participate in a program, 20 students are impacted. ....However, 20 teachers can impact upwards of 5,000 students over a 10-year period."*

Furthermore, it has been demonstrated that a successful approach to improving science education at the high school and university levels is the involvement of instructors in research activities with practicing scientists (Vivio, 1985). The enthusiasm generated during the research project is carried back to the teachers' classrooms, and they are able to make their subject matter more alive and interesting for all students in their classes. Elementary and middle school teachers are no less eager to interact with scientists in an effort to improve science teaching in their classrooms.

With the above statistics and research findings in mind, the Alabama A&M University Department of Chemistry embarked upon a project to train elementary and middle school teachers on how to teach science in a manner that is interesting and exciting. In 1984, with financial and technical assistance from Lawrence Livermore National Laboratory (LLNL), Alabama A&M hosted the first of a series of annual science workshops for elementary and middle school teachers. The workshops held at Alabama A&M are modeled after the Lawrence Livermore National Laboratory Elementary Science Study of Nature Program (LESSON). The LESSON Program was begun in 1969 as a Laboratory outreach activity that would address the problem of the underrepresentation of residents of the San Francisco Bay Area communities, especially minorities and women, among the technical staff members at the Laboratory. The LESSON activities at that time consisted of visits by laboratory scientists and engineers to elementary and middle school classrooms in the Bay Area. The program was highly successful, and it was difficult for the Laboratory to fulfill all of the requests for speakers. The LLNL personnel realized that a more efficient way to impact students was to train teachers on how to make science exciting in their own classrooms. Hence, in the summer of 1974 the first teacher workshop was held by the Laboratory. The workshop was an instant hit with teachers, and has been held at the Laboratory each summer since 1974.

As stated earlier, the workshops at Alabama A&M University are quite similar in goals and activities to the Livermore Laboratory workshops. The overall design and implementation of the workshop activities are discussed in detail below.

## THE PROBLEM

The science education literature has long reported the lack of attention given to teaching science in the elementary and middle school classroom (Houk & Borchert, 1986). Although there are several reasons for this neglect of science, the two reasons most often stated by teachers are: 1) an inadequate background in basic science concepts, making teachers uncomfortable with teaching science, and 2) the severe shortage

or complete lack of materials that can be used for demonstrations and student activities in the classroom. The Science Improvement Project (SIP) workshops at Alabama A&M are designed to address both of these concerns.

## PROJECT GOAL

The overall goal of Project SIP is to increase the number of elementary and middle school students who have the interest and ability to pursue a quantitative career.

## PROJECT OBJECTIVES

The specific objectives of Project SIP are:

1. To teach basic science concepts in the areas of biology, chemistry, physics, electricity and magnetism.

2. To provide teachers with science lessons and low-cost science experiments that can be done easily in the classroom.

3. To increase the interaction between North Alabama scientists and elementary and middle school teachers.

4. To increase the amount of hands-on science experiences provided to North Alabama elementary and middle school science students.

5. To increase the number of minority and female students who actively engage in science activities in the pre-high school classroom.

## PROJECT ACTIVITIES

The activities designed to meet the objectives stated are described below.

### Annual Summer Workshop

A 40-hour workshop for 25 elementary and middle school science teachers is held at Alabama A&M University each summer. The teacher participants are selected from those who respond to the workshop announcement circulated during the spring. The 1988 Project SIP workshop was the fifth in the series. The workshops are held for four hours each day over a 10-day period. A typical workshop schedule is shown below.

***Day 1*** *Introductory Activities and Pretest*
***Days 2-3*** *Biology Activities*
***Days 4-5*** *Physics Activities*
***Days 6-7*** *Electricity and Magnetism Activities*
***Days 8-9*** *Chemistry Activities*
***Day 10*** *Individual Teacher Presentations, Closing Activities, and Posttest*

The introductory activities consist of an overview of Project SIP, from its origins at LLNL to the present, the 40-item pretest covering content material from the workshop areas and a fun hands-on science activity that gives the teachers a preview of activities to come. (A copy of the "Think Ink" activity is provided in the Appendix.) The teachers who attend the workshop also receive a large notebook referred to as the *LESSON Manual* on the first day. This is a large three-ring binder that contains three lessons covering the four science areas of the Project (Lawrence Livermore National Laboratory, 1986). Each lesson contains a set of objectives, background information for teachers, worksheets for students, and science activities that can be performed at home. After the first day, the teachers are usually quite excited about the workshop, and often ask if they can bring an additional teacher for the remainder of the workshop.

The next eight days of the workshop consist of presentations by scientists in the content areas, interspersed with conducting the experiments that are described in the manual. On the first day of each new subject area, the teachers are given a large box (referred to as a *kit*) that contains all the materials necessary for conducting the activities in that area. For example, the biology kit contains such items as a small microscope, an empty plastic bottle for making a model of a lung, materials for making a cell model, etc. At the conclusion of the workshop, teachers have four kits containing approximately $400 worth of materials for them to use in their classrooms. The scientists who present the content material to the teachers include a wide range of scientists from throughout the area such as Alabama A&M University professors, scientists from the NASA Marshall Space Flight Center, personnel from the University of Alabama at Huntsville Energy Education Center, and scientists from the Army Missile Command at Redstone Arsenal. Thus the teachers have the opportunity to interact with a wide variety of science professionals whom they can use as future resource persons when they return to their classrooms.

### Follow-Up Activities

After the teachers have returned to their classrooms, periodic visits are made to ensure that they are using the materials in the most effective manner, and to give guest lectures to their students. The follow-up visits are an excellent time for the teachers to request additional materials, and for them to "show off" how well they and their students are doing with science.

## PROJECT EVALUATION ACTIVITIES

The Project SIP evaluation activities include components that are designed to evaluate the effectiveness of the workshop as well as the implementation of the materials into the individual classrooms of participants. The workshop evaluation consists of the 40-item pre- and posttest measures of actual cognitive gains of the participants and an evaluation form to ascertain the effectiveness of the workshop in meeting the stated objectives. Each year of the workshop the cognitive gains of the participants have been impressive. The pretest average is approximately 15 out of the 40 items, and the posttest average is usually around 25-30. The exact gains have been statistically significant at the 0.01 level for each of the five years of the workshop. Additionally, the participants have awarded the workshop an average score of 9.8 out of a maximum 10 for its overall effectiveness. This compares to an average of approximately 7.5 for all in-service workshops provided to teachers by the Huntsville City Schools. The teachers have consistently made very positive comments about their workshop experiences. Some of them are listed below.

I can't wait to get back to my classroom to teach science in the fall!
I didn't know Physics could be so much fun!
Every time we got a new box of materials it was like Christmas morning! I couldn't wait to see what was in the next box. I'll be the envy of every teacher in my school.

Evaluations after teachers have been using the materials have included such comments as:

I've never seen my students have so much fun learning science.
Science has changed from the stepchild to the belle of the ball in my classroom!
My students are so excited about science because I'm excited about science!

## PROJECT RESULTS

> *"The future technological needs of the nation require that all of our students be given a science experience that encourages the further study of science and the serious consideration of science as a career. The teacher is the most important part of the process."*

During the five-year lifetime of Project SIP, the philosophy and materials of the Lawrence Livermore Laboratory program have been disseminated to teachers throughout the North Alabama area.

- Over 250 teachers have been introduced to the philosophy and activities of the project.
- Over 6,000 students have used the project materials.
- Over 20 local scientists have been introduced to teachers and students in North Alabama.
- Mentor relationships have developed between scientists and students.

The increasing national interest in the LESSON Program, and the successful implementation of the LESSON Program at Alabama A&M University prompted Lawrence Livermore National Laboratory to hold an HBCU LESSON Conference to introduce other historically Black college and university faculty and staff members to the program. The first national conference was held in January, 1987, with representatives from 13 HBCUs in attendance. The second conference was held in January, 1988. These conferences have resulted in the presentation of LESSON workshops in the Virgin Islands and in Hampton, Virginia. Additional national conferences are planned for the future.

## FUNDING SOURCES FOR PROJECT SIP

The implementation of a workshop such as SIP, which provides materials and information to teachers, requires significant funding. This funding has come from two major sources for the workshops at Alabama A&M University. For the first two years of the project, funding was provided by a grant from the Department of Energy through Lawrence Livermore National Laboratory. The next three years of the project were funded by the Office of Equal Opportunity of the National Aeronautics and Space Administration. The project has also received some support from the Alabama A&M-University of Alabama at Huntsville Regional Inservice Education Center since the inception of the Center in 1986.

A full-scale two-week workshop can be conducted for 25 teachers for approximately $15,000. However, smaller, shorter versions of the workshop can be presented for a nominal cost. Half-day and full-day workshops can be presented to give teachers an idea of what is possible to make science interesting in their classrooms. Possible sources of funding for a small-scale workshop include local businesses and industries, PTA groups, civic organizations, or a nominal fee charged for participation. Alabama teachers have said

that they would have gladly paid to participate in the project, and are quite surprised that the materials and information are free.

## STARTING A WORKSHOP FOR TEACHERS

Anyone interested in conducting a workshop for teachers should first approach the district offices of the school system in which the workshops are to be held. Most district officials recognize the need to improve science teaching, and are quite willing to collaborate on a project. A one-day small-scale workshop is a good precursor to the two-week workshop because most teachers are reluctant to give up two weeks of a very short two-month summer vacation to attend one workshop unless they have a preview of what is to be offered. This "mini-workshop" should be filled with interesting and fun activities. The two-week workshop should involve a number of area scientists who will present the concepts to the teachers at an elementary level, but in a manner that is not condescending. The teachers are very bright and enthusiastic, and should not be made to feel inferior. The materials for the workshop can be obtained from a number of different sources, such as Carolina Biological Supply, Fisher Scientific, Toys *R* Us, etc. Currently, an independent supplier in California is determining the feasibility of supplying complete kits, but the details have yet to be finalized.

## CONCLUSIONS

Teacher workshops are an effective way to improve the quality of science education at the elementary and middle school levels. Teachers are interested in doing more and better science activities with their students, but they need to be shown techniques and given materials with which to be more effective science teachers. Excited science teachers produce students who are excited about doing science. The future technological needs of the nation require that all of our students be given a science experience that encourages the further study of science and the serious consideration of science as a career. The teacher is the most important part of the process.

The Alabama A&M University Science Improvement Project has successfully trained over 200 teachers to be innovative and effective in their science classes. The dual emphasis on content and technique provides teachers with the knowledge and materials they need to make science the exciting subject that it should be. The project has demonstrated that scientists and teachers working together can make a difference in the teaching of elementary and middle school science.

## SOURCES AND MATERIALS

A copy of the *LESSON Manual* can be obtained by contacting:

Science Education Center
Lawrence Livermore National Laboratory
Livermore, CA 94550.

Anyone interested in acquiring a complete listing and sources for the materials used in Project SIP can contact:

William O. Raymond
2368 Buena Vista Avenue
Livermore, CA 94550

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## APPENDIX

*Think Ink* Activity

**BY COMMAND—INK**

Effect: Two colorless liquids are mixed and remain colorless. Suddenly, after a definite lapse of time, they change in a flash from a colorless solution to one looking like ink.

Materials: The following solutions:

(1) 12.5 grams of concentrated sulfuric acid dissolved in 125 cc of distilled water.
(2) 2 grams of potassium iodate dissolved in 1,000 cc of distilled water.
(3) A solution prepared by dissolving 2 grams of soluble starch in 500 cc of boiling distilled water, then adding 0.4 grams of sodium bisulfite and 5 cc of sulfuric acid solution (solution no. 1 above).

What To Do: Thoroughly mix equal amounts of solutions (2) and (3) by pouring them back and forth once or twice from glass to glass. After a lapse of several seconds, the colorless liquid changes in a flash to the color of dark ink.

What Happens: When the two solutions are mixed, they immediately react to form sulfurous acid and iodic acid. These then react with each other to form hydriodic acid and sulfuric acid. The hydriodic acid reacts with any remaining iodic acid to release free iodine which imparts the desired color to the solution. Before this can happen, however, the iodine reacts with any unused sulfurous acid to form hydriodic acid. The solution remains colorless until all of the sulfurous acid is used up. Then the iodine reacts with the starch to change the colorless solution to a dark color that looks like ink.

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# PROJECT PRESERVE AND THE DUAL DEGREE ENGINEERING PROGRAM AT XAVIER UNIVERSITY OF LOUISIANA

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My charge on this occasion is to provide you with information about Xavier University, its engineering program, and the *Project Preserve* program with which the university has recently become involved.

## XAVIER UNIVERSITY OF LOUISIANA

Xavier University is a predominantly Black, Catholic-based university located in New Orleans. It was founded in 1915 by Katherine Drexel and the Sisters of the Blessed Sacrament.

Xavier has three major academic units: the College of Arts and Sciences, the College of Pharmacy, and the Graduate School. In all, approximately 2,500 students are enrolled at the university, most of whom are in the College of Arts and Sciences. The College of Arts and Sciences has 31 departments, including the Physics/Engineering Department.

During the past five years, Xavier has received considerable local and national attention as a result of its students' successes in the health sciences. The underlying factors contributing to these successes have

established a basis for projecting expected favorable results with the Project Preserve program. Consequently, it is important to digress for a moment to consider the nature of the not-so-visible factors.

Over the past 12 years, a well-defined and systematic (though evolving) approach to the educational process has been developed in the sciences at Xavier. This strategy encompasses Xavier's philosophical concept of *standards with sympathy* and the pedagogical concepts of Piaget and Arthur Whimbey as applied to student learning and problem solving. From this confluence of concepts have evolved three distinct components to the science teaching process at Xavier, two of which apply directly to the Project Preserve students.

***"The benefit to the student is one of a "second chance" to pursue an engineering career. Coupled with that opportunity is financial assistance, counseling, and presumably a more compatible environment."***

The first component is the summer science program, which focuses heavily on problem solving, vocabulary building, and the development of peer support and cooperation mechanisms.

The second component is the method in which freshman classes in the sciences and mathematics have been structured. In particular, all freshman-level biology, chemistry, mathematics, and most physics classes are taught in a modular approach. This approach provides *students and teachers* with a running account of the students' performance and, consequently, provides for weekly feedback between the students and the teachers. Drill sessions are also a part of this structure and provide an opportunity for students to receive faculty assistance in problem areas. The drill sessions are also the forum in which students take their quizzes and exams.

The third component is the tutoring process. Until recently, a less formalized, although extensive, peer tutoring process encompassing all science courses was in place. With the recent advent of substantial funding from various sources, the tutoring process has become much more formally structured, and it promises even greater successes for the future of students in the sciences at Xavier. The particular formalizing of the tutorial program includes the designation of a full-time person to oversee a major portion of the tutoring effort and to serve as a tutor. In addition, specific sites have been selected for the tutoring, and high-achieving upperclassmen have been contracted to provide peer tutoring services at designated times.

## ENGINEERING PROGRAM AT XAVIER UNIVERSITY

A discussion of the engineering program at Xavier is a precursor to zeroing in on the Project Preserve program itself. Not unlike other dual-degree engineering programs, the program at Xavier offers the 3-year/2-year option. After having completed three years of study at Xavier and two years at an engineering school, students are eligible to receive two degrees: a Bachelor of Arts or a Bachelor of Science degree from Xavier *and* a Bachelor of Science from the engineering school that they attended. Table 1 outlines the Dual-Degree Engineering Program curriculum for engineering students (except Chemical Engineering). Table 2 gives the curriculum for the Chemical Engineering program.

As a means of establishing the viability of the Xavier engineering program, it would be useful to look at some data reflecting students' performances in the program. Over the past nine years, approximately 330 students have enrolled in the program. Of the 278 who have been tracked on the basis of ACT or SAT scores, 94 are currently enrolled at Xavier University (XU), 36 are enrolled in engineering school (ES), 26 have graduated with engineering (GE) degrees, 68 have graduated or are still enrolled in other sciences (OS), 5 have transferred to nonscience (NS) majors, and the status of 89 is unknown (UNK).

Using student ACT scores as a basis for evaluation, Table 3 and Figures 1 through 4 provide the retention profile for students in the dual-degree engineering program (DDEP) over the past nine years. This table and the figures provide information on the retention of students in the engineering program in relation to their ACT or SAT scores upon entry to the program. These data clearly confirm conclusions reached by earlier research at Xavier University, which showed a high degree of correlation between student test scores and student predictability of success at Xavier. Most importantly, the data show that in the worst-case situation, at least 40 percent of those engineering students with ACT scores in the range of 6 to 15 are salvaged in the sciences. This statistic alone exceeds the national average for minority students in the sciences.

It is these "snapshots" of the program that give rise to high expectations for the Project Preserve participants. These expectations are reinforced when we compare the 22 average ACT (SAT) scores of the currently enrolled Project Preserve students, with the historic rate of success of Xavier students with such scores.

## PROJECT PRESERVE PROGRAM

Project Preserve is a program that targets minority students who have had, or are having, unsuccessful experiences in engineering school. The program is underwritten by a grant from the National Aeronautics and Space Administration (NASA). Carole Morning, a former vice president of the National Action Council for Minorities in Engineering (NACME), serves as the principal investigator and Xavier University as the financial/program administrators of the grant. The other universities participating in the project are California State College at Northridge and the City College of New York.

The underlying premise on which the program is founded is that there are institutional and student personality variables that significantly contribute to retention differentials. Suggested among these variables are: student's lack of timely adjustment to the brisk pace of college instruction; failure to receive and/or act upon negative performance feedback on a timely basis; absence of or failure to take advantage of an effective, comprehensive minority engineering support program; problems resolving conflicts between institutional characteristics (for example: size, research vs. teaching orientation, lack of structure) and personality needs; absence of positive professional role models; and lack of access to informal communication, knowledge about the prevailing culture, and other information related to how one best survives and prospers in a given environment.

The institutions selected to participate in this project are believed to have an understanding of these factors and a commitment to manifesting instituting institutional structures which will contribute to the amelioration of the concerns cited.

The selection and participation of students in the program requires their willingness to transfer to one of the participating universities for approximately two years. After those two years, a student who is progressing satisfactorily may remain at the Project Preserve school or transfer to another university (including, possibly, the original school of residence) to complete their degree program.

As a program participant, a student must meet the following conditions:

1. The student must be a member of an underrepresented minority group in engineering (American Indian, Black, or Hispanic).

2. The student must be, or have been, enrolled in an institution that grants engineering degrees.

3. The student must be on academic probation, suspended status, or in an academic position that precludes his or her continuance in engineering.

The benefit to the student is one of a "second chance" to pursue an engineering career. Coupled with that opportunity is financial assistance, counseling, and presumably a more compatible environment.

Six students are participating in the program at Xavier. Two of the students are from out of state. The other four transferred from schools within the state of Louisiana. All the students have ACT scores above 18, and only one has an ACT score below 22.

Xavier is currently authorized to accept 25 students into the program; however, this may change if the demand supports an increase and the results confirm the viability of the program.

## SUMMARY

The Project Preserve program, much like other programs at Xavier, represents a commitment by the university to the national effort to increase the participation of minorities in the sciences and engineering. The successes in the health sciences and the experiences gained therein, are now being translated to other areas of the sciences and engineering. A cooperative effort among faculty, and between faculty and administrators, has contributed significantly to the development and implementation of other programs in the sciences and most recently to the Project Preserve program. Taking into consideration all of the factors cited above, it seems reasonable then that a retention rate approximating 75 percent is achievable—with students who might otherwise have completely deserted the engineering profession.

## Table 1. Dual-Degree Engineering Program (DDEP)
(Except Chemical Engineering)

| Course | 1st Semester (Hours) | 2nd Semester (Hours) | Title |
|---|---|---|---|
| **FRESHMAN YEAR** | | | |
| Physics 1120-1120 | | 4 | General Physics with Calculus (lab) |
| Physics 1060 | | 2 | Engineering Graphics |
| Mathematics 1030-1070 | 4 | 4 | Pre-Calculus/Calculus I |
| English 1010 | 3 | 3 | Composition & Rhetoric/Composition & Literature |
| Speech 1010 | 3 | | Speech Fundamentals |
| Chemistry 1010-1020 | 4 | 4 | General Chemistry (lab) |
| Total Hours | 14 | 17 | |
| **SOPHOMORE YEAR** | | | |
| Physics 2110-2120 | 4 | 4 | General Physics with Calculus (lab) |
| Mathematics 2030 | | 3 | Linear Algebra |
| Mathematics 2070-2080 | 4 | 4 | Calculus II-III |
| Computer Science 1030 | 3 | | Fortran |
| History 1030-1040 | 3 | 3 | World Civilization |
| Soc. Sci. or For. Lang. | 3 | 3 | Social Science or Foreign Language |
| Total Hours | 17 | 17 | |
| **JUNIOR YEAR** | | | |
| Physics 3010/3120 | 3 | 3 | Electricity & Magnetism/Network Analysis |
| Physics 3210-3020 | 3 | 3 | Mechanics-Statics/-Dynamics |
| Physics 3310 | 1 | | Advanced Laboratory |
| Physics 3510 | 1 | | Seminar |
| Mathematics 3030 | | 3 | Differential Equations |
| Theology | 3 | 3 | Theology Sequence |
| Philosophy 3040/3250 | 3 | 3 | Logic/Philosophy of Science |
| Music or Art/English 2010 | 3 | 3 | Music or Art/World Literature |
| Total Hours | 17 | 18 | |

**SUMMARY**

| | |
|---|---|
| Physics | 28 |
| Mathematics | 22 |
| Computer Science | 3 |
| Chemistry | 8 |
| English Composition | 6 |
| World Literature | 3 |
| Music or Art | 3 |
| Philosophy | 6 |
| Theology | 3 |
| Speech | 3 |
| World Civilizations | 6 |
| Soc. Science or Foreign Lang. | 6 |
| Total Semester Hours | 100 |

## Requirements for the B.S. or B.A. Degree in Physics (four years)

| B.A. Degree in Physics | | B.S. Degree in Physics | |
|---|---|---|---|
| DDEP curriculum | 100 hr | DDEP curriculum | 100 hr |
| Modern Physics | 3 hr | Modern Physics | 6 hr |
| Advanced Engineering Courses | 28 hr | Thermodynamics | 3 hr |
| | | Physics/Optics | 3 hr |
| | | Advanced Engineering Courses | 21 hr |
| Total | 131 hr | Total | 133 hr |

## Table 3. DDEP Enrollment Data, 1979-1988 (9/17/88)*

| ACT or SAT Scores | XU | ES | GE | ER | OS | NS | UNK | Totals |
|---|---|---|---|---|---|---|---|---|
| **ACT 25-30 SAT 1110-1330** | 8 | 5 | 5 | 4 | 0 | 0 | 1 | 23 |
| **ACT 20-24 SAT 890-1070** | 31 | 11 | 7 | 11 | 2 | 0 | 16 | 78 |
| **ACT 16-19 SAT 710- 850** | 25 | 7 | 6 | 13 | 2 | 3 | 36 | 92 |
| **ACT 6-15 SAT 400- 670** | 26 | 3 | 6 | 9 | 3 | 2 | 36 | 85 |
| Totals | 90 | 26 | 24 | 37 | 7 | 5 | 89 | 278 |

*As of 9/17/88: 278 students (out of 334) have been tracked on the basis of ACT or SAT scores.
**XU**—Currently enrolled at Xavier University; **ES**—currently enrolled in engineering school; **GE**—graduated with engineering degrees; **OS**—graduated or still enrolled in other sciences; **NS**—transferred to nonscience majors; **UNK**—status unknown; [**ER**—returned to engineering school].)

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# WHAT WORKS AND WHAT IT TAKES

**Howard Adams, Ph.D.**

**Executive Director**
**National Consortium for**
**Graduate Degrees for Minorities in Engineering, Inc.**

*Dr. Howard G. Adams is Executive Director of the National Consortium for Graduate Degrees for Minorities in Engineering, Inc. (GEM). He received his Bachelor of Science degree from Norfolk State University, his Master of Science degree from Virginia State University and his Ph.D. from Syracuse University. Adams has been involved all his professional life in education, from teaching, in the Norfolk City School System, to Vice President for Student Affairs and Director for Alumni Affairs at Norfolk State University. In demand as a lecturer and consultant, he has spoken at more than 100 colleges and universities and has presented papers at national conferences across the country. He is a member of the board of the Relations With Industry Division of the American Society of Engineering Education, and the Council on Economic Priorities. He serves currently as a member of the U.S. Task Force on Women, Minorities and the Handicapped in Science and Technology. In recognition of his work in the Minority Engineering Effort, Adams has been awarded the National Society of Black Engineers Torch Bearer Award. He has been listed in the 21st edition of Who's Who in the Midwest and the Fifth Edition of Who's Who Among Black Americans.*

Thank you.

I thought I would talk about a couple of things. They wanted me to tell you something about what it takes to get students out of graduate school with degrees, and I am going to talk about that, because that is what we do. Also, I wanted to share with you a little bit about how I deal with students, because that is what I do. I talk to students—under the tree, in the garage—I will find students to talk to almost anywhere. Students do not want to talk to you, because they want to know, "Who is this guy who just comes in here?" They are out there talking under the tree, and I just go interrupt them and say, "Come here, let me talk to you." So I thought I would give you a little thumbnail sketch of how I do that.

But first, I would like to tell you that this is being brought to you through the courtesy of the GEM Program that pays my salary.

I always thought I would win the students by trying to say, "Can we talk?" You have to get the kids' attention, to say, "Let's talk about something. Let me tell you about graduate school." And you get, "We don't want to talk about graduate school." So I try to get their attention, and I tell them we are going to focus on Ph.D. and M.S. degrees. I just start with some questions: "Did you know... ?" which was a famous question of Dr. Brooks, a president of Norfolk State University. He would always start off with, "Did you know?" "Did you know that Norfolk State is doing this," or "Did you know that (something, something)?" So I thought that was a good question to start with.

I tell the students about the fact that it is free, what the numbers look like, and something about what

the rewards are. I have their attention by then, and I say, "Okay, now we are going to try to give you some facts so you do not have to fear anymore." Because most of the time when I am talking to students, they say, "Well, I don't know whether I can do that or not." Everybody is always afraid. So I say, "Okay, let's take care of that. The reason that I know you can do it is that I have already looked in the crystal ball, and I have asked myself some questions, and you can do this if you really want to do this. You can go to graduate school. But if you are going to, you have to get on the ball. All right?" By the time I get through that little scenario, the students are having some fun, and I can actually get into a presentation and talk to students about how to go to graduate school.

If I am talking to Black students, I simply tell them that it does not look good. That always gets a shocked reaction. In fact, in a ten-year period, Blacks have lost ground. We have been talking, through this entire symposium, about all of the exciting things that we are doing, and we are doing some great things. But the numbers look bad—the numbers of Blacks obtaining graduate degrees in science and technology are going down. So, all of the things that we are doing have not resolved this issue, at least. We have 26 percent fewer Blacks getting Ph.D.s in 1986 than we had in 1976. This is just a horrible thing! I think that all of us have to relate this fact over and over again. We have to show that, because that is what the problem is. All of the people who are talking about all of this money that we have—it does not get to these students.

That is what it takes. It does not take any of the other stuff. You do not have to ask the kids whether their grandmother read to them when they were babies, what side of the tracks they slept on, whether their daddy was home—none of that stuff. What you have to have to go to graduate school is some money. That is what they start with. If you do not have any money, you do not go to graduate school. And in the sciences, graduate school is free. It is a well-kept secret that in the United States you do not have to pay to go to graduate school in the sciences—it has always been free. Anyone you see who paid to go to school in the sciences does not have anything on the ball. As a matter of fact, they are embarrassed to hold up their hands when you ask. It does not cost anything. And that word has not gotten around to minorities and women, specifically. They do not know that.

Then I try to give the students some sense of what the numbers look like, just in terms of graduation rates, period. I tell them about the number of people, overall, who have high school diplomas, the number of people who have no degrees whatever. Then you get down to the doctorate, where it just looks bad, period. There are not enough people of any kind getting doctorates in science and technology, but when you look at it for Black folk, it looks even worse. And the kids are just shocked when you say that. But I always have to point out, because I am talking to mixed audiences, that Anglo folk are not doing very well, either. You know, we do not have to feel as bad as we think we have to—because they are not doing very well, either. So, they are not getting the word, either. If we can get the word to them, then some of it will spill off the table and we would get a part of it.

## WHY DO SO FEW BLACKS GET PH.D.'S IN SET FIELDS?

Why is it that the students are doing so poorly? One of the reasons is that *we lose ground as we progress*. Blacks got 2.7 percent of the B.S. degrees in engineering. Then the numbers drop off to about half of that at the master's level, and as we progress to the Ph.D. level, we have only a small percentage of that. So when you talk about the pipeline leaking, if we go all the way back and take 100 minority students who were in high school in the 9th grade, we would know that about 70 percent of those would finish high school. Then something like about 28-29 percent of those would go off to college. We would get about half of those in fact graduating, with about half of those thinking about going to graduate school. Then sometime later we would get some percentage—less than 1 percent—who would actually get a doctorate. So we just lose ground. In engineering, these are the reasons why we do so poorly.

The underrepresentation at the graduate level in engineering is due strictly to these things, and they are facts, but they are very explainable through *strong recruitment activities by industry*. And everybody wants to blame industry. A B.S.-level recruiter gets paid to recruit people. You can't get mad at the Bell Laboratories people because they come to the campus to recruit. If they do not recruit anybody, they lose

their jobs. They are very good at recruiting—that is what they do. At the University of Michigan a couple of years ago when I was there, IBM was recruiting that day. They brought 27 recruiters and took over the whole ballroom. They passed out soft drinks, gave everybody name tags, sent you anywhere to talk to anybody you wanted, and told you where you could work all across the country. I was the only person on the whole campus that day talking about graduate school. Two weeks ago, I was at the University of Oklahoma, and 47 recruiters were there on Saturday morning for breakfast to talk to students. I was the only person in the whole room to talk to kids about going to graduate school. And yet what we do is we allow ourselves to write a report that says we could not find anybody. My attitude is that you ought to get fired for doing that, but you do not, you get promoted. In fact, the Affirmative Action people are just as bad—they do the same thing. They write a report to explain away why this does not happen.

*They do not really know what the advantages are of having advanced degrees.* The word is out that they do not pay. We always tell the stories about some person with a Ph.D. in physics who drives a taxicab in New York City. I always tell the truth—that person would have been a failure, anyway. We are not talking about that person. When we look at salary scales, we see that it is not true that advanced degrees do not pay. We do not make a case for the Ph.D.—we say it is not needed in your career as an engineer. And we know that that is not true any more. We are scaling it on Anglo males who have been in the workforce for 25 or 30 years. When they went to work, you did not need an advanced degree. But the turnaround time today in technology is much shorter. We cannot wait ten years for you to come up to snuff. If you are sending a B.S.-level engineer out there, they are going to get lost. There are not many places for them today. They can get a job, but they will not have a career. The turnaround time is too swift for that.

*There has been a shift in interest.* Most of the students think that if they go get an M.B.A., they are going to get up on the top floor. "Just punch the button when I get it, and, boom, I'll go right to the top floor and get in as a manager." And they really do not know what a manager is all about. We have to talk about that. What do you mean by "management?" The Vice President of Engineering is a manager. The Vice President of Research and Development is a manager. A section head is a manager. All these people are people who are on the technical side of the business, and we have not done a very good job of talking about that.

*They perceive that there is no funding available.* We can't give the money away! Every dean, when I hit the campus, the first thing they start pumping me with is, "Oh my God, I wish you had been here yesterday, I had all this money." So, now that I know they are going to tell me that, I always find myself a student before I get in his office, so I can have the student sitting by the door. As soon as he tells me that, I say, "Let me go out here in the hall and get this student that you can meet, because you don't know each other." I almost made the man at UCLA have a heart attack, because he came in telling me, "Oh, my God, I wish you had been here, we had all this money." I said, "Wait a minute, I've got a student out here beside the door." I went out and got the student. "Let me introduce you," I said. "Young man, this is the Dean, he just told me he had some money. If he does not give you any, you call me collect, and we'll find out why he did not give you some money."

*They do not know what area to go into.* Everybody worries, "If I go to school I'm going to major in the wrong thing." I always have to tell kids that, a lot of times, when they ask if you have a master's degree, they do not ask what it is in. They want to know whether you have one, and whether you have a Ph.D. You are a whole lot better off having one in Tiddlywinks, and being able to explain why you got it in the wrong field, than if you did not have one at all. So we really have to get kids together. They think that you are going to be overqualified, that you are very narrowed or overspecialized if you go to graduate school.

*And they definitely do not understand the financial aid procedures for graduate school.* We have some factors about the institutions themselves. These are things that we have to work on, and these are policy issues at both the national and the local levels.

*People do not know that graduate admissions are controlled by the department. We* select the people that we are going to admit. It is totally different from undergraduate school, almost totally controlled by the department. Although the graduate school might screen people, those applications in fact go to the department. So if you do not know how to play the game about getting in, or finding out how to do that, you probably will not get in. They do not have a systematic procedure for recruiting. We take whoever shows up.

If you want to know why there are so many foreign students in graduate school, it is because they show up. If I was sitting in China, and I was trying to get to the United States, the best way to go would be for me to go to graduate school. In fact, the only thing it costs is a one-way ticket over here—it does not cost you anything to go once you get here. Those countries do not have the same kinds of schools that we have. What they do is just pack people up with a little grip case and say, "Listen, you go off to MIT. You five go to Michigan. You go to Berkeley." You pick up the application thing, you will find out that there are five to ten graduating from all of our schools. Those countries are just beating us to death, competitively, because they send their people over here. They know it is free, it does not cost anything. We have to make a case for that.

I think minority people in particular almost have to get angry about it. I have to remind people, I was born *here*. My grand-daddy was born here. My great-grandfather was born in the United States. I get angry that you can come over here and get all this money. I have been here all the time, and I cannot get any. And I cannot go over there and get it. You know, yesterday the students tried to beat me up when I was at Prairie View A&M University. African students ran up to me, and the Iranian students—they wanted to know, "Why is this just for minority students?" I said, "When we get so we can go over there, and get some of your money, we'll give you some over here." They all got off my case in a hurry. And I was not embarrassed to have to say that. That is a fact, that we cannot go over there to get any money. They have a lot of oil; they do not give us any. Okay, so, when we can go over there, I think that is when we will have to talk about that.

## WHAT DOES IT TAKE?

What does it take to be successful in getting a graduate degree? If you are going to be successful, *the first thing you have to have is funding so you can go full-time*. Most minority students, even in the sciences, attend part-time. In engineering, the percentage of minority students who go part-time is overwhelming. But you want to go to school full-time at the graduate level. You have to be a full-time student, very visible, working in the department, that kind of thing.

You need *a mentor*. You do not get out of graduate school unless somebody kicks you out. You have to have somebody who says, "I'm going to get you out of here." Once you find that person, doors just open for you. It becomes very smooth, people think you are intelligent, you get a copy machine, you get somebody to type your dissertation for you, you get all of the keys. I have to say to people, when I go out to the campuses, "I do not see minority students with keys." As a matter of fact, at Notre Dame, I used to get up and say that, and they finally got embarrassed and started giving some Black folks some keys. Because I told them, "I don't ever see anybody but myself—I'm the only one who has a key around here." If you cannot get in the building, you cannot do your work. You have to have a key, and the key comes with funding. Because if a professor gives you some money, he is going to give you a key so you can get in to do your work. Without any money, you do not get a key. You have to come only when the building is open.

You need to support the things that colleagues do. It is *collegiality*, feedback, that you have to get, and you cannot wait six months to get it. You need that feedback on a constant kind of basis. If you tie it to the department, generally you meet once a week to talk about what you are doing. You talk about your research, you talk about what the problems are. Minority students just do not get tied into that. You have to have a department that will claim you. And you can't be treated like you are special. When you come in on soft money, you are on the outside looking in.

One of the things that we do with the GEM program, we try to make sure we *get the students tied to the department*. The first day, we will not even pay you until somebody—they might be lying, but somebody has to sign off and say that they have seen you, that you have gotten a program of study together. If you do not have one, you are supposed to call us and tell us, "They wouldn't talk to me." A lot of times that happened to us.

**Question from the floor:**

Is there any way they can take care of that during the early admissions procedure, before they get there?

That is what we are trying to work on, and that is what we ought to be doing. But the information that we need is not very well understood. One of the things that we are doing with this program is trying to write some information on how to do these steps. I just finished a piece on how you do the application process. How do you really sell yourself on the application? How do you find a mentor when you get there? How do you get hooked up, how do you get tied down? Yes, we have to do that. And you ought to know this information ahead of time. But they do not know that.

Students ought to know what the admissions process is on the campus, and how to get a mentor. You might not know exactly who that person is going to be—you will not always know that, starting off—but you ought to know at least how the process works on the campus. Do they do it like at Georgia Tech, for instance, in the fall of the year? Each quarter, professors go in and have seminars to explain what their work is. Graduate students are invited. You go in and find out who the people are who seem to be working in your area, and then you go talk to these people. Minority students, if they are not tied to the department, might not go to those seminars. So, by the time you discover what you ought to be doing, you are already a quarter behind. You have to tie that down. That is what I am talking about.

So, where are we then with minority students? And, particularly, let us reflect on this and the role GEM tries to play. I say that minority students trying to find some funding is like looking for a needle in a haystack. That is about what it is like. We hear a lot about the kind of funding that is available, but it really does not get to minority students. They have a hard time identifying the funds. The reason that is true is that the funds that tend to support graduate education are tied to a professor, on a research project, and tied to the department. The funds come primarily as RAs—research assistantships. And in science and engineering, if you really want to be successful, you need to get an RA, because you have to do some research work.

Let's look at this as it breaks out. I was fascinated when I got this information on the doctoral recipients in the sciences last year, from the National Science Foundation. This is *university support—in terms of fellowships, assistantships, etc.* Foreign students got 76 percent of their support from the universities—76 percent. Black students got 29 percent. This is what flowed out of the university; it did not come from some outside source. This is what you want to get, if you want to be successful. This is the kind of money you need. This is going to ensure you having a paper published, a dissertation topic, laboratory equipment, a key to the copy machine, typewriters, study carrels—all of the things that make you successful. You want to know why foreign students graduate? They are tied down from the day they get here. You want to know why minority students do not? They get their money from outside the university. Even when it comes from the National Science Foundation, they are not tied to the department.

They changed the rules last year. We have been beating on them a long time about that. I get up in meetings—and people think I am crazy, because I would talk if Jesus was in there—I just get up when they are talking. I always have my transparencies. I keep mine with me all the time, so when they come up with one of these silly things, I can go get mine and put it up on the overhead projector. "Wait a minute, hold it, that ain't true. Let me get up here and put this data up here." I put it in my reports, too. I always name the National Science Foundation as one of the bad sources. They do all this talking, but the rules are poor. Their policies are very poor. They call me to ask me, "Please take that out of your report, we just changed the rules on that. We will adjust that." But if you do not tie this down, it does not work very well.

## THE GEM PROGRAM

Let me talk quickly, then, about what we are doing. I run something called the GEM Program. We do not ask students who their mother was, we do not ask them where they came from, what side of the

track, we do not ask them whether somebody rocked them when they were a baby. What we want to know is, "If we give you some money, will you go to class every day, study real hard, and graduate?" Now, you have to ask that question, but you have to put a little bit of stuff in there. Because, I tell the students, "If you do not graduate, I will break your arm off, if you take my money. And do not call me and tell me that the goat ate your paper. If you can't keep your paper from the goats, don't have no goats. I don't need to know that you and your girlfriend broke up, or boyfriend broke up—that might happen to you. If you can't sort out the difference between going to class, being successful, and having a relationship with somebody, don't have one. Particularly if you are going to take my money. I need a graduate in a hurry."

Right now, we have 55 universities that belong to the consortium. Students get a portable fellowship that they can take and go anywhere they want to go that they are admissible. And by and large, they are admissible anywhere they want to go, because our students graduate—you can't do any better than that. There are 61—well, the data has changed in the last two weeks, and I have not had a chance to update that. It is 63 now—we have had 600+ master's-degree people graduate, 15 Ph.D.'s, and we gave 156 awards last year. Currently there are about 230 students in the program. Our completion rate is 86 percent of the students we spend money on, and we do not even ask them any of those questions that people ask. We just want to know, "Do you want to go to school?"

This is in engineering, now, it is not one of those little funny majors. It is engineering, it is real tough, and we tell students that you are supposed to graduate in a year and a half. The going rate is two years. Our students finish in a year and a half. They get mad with me because I tell them they have to take 12 hours. The going rate is 9. Our students pass 12 hours, at the best schools in the country, and they walk—on time.

You say, "Well, okay, what do you mean when you say, 'They walk?'" I thought I would bring the graduation rates for you so you could see them. These are real live people, too, these are names. I can tell you where they are. This is Georgia Tech. We had one bad year at Georgia Tech, in 1982-1983. I will tell you about those, because we tried an experiment and it did not work, so we backed off of that.

This is the total number of students who were enrolled and the total number who graduated, and if they did not graduate or did not drop out they just rolled over to the next year. That is all that means. So, 24 students were at Georgia Tech who we were sponsoring, in 1986-87, 17 graduated, and we did not lose anybody. The bad year we had was right here, and three of those people were physics majors. We tried to send physics majors from a small program that was on a semester system, to a quarter system. And we found out it did not work. We can send them to a semester program, but you cannot send them to a quarter program, if they try to change systems. And so they did not make it in that program, and that is the only bad year we had. But if you take those three students out, our graduation rate has been fantastic at Georgia Tech, and that is a good school.

At University of Michigan, you can see we only had one student who did not finish. That was in 1981. Everybody else who has gone there has graduated. Two of those students stayed on and got a Ph.D.—they graduated last year.

These are the data for Cornell University. Out of 41 students who were going to Cornell, we only lost two. We have not lost anybody at Cornell since 1982.

This is Howard University. We have only had one student go to Howard who did not graduate—that was in the first class. Everybody who has gone since has finished.

AT MIT, we have not lost a student since 1980. We had two people get their Ph.D. from MIT last year.

This is Stanford. These are real, live students—live names, working. One of these students came back and has graduated, so we have to change this data. She finished last year and I have not had a chance to change that yet. Nine, six, nobody dropped, everybody walked. All right?

Now what is it about this that makes this possible? Well, let me tell you what the students look like, so you know. We read cold applications from a GPA of 2.7. But we do not merely read at that level. I do not read at a level where I will not pick somebody. So I pick somebody from the lowest point we read. If the committee does not pick somebody, I go back and pick somebody. So we are going to read at 2.7 this year, and there will be at least one person going from 2.7. There might be more. But typically they will pick somebody from below that, so I do not have to worry about it.

We have had people with GPAs from 2.2 all the way to 4.0—and they graduate. Almost invariably, one of the low students gets out faster than the other ones do. For example—he won't even mind me calling

his name—Stacey Brown graduated from the University of Michigan with a shade under 2.5. We sent him to Georgia Tech, and he finished in three quarters. He has gone already. But I told him I would break his arm off if he did not finish before everybody else did, because I did not want them to try to say we were doing something illegal. A young lady who is going to graduate this year with her Ph.D. in Chemical Engineering from Georgia Tech, hopefully in May, went in with a 2.78. And if she stays on schedule, she is going to be the first student in her group, the students that started with her, to graduate with a Ph.D., including the Chinese. She is going to beat everybody out. She is tough, and she is being courted by everybody around the country for a teaching position, because she wants to teach. She has had outstanding credentials. She was invited to China last year to give a paper.

The students look about like this, over a five-year period. About 68 percent have been Black, about 16 percent Hispanic, and out of 100 students, about every other year we will have two American Indian students. About 18 percent of the students come from HBCUs, so you can feel good about that. Thirty percent are female. The overall GPA is 3.3.

## WHAT MAKES GEM SUCCESSFUL?

These are things that we think are important about our program:

1. ***Fellowship supportable.*** With money in hand, people do not start asking those silly questions anymore. As a matter of fact, when they ask silly questions, I tell the students to go some other place. If I go into a school and find out they are waiting around on GREs, I simply tell them to go to another school—do not even wait on that. So we got rid of all those problems. Students are admitted.

If there are problems, I go there and have a little meeting. Usually because I am who I am, and after I have been there a few minutes, people get angry. They want to know, "Well, who does this person think he is, to come up here to tell us what to do?" We will talk a little while longer, and then I say "Well, I am not satisfied with the meeting we have had so far. I travel the country, and I talk to students. I am going to have to tell students not to come here anymore. What do you want me to do?" And they say, "No, we don't want you going around telling them that." And they usually say, "What do you want us to do?" By the time we get through, we have a very good meeting of the minds. If we don't, we cut them off. That is the end of the story.

2. ***Funding that pays tuition and fees.*** We do not ask you whether you are rich or poor, you just get it automatically. That is what it is all about. People are shocked at that. "You mean it is not on an as-needed basis? You could be a millionaire and you would still get the money!" But if you are dirt poor, you would not get any more. We give you the same amount.

3. ***High expectations.*** We do not talk to anybody we do not expect to graduate. We expect them to graduate in the same amount of time, take the same number of courses, and work as hard as everybody else does. If you went in poorly prepared, you have to work harder. And we tell them that.

When they do poorly, if I get back bad grades, I jump on a plane, go to the school, and get everybody in a room. I had to go to Georgia Tech and do that. The students were not doing very well, so I went down, and told them I would be there at 1:00 and I wanted everybody and their grandmother to be there. They were sitting in the room when I got there. I went in there, and I got nasty. I talked like I was crazy. And they were angry. I could see them, you know: "This Black man coming... You don't understand nothing... You're just the worst person in the world." And when I finished I said, "I know you all don't like what I said. I am going to the bathroom, and while I am gone, anybody who does not like what I am saying, you get your stuff and pack up and leave here. If you like what I said, you be here when I come back." When I got back, everybody was still sitting there. "So, all right now, we are going to get these grades up. If you do not, I am going to cut your money off."

I tell you what—they have that meeting themselves now, before I get down there. They get their students together and say, "Listen, this man is serious, he will cut your money off. Do not write him that silly stuff." And I do not have any silly reports. They do what they are supposed to do.

4. ***A practical internship.*** We tell the companies we do not make any excuses. We tell companies, "You show them where the bathroom is the first day, and where to get some lunch, and you put them to work, and make high demands. We do not care whether they have to stay up all night to get it done, but they have to have a legitimate job to do." And so everybody gets a legitimate job in the summertime. If they do not, they call, "Listen, they do not have me doing anything. I know you're going to get angry with me because I am not going to have any report." They have to write a report at the end of the summer. "It's tough—the world is tough. Do it."

I have a couple of little tidbits to tell you. We had one young man who was working at Western Electric in Princeton. He was from Seattle. He told me, "Dr. Adams, we do not have a viable Black community in Princeton," whatever that is. He was living in Newark, so he was late several days. His employers called me, and I said, "I can solve that. It won't take much time to take care of that problem." And he was trying to tell me again about this viable Black community. I said, "Hey, fellow, I don't care where you live, you can live in China, you've got to be back by 8:00 am." He was getting ready to try to explain it to me, but I said, "Whoa, we're just wasting a lot of time. I am going to ask you two questions. Do you have a watch?" He said, "Yes." "Can you tell time?" He said, "Yes." "The next time you are late, you are fired." His boss called me about two weeks later, and said "What did you say to him? He has not been late any more." Solved that problem. So there is no nonsense.

5. ***Very good support from the institutions.*** We have good people. We have the Dan Davis's at the campus, we have materials at the campuses, we have a contact on the campus that can turn things for us. They come to meetings, and we talk about what it is we are trying to do. We try to make it a personal kind of experience so that people understand that this is serious. But everybody hears this. What I am telling you here, now, I said to the Board. And if they get to where we do not agree, there are things I can do—I had to quit one time. I went to a board meeting, and we had a little ruffling about how they did not like Howard Adams as well as I thought they should like him. I got up and said at the Board meeting—nobody expected me to say that—I finished giving my report, and I said, "I want you all to know I won't be here next year this time." The place got real quiet. They said, "What did we do? We need to talk about that." So we talked, and I am still there. That is what you have to do. Everybody has to be working together.

It has to be a serious program. You really have to start in seriously. I do not care where you are working with students. I go into high schools, and I will not talk to kids with their hats on. I tell them, "You've got to take your hat off for me to talk to you. You don't want to take your hat off?"

We do not give degrees. We make sure people understand that—GEM does not give degrees. I do not write papers, I do not conduct research.

At MIT, we had a student who was working with a professor, and he was not going to get his thesis done. Everybody was afraid, because this guy is a full professor—he weighed a whole lot, his tail weighed a ton, he was a tremendous researcher. So, I had to call him, and I could tell on the phone that he was angry. "Some guy from Indiana calling me." You know, "I am Professor So-and-so." And I said, "Doctor, we do not need to discuss that. I've got to ask two questions. Will my student have his thesis done at the end of the semester?" I said, "No—will he have a thesis? Yes or no." He said, "No." "Hell, he can't work for you no more." End of story. And I said, "You make sure that you understand that we had this conversation—the student did not have this conversation. I've had it with you. We are going to assign him to somebody else. And if I find out that you got in the way, I'll be back." I called another professor, and the man said, "Doc, he'll be gone at the end of this semester." He already walked. So we can do that. But again, what we are talking about—this is serious business.

This is from the top down, with the deans. When I go in, when I go on a visit every year or every two years, we make sure we talk to all the department heads. This is my year to talk to department heads. Everywhere I have been this fall, I have seen department heads. We get in a meeting, we talk to department heads, and I let them know, "Hey, I've got good records here." That is one of the things I keep telling you—you have to have good stuff, good documentation. I can tell people exactly how much money we sent them, how many students dropped, what it costs per student, where they came from, where they got everything. We lay this out. I walk into a school and I can tell the University of Michigan, without any trouble at all, "In 1987 I sent the University of Michigan $27,000. Our students graduate, they graduate with quality degrees from the best schools in the country, ahead of other students." So, I guess I rest my case.

I am trying to say that, when we have had a problem, this has worked. I do not put any more pressure on anyone, other than the fact that where we have to have some red tape cut, we have it cut.

Since we are not always going to be there, we have a person on the campus. But it is set up institution-wise. At one of our new schools, we went on the campus, had meetings with the dean, with the vice presidents. We had meetings with people to try to talk about what our philosophy was. We had a meeting of the minds right there, and we said, "Okay, you tell us how you feel you can fit into this scenario." And the school agrees. Then, it goes down to the professors. I think that is what you have to do in terms of the institution—that is what it takes. I think you have to get it at that level.

I am not sitting up here talking about Howard Adams, now. I am trying to tell you what my philosophy is, both as it applies to students, and as it applies to what we are trying to do. Because we are talking about science. Science is serious business. You cannot do science unless you want to be serious. You cannot do science unless you are willing to stay up all night. But you cannot do that unless you can get in the labs—so you have to put all of the pieces together.

Let me just end on this note. If there is a problem right now, the problem is simply that we do not get the right information to students. Students do not have the right information, and all of us have to work on that. They do not have good reasons—or think they do not have good reasons—for going through what we are talking about going through. They do not have a good reason, even, to be successful—they do not know what it means. They have seen people who have shucked, and gotten by.

You cannot do that in the sciences if you are going to be successful. We have to talk about why science is different. If you want to be successful in the sciences, you have to learn how to work all of the problems all of the time. You have to do things in sequence—if you do not take this course this semester, you will be a year behind. We have to talk to students like that. That is one of the things that we try to do with this program.

The final thing that we try to do is, after we have worked with the students and the institutions, we have put the onus back on the people that have the money. When I go to a company, I simply do not go in like I am begging for some money. I go in and lay out my stuff, and I tell them, "In this room today, I am talking to people who give away money. I would not be here otherwise. You all give money away. That is your job. If you do not give any away, you are going to lose your job. You have to give some money away. And since you are going to give it to somebody, I am going to try and tell you why you ought to give it to me. This is what we will do with it. Now, if you give it to somebody else, and it does not work, I will come back also. So, you could hedge your bets a little bit, and give it to me—it will work." And we get our money.

Thank you all.

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# IMAGES OF SCIENCE: FACTORS AFFECTING THE CHOICE OF SCIENCE AS A CAREER

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*Until July, 1988, Robert Fullilove, III, was Director of the University of California at Berkeley's Professional Development Program (PDP), a highly acclaimed program in mathematics and science working with minority undergraduates. Currently, he is an Education Specialist in the Department of Epidemiology and Biostatistics and a Research Associate at Multicultural Inquiry and Research on AIDS (MIRA) and at the Center for AIDS Prevention Studies. He has published extensively on subjects ranging from the characteristics of adolescent Black fathers to issues in mathematics and science education and has considerable expertise in program evaluation. He is Principal Statistician on several AIDS research projects including the four-year AIDS In Multicultural Neighborhoods (AIMN) cohort study of AIDS in Black and Hispanic neighborhoods in San Francisco. In February, Fullilove and his wife, Dr. M.T. Fullilove, will take up appointments at Columbia University, conducting further research on AIDS.*

Dr. Fullilove's remarks at the Symposium were excerpted from a research study he conducted for the Office of Technology Assessment (OTA). CASET thanks Dr. Fullilove and the OTA for allowing us to publish the full text of the research.

## PREFACE TO THE 1990 EDITION

This paper was written two years ago as part of a contract with the Office of Technology Assessment of the United States Congress. Within a year of its completion, I had become heavily engaged in AIDS research as part of the Center for AIDS Prevention Studies at the University of California - San Francisco and directly involved in a series of studies of crack cocaine use among Black teenagers in Northern California. Although the research presented here in this report and my subsequent studies of teenage crack users may seem to be at two opposite ends of the research spectrum, they are, in fact, quite linked.

In a study published in the Journal of the American Medical Women's Association (Fullilove and Fullilove, 1989), my wife and I describe a survey we conducted of 222 Black adolescent crack users in San Francisco and Oakland, California. Our data (plus conversations held with many of our survey participants) revealed that problems with school and a feeling school "wasn't

working for me" were common among teen crack users. While it is much too facile to blame crack and other drug abuse on school failure, there is no question that school failure is an integral part of the personality profile of many of the crack users we interviewed.

This report attempts to cite the problems this nation will face in training sufficient numbers of young people—particularly minority youngsters—for the scientific workforce of the future. One of my principal findings is that much of what happens in our schools simply will not produce the scientists and engineers we will need in the years to come. I have also tried to indicate, however, that the future is not entirely bleak: some programs and educational strategies have done remarkably well in promoting high levels of educational achievement among women and minority students. In the two years since this report was released, I continue to remain optimistic.

If there is one lesson I have learned since making the switch from educational research to AIDS research, however, it is this: the solutions to many of the problems cited here in this report are within our reach as a nation. While the twin scourges of AIDS and rising levels of drug abuse make our need to implement solutions more acute, I believe we possess the courage and the resolve to implement them. What is not clear is how much longer we will have to wait before we begin.

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October 17, 1989

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# IMAGES OF SCIENCE: FACTORS AFFECTING THE CHOICE OF SCIENCE AS A CAREER

> The Nobel Prizes were announced recently and, once again, the United States did well. We should take pride in the fact that our system continues to produce such successes. Unfortunately, the Nobel Prizes are a better measure of the success of past policies than they are an indicator of the future. We will do poorly in science and engineering in the future if we do not train the people that we need. Recent data suggest that we are not doing this well enough... We are attracting a smaller fraction of our best students to the sciences, and the size of the relevant age groups is declining (Bloch, 1987).

The crisis to which Bloch alludes is the subject of this report. The report is admittedly ambitious, because in addition to attempting to describe the dimensions of the problem this nation faces in producing enough scientists and engineers, it will also attempt to describe how *images* of science may affect whether American students choose careers in these and related fields.

There is no dearth of research examining science, science education, mathematics education and other related subjects. Nor is there any lack of research examining various permutations and combinations of these topics.

It quickly becomes apparent that this literature is nothing if not voluminous. The strategy pursued in the preparation of this report, as a result, was to look for breadth, rather than depth. Thus, studies that attempted to summarize and synthesize large bodies of relevant research were eagerly reviewed and their analysis received considerable attention in its preparation.

Well over 200 articles and reports were reviewed. In some respects, however, only the surface of this broad topic was scratched. However, the outlines of "the forest" did emerge from among the many "trees" that were examined.

The assumptions that motivated this effort were reasonable. Television is a part of virtually every American home, and through this medium, a wide variety of *images of science* find their way into our living rooms each day. Television presents scientists as figures in the news and as characters in melodrama; we see them inventing the weapons that may ultimately destroy us and, conversely, foretelling our doom if we don't mend our ways. In the movies scientists are our favorite villains, and, on occasion, our most revered heroes. With so many conflicting images, isn't it reasonable to wonder how these images affect our young?

The question is certainly reasonable, but the relevant research, unfortunately, is far from helpful in providing us with answers. If anything, the search for answers to the question, "Do images of science affect whether or not students choose careers in science?" only turns up more questions. Perhaps what the search for answers really reveals is the limitation of social science research as a tool for resolving and responding to complex questions. Certainly, what the research literature continually indicates is: (1) how little of the variation in complex behavior we are able to explain using traditional survey research methods; (2) how often methodological barriers cloud our ability to measure the behaviors and the variables we are interested in understanding; and (3) how difficult it is to convert research findings into effective policies and/or programs that can remedy the problems the nation faces in increasing its science and technology workforce.

What the literature review for this report suggested, more than anything else, was how much becoming a scientist depends on doing well in mathematics and science in school. For example, minority students—most particularly Black students—continually report that they like science, they like mathematics, they would like to do well in science, and they understand the value (and the importance) of careers in science. Yet despite these positive attitudes, their achievement in science and mathematics courses and their participation in science careers lags far behind that of Anglos and Asian Americans. Student attitudes, we conclude, are not the problem.

As this report hopes to demonstrate, the way to reverse the trends cited by Bloch is to

create the conditions in the schools that will maximize the opportunities of students—all students—to do well. Prototypes of programs and instructional strategies exist that have promoted high levels of achievement among the very students who are believed by many to be the most hopeless. In addition to highlighting these prototypes in this report, an attempt is made to discuss the manner in which television might be used to enhance the efforts of the schools to improve science and mathematics instruction. But first, some effort to describe the current crisis in science education and in the preparation of American students for science careers is in order.

## The Problem

> The size of the 18-19-year-old group will decline significantly in the next decade. Unless education in mathematics, engineering, and the sciences is made more effective for all students and more attractive to potential faculty members, and especially to the presently underrepresented (women, minorities, and the physically handicapped), both the quality and number of newly-educated professionals in these important fields will fall well below the nation's needs—with predictable harm to its economy and security (National Science Board, 1986).

The supply of scientists and engineers is threatened by a number of factors: first, there is evidence of a decline in the proportions of students entering college prepared to major in or graduate with degrees in science; secondly, the nation's changing demographic profile suggests that the future science/technology workforce will increasingly come from the ranks of its non-Anglo schoolchildren whose academic preparation leaves much to be desired; thirdly, the academic preparation of all students, irrespective of race or gender, is poor, particularly in the areas of science and mathematics; and finally, the prospects for an improvement in these trends appears bleak because students show less interest in and little preference for science the further along the educational pipeline they progress.

## The Evidence

In 1986 the annual survey of American college freshmen (Astin et al., 1986), conducted as part of the Cooperative Institutional Research Program (CIRP), found declining interest among those surveyed in pursuing careers in engineering and computer science. Specifically, 3.5 percent of the respondents to the 1986 survey indicated an interest in computer science careers; 9.7 percent of those responding expressed an interest in engineering. These percentages represent, respectively, declines of 60 percent and 19 percent from the proportion of students expressing an interest in these fields in 1982.

Similarly, the National Science Board (NSB) reported for the period 1973-83 that the number of undergraduate science majors fell by about 15 percent and that the number of baccalaureate degrees awarded between 1960-1980 in the natural sciences, engineering, and mathematics just barely managed to keep pace with the increase in the proportion of 22-year-olds in the general population during this period (NSB, 1986). Part of the problem is that science courses in the schools have become a means to an end and serve less and less as the gateways to science careers. As Tressel (1987) observes: "Most students who take high school science do so only because it is required for college; only one in ten has any plan to pursue science further, and in fact only one in thirty will actually do so and complete their undergraduate studies. And of these, less than one in four will go on to higher studies."

The picture for minority students is even bleaker. They comprise an ever dwindling proportion of students in the educational pipeline (e.g., ACE, 1987), and even those who manage to persist to college find that the going, if anything, gets tougher. This pattern is typified by the experience of Black students in engineering. As reported by Garrison (1986),

for example, "Blacks comprised 6.1 percent of the first-year engineering students in 1981. This figure fell to 4.9 percent of the second-year students in 1982, 3.8 percent of the third-year students in 1983, and 3.2 percent of the fourth- and fifth-year students in 1984."

To add to this litany, recent assessments of the academic preparation of the nation's students from elementary school to graduate school suggest that U.S. students do not compare favorably with their peers from other industrialized nations. To cite a few of the most widely reported results:

- Stevenson and colleagues (1986), in a study of scholastic achievement among schoolchildren in Taiwan, Japan and the U.S., report that American 1st- and 5th-graders are severely overrepresented among children receiving low scores in mathematics and are severely underrepresented among those with high scores in math.

- The Second International Science Study found that American student performance in science had improved over that reported in 1983 but was well below that attained in 1970 when the first international study was undertaken; moreover—and perhaps more significantly—the study found that students in England, Japan, and six other countries outperformed the top American students, despite the fact that the Americans had had advanced coursework in physics, chemistry, and biology (Rothman, 1987).

- As Steen reports in his analysis of mathematics education in the U.S.: "Non-U.S. citizens who take the Graduate Record Examination in mathematics average 100 points higher than U.S. students. The performance gap is twice as high in mathematics as in any other field—the next highest being in physics, the most mathematical of the sciences" (1987, p. 251).

The less-than-stellar academic performance of American students in mathematics and science is mirrored by their very evident dislike of these subjects. The 1982 National Science Assessment found among 13-year-olds:

- slight, but nonsignificant, declines in science achievement between 1976 and 1981;

- levels of achievement that were below 1969 levels; and

- little change in generally lukewarm opinions toward science careers.

Among 17-year-olds the Assessment reported:

- continued, significant declines in science achievement;

- major declines in students' willingness to support science research and to use science information; and

- declines in students' perceptions of themselves as change agents for socio-scientific problems (Hueftle et al., 1983).

The report's authors caution:

> ...News of waning science achievement cannot be accepted without concern—particularly when it is coupled with eroding student attitudes... Perhaps young adults do not have enough science knowledge to face complex technological problems, and feel less certain that they—or anyone else—can solve these problems as a result. If so, we may be moving dangerously away from the enlightenment Jefferson felt was so critical for citizens to

maintain if society was to preserve control over its processes (Hueftle et al., 1983).

In subsequent sections of this report an attempt will be made to summarize the literature in a number of widely varied fields in an effort to understand the relationship between public images and perceptions of science and choosing a career in science or engineering. Along the way, we will look at how science is portrayed in the media and how it is perceived by students and the general public. Some factors that affect career choice are examined, followed by a 0discussion of media and its impact on career choice. Recent research on science and mathematics achievement is discussed next, followed by a detailed look at the work of mathematics educator Uri Treisman. Finally, in a concluding section, a modest proposal to measure attitudes and school behavior is made.

## I. IMAGES OF SCIENCE

Hueftle and colleagues suggest that the images of science U.S. schoolchildren possess—particularly from nonschool sources such as radio, TV and other popular media—contribute to the relatively low esteem in which science and scientists are held. The public image of science has been studied in a number of separate settings over the years. Some of the more notable of these include the following.

- Gerbner (1987) studied the content of network prime-time dramatic programs for the 10-year period between 1973 and 1983. Among the results reported, he observes: (1) images of science and technology appear in seven of every ten dramatic television programs: the average viewer will see these images most prominently in programs that describe life in the future or in adventure shows featuring "fast-moving, globe-trotting adventure." (2) Doctors are more positively portrayed than other scientists. (3) There is an imbalance with respect to the successes television characters achieve: "for every scientist in a major role who fails, two succeed. But for every doctor who fails, five succeed, and for every law enforcer who fails, eight succeed" (1987, p. 111).

Gerbner notes that at the root of the failures experienced by TV scientists is the fact that roughly 5 percent of the scientists portrayed on television kill someone and about 10 percent managed to be killed—the highest victimization rate of any occupational group seen on prime time (including private eyes, policemen, and members of the army).

Gerbner also found evidence that heavy television viewing had a negative effect on the attitudes of respondents to a survey designed to assess science attitudes. Results suggest that the more people watch television, the more they think of scientists as odd and peculiar. This image is particularly pronounced among viewers who report watching little or no public television. Gerbner reports, "Exposure to science and technology through television entertainment appears to cultivate a generally less favorable orientation toward science, especially among higher status groups whose light-viewer members are its greatest supporters" (1987, p. 112). In sum, he concludes that while television drama generally presents positive images of science to viewers, these images are less positive than televised images of other professions and tend to diminish rather than promote positive public attitudes toward science.

- In a nationwide study sponsored by the American Association for the Advancement of Science in which high school students were asked to compose essays describing scientists, Mead and Metraux (1957) constructed a composite description of science and of scientists from over 35,000 student responses.

Overall, science was perceived as a singularly masculine activity. The field was described by respondents in a variety of forms: as a "very broad field" for some, as a single entity for others, and for still others, as a melange ("medicine and gas and electric appliances"). The goals of science could be described in humanitarian terms ("working to better mankind, finding cures, making new products"), or in individualistic terms ("making money, gaining fame and glory..."), or destructive terms ("dissecting, destroying enemies, making explosives").

The common image of the scientist that emerged from these essays portrayed him as a man "who wears a white coat and works in a laboratory," and who "spends days doing experiments... with plants and animals, cutting them apart, injecting serum into animals." He is perceived in a positive sense as "a very intelligent man—a genius... [with] long years of expensive training.... He works for long hours in the laboratory, sometimes day and night, going without food and sleep." But on the negative side, "his work is uninteresting, dull, monotonous... and though he works for years, he may see no results or may fail... He has to keep dangerous secrets; he is endangered by what he does... He may sell secrets to the enemy... He may not believe in God or may lose his religion... He neglects his family.... He is never home."

The authors offered a number of observations of this composite.

> The number of ways in which the image of the scientist contains extremes which appear to be contradictory—too much contact with money or too little; being bald or bearded; confined work indoors, or traveling far away; talking all the time in a boring way, or never talking at all—all represent deviations from the accepted way of life, from being a normal friendly human being, who lives like other people and gets along with other people (1973, p. 318).

- Following the work of Mead and Metraux, Chambers (1983) reports the results of the Draw-A-Scientist Test (DAST) that was administered to 4,807 children from kindergarten to grade 5 in Montreal over a period of 11 years (1966-77). As the title of the test suggests, the DAST requires students to draw a picture that best portrays their image of a scientist. Each drawing is analyzed and scored according to the degree to which *standard images* of a scientist are present (for example, lab coats, eyeglasses, beards, etc.). The average number of standard images present in the drawings ranged from .31 per student (among kindergarten students) to 3.26 per student (among 5th-graders). Chambers concluded from the study "(1) The stereotypic image of the scientist, which Mead and Metraux examined in high school students, was found to appear among students at the grade school level. (2) The evidence indicates that the various elements of the stereotype appear with greater frequency as students advance through the grades."

- Etzioni and Nunn (1975) surveyed national public opinion polls and attitude surveys to examine the attitudes of Americans toward science. Among their findings were: (1) most Americans value science and see it as the means through which this nation enjoys a high standard of living; (2) similarly, Americans hold generally favorable opinions of scientists and trust their judgement; and (3) opinions and attitudes toward science vary significantly by age, education, region, socioeconomic status, and personality type. The authors note that although a large number of people approve of science as a "technological golden goose," they have much less appreciation for it "as an approach to the world, as an exciting or aesthetic experience, or as a great puzzle solver" (Etzioni and Nunn, p. 239). In general, they conclude, science is among the least understood of American institutions.

- In a similar analysis, Komarnicki and Doble (1986) examined public opinion surveys of attitudes to science conducted during the period between 1972 and 1986. Their findings largely mirror those of Etzioni and Nunn (1975); for example, the authors found that there is widespread public support for science, technology and engineering as the source of the nation's unprecedented standard of living. Among the 35 distinct findings they

report from their review, they observe: (1) the public believes that technology has increased economic productivity, but it is uncertain whether technology creates more jobs than it takes away; (2) the public is moderately interested in science and technology but confesses to a lack of adequate information about these subjects to make informed judgments about them; (3) if asked by a young person for advice about what career to choose, the majority of Americans would recommend a career in engineering, computers, or electronics; and (4) although public support for science/technology is generally high, there appears to be evidence that this support has slipped in recent years.

Significantly, public attitudes toward science become more favorable as the level of education of respondents increases. As reported by Komarnicki and Doble, for example, when a 1983 survey asked, "How much interest do you actually have in scientific and technological matters?" responses were highly correlated with the level of education of respondents—the greater the amount of education, the greater the level of interest expressed. Unfortunately, even among the best-educated within the sample, only a small fraction (15 percent) rated itself as well informed about new inventions, new technologies, and scientific discoveries. Among the least well educated of this sample, only 5 percent admitted to being well informed about these issues (Komarnicki and Doble, 1986).

### Summary

I have suggested throughout this review that the images of science and of scientists, are complicated by a variety of factors. In general, the surveys of attitudes and images do not lend themselves to simple characterization. Public responses to questions about science and technology vary tremendously, according to what questions are asked, when they are asked (for example, after a scientific triumph or after a technological disaster), and who is asked. There is scant evidence, however, that the science education the average American has received (either in school or through other information media) has succeeded in promoting an appreciation for science or an ability to keep abreast of technological developments.

The assumption of many commentators on these attitudes is that public opinions about science provide us, as Etzioni and Nunn observe, with "an indicator of the changing status of rationality." The authors claim that positive attitudes toward science reflect the degree to which "institutions embodying rationality" are accepted by the general public as well as the degree to which the public will support their continued growth and development. However, it seems equally clear that these attitudes also reflect the degree to which science and mathematics education in the schools have been successful in providing the public with a foundation for understanding and appreciating the technology of today. Results suggest that such a foundation has not been laid, and that critical developments in science are only dimly understood by a large sector of the American public.

## II. MEASURING ATTITUDES TO SCIENCE

When scientists and mathematicians describe their work, they frequently speak of its beauty or of the awe it inspires. Hammond (1978), for example, quotes the mathematician Hans Bers on the subject of beauty in mathematics:

I think the thing which makes mathematics a pleasant occupation are those few minutes when suddenly something falls into place and you understand.... Some people have it only once or twice in their lifetime. But the quality of this experience—those who have it know it—is really joy comparable to no other joy (1978, p. 27).

At the heart of our objectives for science education lies the hope students will perceive the beauty of Nature's harmony through their studies and will become inspired to learn more. Moreover, we assume that, at the very least, science instruction should manage to promote positive feelings about science, about scientists and about the fruits of their labors.

Measuring such attitudes, however, is far from straightforward. Hugh Munby's 1983 study, "An Investigation into the Measurement of Attitudes in Science Education," examines some of the difficulties encountered in defining attitudes to science and in correlating achievement in school science with student science attitudes. His report contains a review of 56 instruments used for measuring attitudes to science that were culled from over 200 dissertations and more than 100 published studies.

Munby observes that these studies offer many definitions as to what constitutes an attitude to science, "and the range extends from scientific attitudes, through attitudes to science courses and activities, to career interests and preferences" (1983, p. 142). Moreover, there are a large number of attitudinal "targets" described in these studies that include: scientists, science courses, the difficulty of doing science in school, knowledge of science, science teachers, science experiments, and the ability to use the scientific method in thinking. Munby concludes that the confusion about what constitutes an attitude to science undoubtedly accounts for "conflicting research reports" from studies exploring the relationship between attitudes and science achievement.

Of critical importance here is Munby's notion that the very concept *attitude to science* is ambiguous and difficult to measure. "Science, it could be argued, is so much a part of Western thinking that its meaning and its implications for society might get lost behind the more obvious and superficial (if not newsworthy) ways in which its presence is felt" (1983, p. 146). It is almost impossible, he contends, to "unpack" the concept of attitude to science so that it becomes a useful explanatory variable in research. He suggests the inconsistent results reported in many studies examining the relationship between attitudes to science and scholastic achievement in science courses may be attributable to our inability to adequately define or measure these attitudes.

For example, the components of an attitude to science—at least as the term is used in the studies Munby reviewed—might include: (1) knowledge of science, (2) awareness of science facts, (3) ability to reason scientifically, (4) opinions of the people who are involved in science, and (5) our attitudes toward the products of science and technology (products which would run the gamut from computers to toxic waste and acid rain). There is considerable overlap among these topics and attempting to represent them in some comprehensive manner—for example, by adding up subscale scores to create an *attitude to science score*—may not produce a valid measurement. We run the risk of defining the variable too broadly (so that the attitude we measure is meaningless) or of defining it too precisely (so that we overlook valuable information).

More difficult still is the task of using a variable purporting to measure attitudes toward science to explain the variation in such complex behavior as academic performance in science courses or pursuing a career in science. As we shall see subsequently, the extensive literature on attitudes and their relationship to beliefs, intentions, and behaviors suggests that there are considerable methodological hurdles to overcome.

## Attitudes: Research and Theory

The seminal work in the area of attitude research is that of Ajzen and Fishbein (1980). Briefly, their model holds that behavior has three components: the cognitive, the emotional, and the behavioral (conative). In this model, an attitude represents an evaluation of an object that arises from our knowledge of it (the cognitive), and is partially a function of what we feel emotionally about the object (the emotional), and partially a function of our predisposition to respond in a particular way to the object (the conative).

The Fishbein-Ajzen attitude-behavior model is the subject of considerable comment and criticism in the research literature (e.g., Liska, 1984), and there have been numerous attempts to test its validity (Liska et al., 1984; Chaffee and Roser, 1986; Carpenter and Fleishman, 1987). What is clear from this body of literature is that there is no simple linear relationship between an attitude and a behavior, particularly if a long period of time elapses between when attitudes are measured and when behaviors occur. Thus, the attitudes children of five express toward particular careers are unlikely to have any significant relationship with the careers they ultimately choose.

The literature similarly suggests that little or no relationship will be observed between an attitude and a behavior that is not directly under the control of the individual. Becoming a scientist or an engineer falls into this latter category since—it goes almost without saying—entering these career fields involves more than simply having positive attitudes toward them.

More useful, perhaps, are efforts to assess the relationship between intentions—since by definition an *intention* implies a predisposition to behavior—to perform a particular behavior and one's resources for carrying out one's intentions. This relationship was the subject of research by Carpenter and Fleishman (1987) concerning the factors affecting college attendance and non-attendance.

Specifically, the authors sought to test the Fishbein-Ajzen model of attitude-behavior to determine how students' stated intentions to attend college, as measured in the senior year of high school, were related to actual college attendance of Australian students two years later. Their findings supported some aspects of the Fishbein-Ajzen model. Specifically: (1) favorable attitudes toward higher education, parental encouragement, and the college attendance plans of friends and peers were significantly correlated with the intention to attend college; (2) intentions to attend college were significantly correlated with actual college attendance ($r$ = .620 for boys; $r$ = .490 for girls). But the authors also found support for Liska's (1984) suggested revisions of the Fishbein/Ajzen model.

Liska contends that intentions mean little if an individual does not have the wherewithal to bring intentions to fruition. Thus, social-structural opportunities, that is, having the money to attend college, attending a school that promotes college attendance, having the grades to compete for college admissions, and so on are necessary conditions for converting the intention to attend college into actual college matriculation. Accordingly, (and consistent with Liska), the Carpenter and Fleishman study found that social-structural opportunities and resources were significantly related to actual college attendance (as were attitudes to college and intention to attend college).

## SUMMARY

From the foregoing, it seems reasonable that choosing a career in science involves more than simply having favorable attitudes toward science. As suggested in Munby's work, the methodological problems inherent in developing appropriate measures of attitude are considerable and not easily overcome. Research investigating the relationships between attitudes and behavior suggests that, at the very least, attitudes must be examined in concert with other variables (for example, measures of intention) in order to explain a significant portion of the variation in such complex behavior as making a career choice. Finally, it seems clear that structural factors must be examined with at least as much interest as those related to attitudes and intentions.

## III. STRUCTURAL (NON-ATTITUDINAL) FACTORS IN SCIENCE CAREER CHOICE

The structural factors affecting the choice of science as a career may be classified on two levels: personal and systemic. At the personal level we include grades, financial resources, family background, and knowledge of careers. At the system level, we include the quality of school a student attends and how a student is tracked in school. These factors, it seems clear, are likely to explain more of the variation in college attendance, science course enrollment, and entry into science/engineering careers than students' attitudes to science (however these attitudes are measured).

### Tracking

There is a growing body of literature that has examined the issue of tracking, some of which is summarized in a review of the literature provided by Rosenbaum (1980). The weight of the studies cited strongly supports the notion that the way students are grouped and tracked in school will significantly affect their academic careers:

- Although ability grouping is frequently justified as a means of promoting student achievement, Rosenbaum found conflicting, even contradictory, claims for the impact of ability grouping on performance:

  > NEA's (1968, p. 42) careful tabulation of the results of the 50 best controlled studies [on ability grouping] published since 1960 dramatically shows the inconclusiveness of this literature.... It shows that for each study exhibiting a net gain in achievement, a comparable study recorded a net loss (for all ability levels except the lowest, which had slightly more losses than gains) (1980, p. 365).

- Rosenbaum also found evidence that "grouping separates students into distinct, hierarchically ordered groups and these groups tend to endure over fairly long periods of time" (1980, p. 371) There is also some evidence that students' self-perceptions are affected by such grouping and that the effects are particularly harmful for those who are placed in lower tracks. Rosenbaum was particularly impressed by the self-reported feelings of students in lower tracks that suggest dramatically (and in ways statistics could not possibly convey) how severely stigmatized the experience of being in a low-rated group can be. He cited a statement made by a student in a Midwestern high school in 1949 as evidence:

  > If you take a college preparatory course, you're better than those who take a general course. Those who take a general course are neither here nor there. If you take a commercial course, you don't rate. It's a funny thing, those who take college preparatory set themselves up as better than the other kids.

Those that take the college preparatory course run the place (from Hollingshead, 1949, p. 169).

- The large body of literature published since Rosenbaum's review suggests similar findings continue to be reported by a variety of researchers. Felson and Reed (1986), Felmlee et al. (1985), Dar and Resh (1986), and Sorensen and Hallinan (1986), for example, have all conducted research examining the effects of grouping on academic performance, self-appraisal, and classroom attention. In each, evidence is presented that there are negative consequences that issue from ability grouping, particularly for students in groups that are perceived as having low esteem.

- Ability grouping has significant effects that persist beyond school and that affect the student's placement in the workforce. Hare (1987) is prominent among social critics who suggest that the American economy cannot accommodate Blacks and members of other non-Anglo minority groups and that the schools play a critical role in enforcing the social order. Specifically, Hare suggests that tracking in schools is an efficient way to assign "undesirables" to inferior social roles and positions. Those who fail to achieve high social and economic status in later life will attribute their career failures to their inability to "make the grade" in school, and will not question a socioeconomic system that assigns high status to high academic achievers.

  > The myth of equal opportunity serves as a smoke screen through which losers will be led to blame themselves, and be seen by others as getting what they deserve. One might simply ask, for example, how can both inheritance of wealth for some and equal opportunity for all exist in the same social system? (1987, p.101).

Colclough and Beck (1986) found significant empirical support for Hare's assertions. Using data collected as part of the National Longitudinal Survey of the Class of 1972 in which a large cohort of high school seniors were surveyed in 1972 and again in 1979, the authors found that curriculum tracking had a significant impact on the reproduction of social class—that is, the likelihood that a student would complete school and enter the workforce in the same social class as that into which he or she was born. Specifically,

> Curriculum tracking was shown to be the critical determinant of reproduction. We find that students from manual class backgrounds are over twice as likely to be placed in a vocational track, and students who have been assigned to a vocational track have an 89 percent chance of being channeled into a manual class destination. Similarly, students with a mental class origin are 1.6 times more likely to be placed in a college-bound track, and 61.6 percent of the college track students are channeled into mental class destinations (1986, p. 470).

Moreover, the authors note that males who were from manual class backgrounds but were placed in a college-bound track in high school had a different experience in later life than their peers in the vocational track. "As expected, for males in the manual class, being allocated to a vocational track significantly increases the odds of class reproduction, but being assigned to a college-bound track has the opposite effect, enhancing the likelihood of class mobility" (1986, pp. 467-468). Thus, although social class has a strong relationship to the track to which one is assigned, there do appear to be significant opportunities available to students—irrespective of economic class—who show early promise in school and who escape the "traps" of noncollege tracking in high school.

## Family Factors

Two surveys of the largely male Westinghouse Science Talent Search (WSTS) winners conducted at very different points in time (Edgerton, 1961; Science Service, 1985) suggest that a parent, a close relative, or a teacher may play a critical role in the decision to become a scientist. In both surveys the influence of males—fathers, brothers, and uncles—receives prominent mention as a factor in the choice of career.

The WSTS is one of America's oldest high school competitions in the sciences. Between 1942 and 1985, Westinghouse awarded $2 million to 1,760 young scientists. Among this group are included five Nobel Prize winners, two Fields Medal winners, and four MacArthur Foundation Award winners. Although they are not a random sample of the science community, WSTS winners constitute an interesting subset of current American scientists and academically talented nonscientists.

In a 1985 survey of WSTS winners, the 58 percent who responded to the survey had become an extremely accomplished group. Most were involved with a college or university: 27 percent reported they taught in institutions of higher education, 24 percent reported they were doing research at a college or university, and another 2 percent listed jobs in college or university administration.

The fathers of 35 percent of those surveyed were professionally involved in science, mathematics, engineering, or medicine; 23 percent reported brothers and 21 percent reported uncles in these professions. Fully 48 percent of those surveyed were the oldest child; another 16 percent were only children. Sixty-two percent of the sample cited a professor or a teacher as playing a major role in their decision to select their careers. Forty-four percent reported they became interested in their current professional field in high school.

The disproportionate concentration of only and first children in the sample was of particular interest. On the assumption that birth order is a random effect, and that scientists are no more likely to be first born children than they are to be the middle or youngest child, this author did a chi-square goodness-of-fit test on sample responses to examine the degree to which the observed sibling order reported by respondents deviated from expectation. The results ($x^2$ = 253.7, with $df = 3, p < .001$) suggest there is a disproportionate concentration of first and only children in the sample. Is there a relationship between the creativity and career achievement of this group and their sibling order?

Sibling configurations of scientists and other eminent persons have been studied frequently (e.g., Altus, 1966), but findings have been consistently disputed because of the suspected presence of methodological artifacts arising both from the manner in which appropriate samples are drawn and the manner in which data analysis is conducted (Datta, 1968). West (1960), using a sample of persons engaged in research (their professional eminence was not studied) and testing his data against a number of hypotheses related to the expected distribution of birth order among such data, found, nonetheless, a disproportionate number of first and only children in his sample. Datta (1968), however, using a sample of Science Talent Search winners and applicants, found no significant difference in the scores of subjects on the Test of Potential Scientific Creativity and their birth order, separation from next oldest sibling, family size, and sex of next oldest sibling. "Birth order," she concludes,"considered as simple ordinal position, does not appear to be a very powerful factor within the [Science Talent Search] sample" (1973, p. 45).

Results of these and other studies (e.g., Terman, 1954) suggest there is no simple, direct relationship between choosing a career in science, family size, birth order, and/or parental influence. These factors are undoubtedly important, but attempts to measure their influence yield inconsistent results that arise from methodological problems that are not easily overcome.

## Factors Affecting Career Choice

Perhaps the most extensive study of the factors affecting occupational selection conducted to date was completed by Wagenaar (1984) using data collected as part of the High School and Beyond (HSB) study sponsored by the National Center for Education Statistics. In order to examine the factors influencing occupational selection, Wagenaar tested a variety of models of vocational choice using an assortment of variables related to aspiration, SES (socioeconomic status), ability, academic achievement, and parental influence. Significantly, however, the best of these models was only able to explain approximately 16 percent of the variation in career selection. Wagenaar concludes, "The results indicate clearly that selection of a given occupation is largely a product of factors that were not included in the equations. Such factors might include actual experience in an occupation, occupation held by a parent or
a close friend, occupational knowledge, other values and beliefs, and psychological traits" (1984, p. 253).

In his own extensive review of the literature on occupational choice, Wagenaar was led to conclude that, whatever their information source, students are not particularly knowledgeable

about occupations or about what is required to pursue a particular career. He cites studies in which (1) only 45 percent of surveyed 9th-graders had the same occupational preferences two years later and only 27 percent had the same occupational preferences one year after high school graduation; (2) high school students demonstrate little knowledge of occupations or of occupational structures; and (3) only a small proportion of entering college students are sure about their major or have any clear sense of the career implications of their undergraduate majors. He concludes, "The thrust of these and other research findings is that adolescents know little about the occupational structure and that most make occupational choices in incremental fashion based on personal opportunity situations negotiated within the larger social structure. Also, adolescents are unrealistic in predicting their own job selections and success" (p. 11).

## IV. MEDIA, YOUTH AND CAREER CHOICE

One is tempted to ask whether media images of occupations influence the *occupational knowledge, other values and beliefs* Wagenaar describes. To what extent do television and other media contribute to occupational choices and the images students have of occupations? The literature on the impact of media on viewers' attitudes, knowledge, and behavior is both dense and complex. Television, as Beniger (1983) observes, has transformed the *shared symbolic environment* of the nation; it has become such an integral part of the American consciousness that "unpacking" its impact on our thinking and behavior poses tremendous difficulties. As Singer and Singer (1983) comment, for example: "Television is a member of the family. Ensconced in 99 percent of American homes, the television set claims the attention of schoolchildren for approximately 4-1/2 hours per day, reaching a peak of 5-1/2 hours a day by age 12 (Lyle and Hoffman, 1972). Poor children watch more than middle-income children (Greenberg, 1976), and Black children watch more than White children (Greenberg and Dominick, 1970)."

The American public is "tuned in" to more than just television, however, and is receiving messages from a variety of media. Larson and Kubey (1983), for example, found that music programming on the radio has a tremendous impact on young people, demonstrating greater powers than television to engage adolescents emotionally. Similarly, Christenson and DeBenedittis (1986) found that viewing television was an activity children and adolescents shared with their parents; listening to the radio, however, particularly for young adolescents, was something done in private as a means of "eavesdropping" on the teenage/adult world.

Christenson and Roberts (1983) suggest that much of the research on media and young people has been motivated by a fear that television and radio threaten the information monopoly of parents and the schools. These fears arise, they point out, because children are vulnerable; they lack both the information processing skills and the sophistication of adults, and are more susceptible to being manipulated and misled. Christenson and Roberts conclude, however, that the effects of television on behavior are complex and cannot be understood simply by analyzing the content of what is viewed. Exhibiting violent behavior, for example, cannot be shown to bear a simple, linear relationship to viewing television shows with a high violence content.

Nonetheless, research findings linking viewer attitudes to the content of what is viewed on television continue to be reported. Atkin (1977), for example, found no relationship between viewing television news and children's attitudes toward political candidates. He did, however, find modest correlations between self-reported viewing of political commercials for presidential candidates and their ratings of candidates. Similarly, Atkin and Ganz (1978) found modest correlations between television news viewing and interest in political affairs among children aged six to eleven. However, Rubin (1978) in a survey of somewhat older children and adolescents, found almost no relationship between either public television viewing, general television viewing, and attitudes toward the American president and the American government.

These results—suggesting that television impact on attitudes and values depends partially on the age of the viewer—support findings reported by Collins (1982) and Roberts (1982). As the child becomes more mature, the ability to judge the information/entertainment content of what is viewed becomes more sophisticated. Children's attitudes toward televised material will be influenced, in other words, by what they have seen and learned of the world. Christenson and Roberts (1983) suggest, as a result, that young children are more susceptible to manipulation than older children. "A child of five years will have fewer prior attitudes on fewer topics than will a ten-year-old, who in turn, is likely to have fewer than a fifteen-year-old. We also expect that what attitudes the young child has will be less firm, less well integrated within a total cognitive map. For these reasons, then, attitude formation and change should be easier to accomplish among younger children" (1983, p. 93).

As children grow older, however, television is particularly critical in the formation of an understanding of social relationships and of the social forces that govern adult life. Peterson and Peters (1983), in their review of the literature of the impact of television on the social reality of adolescents, suggest that television provides adolescents with glimpses of adult life and adult roles that are not otherwise available to them.

> Television may function as a window into the world of social actions extending far beyond the teenagers' more restricted range of daily experiences. That electronic images can expand the youth's world is especially important because adolescence is a period of "age segregation" in which few social contacts occur outside one's age group. Except on television, adolescents have few opportunities to observe adult role models in a wide variety of careers.... Thus, although "media culture" may offer somewhat stylized versions of reality, television also introduces adolescents to aspects of roles that lie outside their daily experiences (1983, p. 72).

The authors suggest that adolescents observe televised role behaviors and experiment with them in their own lives; these roles include how to interact with peers (by providing a glimpse of expected, age-appropriate behaviors—for example, how to be "cool"), how to exhibit age-/gender-appropriate behavior, how to assume an appropriate sexual identity, and, in terms of our interests here, how to acquire an understanding of adult occupations. Similar observations are made by Ellis (1983), Noble (1983), and Bontinck (1986).

Some television viewing is associated with negative attitudes, particularly in promoting racial and sexual stereotypes (Graves, 1975; Seiter, 1986). A number of observers (e.g., Morgan and Rothschild, 1983; Durkin, 1985; Harris and Stobart, 1986; Seiter, 1986; Livingstone and Green, 1986) have commented that television programs and advertising consistently portray women as submissive to men and as holding jobs that are typically defined as "female" roles. Durkin (1985) and Graves (1975) also present evidence that television can be influential in changing attitudes toward women and/or members of another race, depending on how images of them are presented to the viewer.

Is it clear from this research, however, that we know how to affect attitudes and behavior using television? Messner (1986) and Gunter and Furnham (1984) suggest that viewers make "highly differentiated judgments" about television content depending on their personality characteristics, the form of the television presentation and its content. Christenson and Roberts (1983) conclude it is difficult, if not impossible, to determine from available research how, and to what degree, television affects children. Similarly, Baggaley (1985), in his review of the literature of media impact on promoting positive health behaviors, concludes that media can be effective in promoting public awareness but does not appear to have much impact on changing behaviors. "The public," he concludes,"is immensely resistant, or even oblivious, to attempts made by media to persuade it of new beliefs or a new course of action" (1985, p. 236).

Thornton and Voigt (1983), in their examination of television and juvenile delinquency, conclude that family, school, and peer factors exert a stronger impact on delinquency than television viewing. Similarly, Messner (1986) found little evidence to support the claim that

high levels of exposure to television violence are related to high levels of crime.

Heavy television viewing has, however, been associated with low levels of academic performance (Fetler, 1983; Ward et al., 1983) and has been cited as one of the possible causes for the decline in the SAT scores of America's college-bound students (College Entrance Examination Board, 1977).

## SUMMARY

Many of the studies reviewed here repeatedly assert that the impact of a television message may depend more on the characteristics of the viewer than on the characteristics of the message. Other studies cite the numerous methodological problems inherent in measuring viewer reactions to televised material. Goldberg and Gorn (1983), for example, in their review of the impact of television advertising on children, are critical of many of the studies assessing the relationship between viewing habits and children's purchasing behavior. They cite, for example: (1) the inability of many—particularly very young children—to answer questions accurately; (2) the unwillingness of some subjects to answer questions honestly; (3) the problems associated with the wording of survey questions so that children understand what they are being asked; (4) the problem posed by experiments in which subjects are exposed to television content in ways that differ from their normal viewing habits; and (5) experiments which attempt in one experimental setting to examine behavior that is typically influenced by a season of television viewing. These views are important because they suggest that the utility of research attempting to "unpack" the attitudes and the behaviors that are attributable to television viewing is severely limited. It suggests there is something of a Heisenberg principle in operation here—that what we observe and measure is largely contaminated by the tools we use to conduct the observations and take the measurements.

Finally, Christenson and Roberts (1983), in their review of the literature on television in the formation of children's social attitudes, observe: "There is no such thing as a 'television message.' People perceive the same material in different ways.... The attitudinal effect of a given program or of a certain steady diet will vary according to the relationship between the 'television view' and the view given by the various other agents that supply information to the child" (1983, pg. 96). They conclude, "As a practical matter, if one is truly concerned about the effects of television on children, it may prove more feasible to improve children's information processing skills than it is to effect any broad, socially significant changes in the television diet that is offered" (1983, p. 96).

## V. SCHOOL ACHIEVEMENT IN SCIENCE AND MATHEMATICS

Cole and Cole (1973) point out that the social stratification observed in the sciences is not a function of social class or political power but rather of intellectual attainment. In their examination of the careers of research physicists, social origins appear to play an insignificant role in the career achievements of sample subjects.

Instead, their results suggest that intellectual ability, talent, and individual achievement carry far more influence and explain much more of the variance in science career attainment than family background or social origins. "In almost all cases where science departs from the ideal [of a strictly meritocratic system] we find the process of accumulative advantage at work. People who have done well at time 1 have a better chance of doing well at time 2, independently of their objective role-performance; the initially successful are given advantage in subsequent competition for rewards" (1973, p. 235).

Undeniably, however, this accumulative advantage seems to favor Anglo men. Women and non-Asian-American minority students fall behind Anglo males in mathematics and science almost from the beginning of their school careers and they don't catch up. The literature on academic achievement and test performance by race and gender (e.g., Kahle and Matyas, 1987; Ethington and Wolfe, 1986; Moore and Smith, 1986) makes the point abundantly clear: females and minority students do not compete equally with Anglo (and Asian American) males academically, and their failure to achieve at an early age has a greater impact on their lack of representation in the science and engineering workforce than any single factor (Kahle et al., 1985; National Science Foundation, 1986). In Women and Minorities in Science and Engineering, the authors assert, "One major cause of the underrepresentation of women and minorities in science and engineering is the different patterns of participation they exhibit compared to men and the majority at all educational levels" (1986, 32).

The most clearly marked differences between men and women and between Anglos and non-Anglos emerge in mathematics. Interest in science remains relatively high for all students, irrespective of race and gender, through the early years of school. However, differences in mathematical proficiency gradually become more pronounced until, at the time the second year of high school is completed, a significant portion of all women and the majority of minority students have dropped out of mathematics and, for all intents and purposes, have given up their options for entering a mathematics-based career (Marrett, 1982; Gordon, 1986).

The suggestion is repeatedly made in the studies reviewed for this report that we will not be able to increase the numbers of scientists produced in this country until mathematics education in the schools at all levels has been improved. In the subsequent discussion, factors related to success in mathematics are examined.

## The Math Crisis

> Since mathematics is the foundation discipline for science, the state of mathematics education is a crucial predictor of future national strength in science and technology. Evidence suggests that our mathematics classrooms, like our smokestack industries, no longer provide adequate support for modern society. They deliver neither the mathematical foundation required for scientific research nor the quantitative literacy necessary for a democratic society (Steen, 1987, p. 251).

Mathematics education—like science education—has been the subject of intense national interest for many years, and efforts aimed at promoting mathematics education reform have been a high priority for the nation's educators (Usiskin, 1985). Few topics have generated more heat and less light, however. As Steen (1987), Stevenson and colleagues (1986) and numerous others have documented, concern to improve mathematics education has not resulted in a more quantitatively literate public—rather, that concern has coincided with steadily worsening reported levels of mathematics performance by American schoolchildren at all levels of the educational system. These declines have appeared despite reams of research into the factors that influence performance and achievement in mathematics.

Steen (1987), for example, argues that mathematics classrooms in America no longer provide the nation with the quantitatively literate workforce that is necessary to maintain national strength in science and technology. "Because of its widespread utility in industrial, military, and scientific applications, mathematics is a crucial indicator of future economic competitiveness. The evidence is overwhelming, however, that the mathematics yield of U.S. schools—the sum total of mathematics learned by all students—is substantially less than that of other industrialized nations" (1987, p. 251).

Steen cites Stevenson and colleagues (1986) in support of this contention. In their comparative study of the mathematics and reading achievement of 720 Chinese, Japanese, and American students they report:

> The data indicate that among the 100 top scorers on the mathematics test at grade 1, there were only 15 American children. At grade 5, only one American child appeared among the top 100 scorers from the total sample of approximately 720 children. On the other hand, among the children receiving the 100 lowest scores at each grade, there were 58 American children at grade 1 and 67 at grade 5 (Stevenson et al., 1986, p. 695).

The authors found significant differences in the schools they observed as well as in the school habits of students, and in parental expectations of student performance. Specifically, they note: (1) American students in the study were engaged in academic activities far less frequently than Chinese and Japanese children; (2) Less time was spent in mathematics instruction in American schools and in mathematics homework in American homes than in Chinese or Japanese schools and homes; (3) American mothers valued homework far less than Chinese or Japanese mothers; (4) American children were most likely to express unhappiness with school and schoolwork; (5) American teachers were more likely to be engaged in non-academic, non-instructional activities than were Chinese or Japanese teachers.

The authors conclude:

> The comparatively low levels of achievement of the American children in mathematics appear to be attributable in part to the fact that they are not receiving amounts of instruction comparable to those received by children in Taiwan and Japan. These cross-national differences become even more profound when they are extended over the school year.... Taken together, these data point to enormous differences in amounts of schooling young children receive in the three countries (1986, p. 696).

In addition to citing significant, alarming differences in the mathematics performance of U.S. and Asian schoolchildren, recent national examinations of academic performance have also dramatized equally significant, and equally alarming differences in the mathematics achievement and aptitude of females, non-Asian-American minority students, and Anglo male students in the U.S. (NAEP, 1980; Matthews et al., 1984; NSB, 1986). As these and other studies have indicated, since the first administration of the National Assessment of Educational Progress (NAEP), women and minority students have earned mean scores in mathematics that have been consistently below the mean of Anglo males. Similar results have been reported from data collected in the National Center for Education Statistics National Longitudinal Study (NLS) and the High School and Beyond Study (HSB) (e.g., Wagenaar, 1984; Ethington and Wolfe, 1986; Goggins and Lindbeck, 1986; Moore and Smith, 1986).

In her review of published research conducted with these data, Marrett (1986) identifies four themes that figure prominently in reported findings: (1) the first is that there is evidence Black and American Indian students have made significant strides in mathematics and science; (2) that despite these gains, the performance of minority students lags far behind that of Anglo students; (3) the factors that influence performance on standardized examinations of mathematics and science affect both minority and nonminority students alike; and (4) there is a need to improve, not just diagnose, minority student mathematics and science achievement. Of particular importance, she notes, is the finding that for minority and nonminority students alike, scores on the NAEP (and the test of mathematics achievement as used in the HSB) are strongly correlated with the amount of coursework a student has taken in mathematics.

It is highly significant therefore, that the amount of coursework in mathematics and mathematics-related subjects taken by women and minority students is much lower than that of Anglo males (Johnson, 1984; Jones et al, 1986; Marrett 1986; Nettles, 1986; Jones, 1987). Jones and colleagues (1984), in their study of mathematics achievement on the NAEP, note, "The average score for students who had not taken Algebra 1, Algebra 2, or Geometry was 47 percent, whereas the average for students who had taken all three courses was 82 percent correct for the same mathematics exercises. The relation of mathematics achievement to courses taken is strong and clear" (Jones et al., 1984, p. 161). One clear implication of these

findings is that the poor performance of minority students in mathematics achievement tests might be substantially improved if schools encouraged (or required) students to continue their studies of mathematics beyond algebra (Jones et al., 1984; Marrett, 1986; NAB, 1986).

Significantly, however, Jones and colleagues also found that the type of school attended was strongly related to both the number of mathematics courses taken and performance on the NAEP. They found, for example, that in schools with less than a 70 percent Anglo enrollment, the mean number of semesters of algebra and geometry was significantly below national means. "Note that 73 percent of all Black students, but only 8 percent of the White students, were attending such schools. In contrast, 66 percent of all White students, but only 7 percent of the Black students, were attending schools that were at least 90 percent White." It is significant, therefore, that the mean number of years of algebra and geometry taken by 1980 NAEP seniors in predominantly (90 percent) Anglo schools was 1.8, while among those in schools with a 70 percent or less Anglo enrollment, the mean was 1.3. There is, in other words, a strong link between the lower NAEP scores of Black students and their overrepresentation in schools where they were less likely to take advanced mathematics courses.

However, Moore and Smith (1986), Benbow and Minor (1986) and Ethington and Wolfe (1986) have all determined in separate studies that differential coursework enrollment does not completely explain all of the difference in male/female mathematics performance. Benbow and Minor (1986), using data collected as part of the Study of Mathematically Precocious Youth (SMPY), found that mathematically gifted males and females in high school did not differ in the number of mathematics courses taken or in their attitudes to science and mathematics. Nonetheless, males performed better on tests of mathematical reasoning, were more likely to take and score highly on college-level science achievement tests, and were more likely to cite an intention to major in a quantitatively oriented field (engineering and physics) in college than females.

Ethington and Wolfe (1986), using data drawn from the first follow-up of the High School and Beyond study (HSB), found that mathematics aptitude and greater exposure to mathematics had a greater positive impact on the overall mathematics achievement of men than it did on the mathematics achievement of women. Expressed in other terms, controlling for mathematics aptitude and the number of math courses completed did not eliminate (nor fully explain) differences in the performances of males and females on tests of mathematics ability. Similarly, Moore and Smith (1986), in an effort to explain sex and race differences in mathematics knowledge and arithmetic reasoning using data from the National Longitudinal Study, report, "Course work was found to affect sex differences significantly in mathematics knowledge but not arithmetic reasoning" (p. 94). Similar findings emerged in their analysis of racial differences in mathematics knowledge. "The positive effects of high school grades in [mathematics] courses is much stronger for Whites than for Blacks. Still, differences in mathematics knowledge shrink significantly when course-work experiences are controlled" (p. 93).

As Marrett (1982; 1986) observes, however, many minority students fail to progress beyond elementary mathematics because they fail to earn the grades and fail to acquire the skills to tackle higher level mathematics coursework. Making higher-level coursework mandatory for women and minority students may not be sufficient, therefore, to improve the quality of their mathematics preparation. Given the hierarchical nature of mathematics, unless students possess the requisite foundation, advanced work is unlikely to be useful and is unlikely to change the patterns of achievement that are described in these studies.

There is evidence, however, that reforms in the elementary and secondary school mathematics curriculum are responsible for some of the gains observed in the achievement of Black and Hispanic students on the NAEP. In his examination of the past 20 years of curriculum reform in mathematics education, for example, Usiskin (1985) lends support for the thesis that the "back-to-basics" movement in elementary and secondary school mathematics was principally responsible for the increase in performance of Black and Hispanic students of all ages on the NAEP. Because this movement promoted the establishment of minimal

competence standards for promotion or graduation in many states, minority students and students of all races at the bottom of the ability distribution have begun to improve their performance on paper-and-pencil tests that emphasize computation skills. Accordingly, the improvements in NAEP performance reported for minority students occurred precisely in the area of basic computation skills.

As Usiskin notes, however, "These successes have been gained at great cost. The performance of the top 25 percent of students on the NAEP declined from 1977-78 to 1981-82. Overall performance on applications and problem-solving items dropped from 1972-73 to 1977-78 and did not improve in 1981-82" (1985, p. 7). He concludes that the only remedy for this situation is a tightening of graduation requirements and a major updating of the elementary and secondary school mathematics curriculum. Specifically, he notes, there needs to be a shift from rote manipulation to problem solving; moreover, "estimation, applications, computers, and statistics and probability all should play important roles in secondary school mathematics study" (1985, p.15).

Other research is not particularly illuminating. In a review of 24 studies concerning minorities in mathematics, Matthews (1984) observes that a significant portion of this literature is concerned with explaining why minority students fail in mathematics; while this attitude is understandable, it is hardly helpful. She comments: "One of the greatest difficulties with past research (and with the prevention or intervention programs subsequently developed) is its emphasis on minority students who are unsuccessful in mathematics. Findings of poor performance do not explain the causes of that performance" (1984, p. 92).

Additional research—cited in a special edition of the *Journal of Research in Mathematics Education*—consistently points to cultural and linguistic differences between minority and majority students in an effort to explain the observed differences in their mathematics achievement. Much of this work has suggested that a greater understanding of a student's culture and language might promote improvements in their mastery of mathematics (Bradley, 1984; Valverde, 1984; Cuevas, 1984; Duran, 1986). These factors, these authors suggest, have particular relevance for the curriculum and for the manner in which key concepts are presented to students:

> Not all cultures interpret the physical world nor generalize about it in consistent ways.... The way mathematics concepts are presented in textbooks may be inconsistent with how immigrant Hispanic students have already been introduced to certain concepts. This inconsistency may cause confusion and delay understanding (Valverde, 1984, p.126).

Significantly, however, the attitudes of Black and Hispanic students to science and mathematics do not appear to differ dramatically from those of Anglo and Asian American students (Duran, 1986; Walker and Rakow, 1985). Duran, for example, in his review of the literature on the science and mathematics achievement of Hispanic students, concludes that the socialization of Hispanics may hinder the development of the requisite skills for success in mathematics and science, despite survey findings suggesting that they hold positive attitudes toward science in general and science careers in particular.

There is much evidence that part of the socialization process for adolescents significantly affects academic achievement. Studies by Jones (1979), Paul and Fischer (1980), Hock and Curry (1981), Ishiyama and Chabassol (1985), and Felson and Reed (1986) all note that as young people mature, their self-awareness, their relationships to their peers and their academic achievement become intricately connected. Felson and Reed, for example, found that students' self-appraisals and their perceptions of their academic performance are significantly affected by the friendship networks to which they belong. These studies suggest that the functioning of peer groups may partially explain why minority students appear to perform so poorly in mathematics. Partial support for this hypothesis was provided, as we shall see subsequently, in a study conducted by Moore (1987).

## Peers, Academic Aptitude, and Academic Achievement

Throughout much of the early decades of this century, the findings described in studies of low mathematics achievement among minority students would have been explained by some researchers as the function of genetic differences between Anglos and non-Anglos (Lawler, 1978). Jensen (1968), in a much publicized study of IQ and academic achievement, for example, concluded that environmental factors such as social class, schooling, and exposure to middle class culture, contributed less to IQ scores than inherited characteristics.

Moore (1987), in an important study of class, race, and IQ, provides strong evidence that socio-cultural forces are at the heart of these differences in test performance. The objective of her study was to test the hypothesis that egalitarian relationships between Blacks and Anglos can positively influence Black children's performance on standardized tests. To test this hypothesis, a unique research/sample design was created. Specifically, a sample of 46 adopted Black children was selected; 23 were adopted by Anglo families (trans-racially adopted children); the remaining 23 were adopted by Black families (traditionally adopted children).

Moore's research was based on earlier studies by Blau (1981) that suggested that being raised by an Anglo family would facilitate the adopted Black child's integration into a *mainstream cultural orientation* by introducing the child into an Anglo friendship network. One measure of such a mainstream orientation, Moore reasoned, would be reflected in higher IQ scores for trans-racially adopted children than for traditionally adopted children.

The sample families were largely similar with respect to socioeconomic status but differed with respect to the racial composition of their neighborhoods and with respect to the friendship networks of the children. The families with trans-racially adopted children tended to live in Anglo or integrated neighborhoods and reported having more Anglo friends than traditionally adopted children. Of particular significance were the patterns of academic achievement and IQ scores reported for each group: trans-racially adopted children had higher reading scores on the Iowa Tests of Basic Skills than traditionally adopted children and reported a higher mean IQ score (117) on the Wechsler Intelligence Scale for Children (WISC) than that reported for the traditionally adopted children (103). The author observes, "Although traditionally adopted children achieved scores that placed them in the average range for the WISC, the trans-racially adopted children showed an advantage of nearly one standard deviation in their performance" (1987, p. 47).

The racial composition of the child's friendship network was highly correlated with IQ ($r$ = .61) as was the average reading level of peers ($r$ = .51). Moore concludes that these results suggest why such a significant difference is consistently observed in the IQ scores of Anglo and Black children, even when they are from similar social class backgrounds. "The larger cultural milieu in which the child is socialized, not just parents' education and income, should also be viewed as a factor in ethnic group differences in children's development of skills and performance orientations measured by instruments such as the WISC" (1987, pp. 51-52).

## VI. EXCELLENCE, ACADEMIC ACHIEVEMENT AND MATHEMATICS

As indicated earlier, the objective of much of the research cited in this report has been to explain the variation in achievement observed in students of different races and sexes; more specifically, the aim of a significant number of such studies is to isolate the factors that account for the failures of minority students. However, it is difficult, if not impossible, to use the results of such research to influence curriculum reform and/or the development of programs to improve student achievement. Perhaps, Sowell (1986) notes, the problem has not been the studies but rather their exclusive preoccupation with student dysfunction.

> The history of the advancement of Black Americans is almost a laboratory study of human achievement, for it extends back to slavery and was accomplished in the face of the strongest opposition confronting any American racial or ethnic group.... One small, but important, part of the advancement of Black Americans has been educational achievement. Here, as in other areas, the pathology is well known and extensively documented, while the healthy or outstanding functioning is almost totally unknown and unstudied. Yet educational excellence has been achieved by Black Americans.... When quality education for Black youngsters is seen, instead, as something that has already been achieved—that happened decades ago—then an attempt to understand the ingredients of such education can be made on the basis of that experience, rather than as a search for exotic revelations (1986, pp. 7-8).

Sowell studied successful Black schools using a list compiled by the late Black educator, Horace Mann Bond. Sowell sought to explain why these schools produced such a significant number of Black achievers—why, for example, 5 percent of the high schools in Bond's study generated 21 percent of the later Ph.D.s, or why four of the six schools cited produced such notables as Wilson Riles (first Black state superintendent of schools), Thurgood Marshall (first Black Supreme Court justice), Robert C. Weaver (first Black Cabinet member), and Edward W. Brooke (first Black U.S. senator since Reconstruction), to name just a few.

Sowell discovered that in their academic heyday (roughly the period prior to *Brown v. Board of Education*), test scores at these schools (IQ as well as achievement tests) had been higher than at Black schools in general, and were higher than those of the general school population of the U.S. He found further that a no-nonsense "law and order" policy characterized their operation: there were few, if any, discipline problems, and high standards of conduct and academic achievement were maintained. Students were expected to strive for excellence, and there was widespread community support for the efforts of these schools to maintain high standards.

Finally, each of these schools was located in an urban setting, a fact Sowell found particularly interesting.

> This is remarkable because, during the academic heyday of most of these schools, most American Negroes lived in rural and small-town settings. This suggests that the rise of such prominent Blacks as those who came from these schools—which is to say, most of the top Black pioneers in the history of this country—seems a matter less of innate ability and more of special social settings in which individual ability could develop; and that the settings from which such Black leadership arose were quite different from the social settings in which the mass of the Black population lived (1986, p. 36).

Desegregation changed the face of Black education, however. Many of these excellent institutions changed drastically in the post- *Brown v. Board of Education* decades that followed. Nowhere, Sowell notes, did desegregation have a more dramatic impact than on higher education enrollments, which saw a doubling of Black student enrollment at predominantly Anglo colleges between the 1960s and the 1970s.

This change, Sowell observes, created as many problems as it solved. While more Black students have managed to enter these schools, their persistence has been far below that of non-Black students and their academic performance has been markedly sub-par. Their academic preparation has often been cited as the cause of these problems, but, Sowell contends, the finger of blame must instead be pointed at institutional admissions policies.

Under pressure to pick minority students, top rank colleges (for example, the Berkeleys, the Michigans, and the Ivy League schools) recruited the best minority students available. Those who were admitted, however, were totally unprepared to meet the academic demands they would confront, and the schools, in turn, were totally unequipped to provide for the educational

needs of these students. What has resulted, Sowell concludes, is a "widespread mismatching of individuals with institutions."

> When Black students who would normally qualify for a state college are drained away by Ivy League colleges and universities, then state colleges would have little choice but to recruit Black students who would normally qualify for still lower level institutions—and so the process continues down the line. The net result is that in a country with 3,000 widely differing colleges and universities capable of accommodating every conceivable level of educational preparation and intellectual development, there is a widespread problem of "underprepared" Black students at many institutional levels, even though Black students' capabilities span the whole range by any standard used (1986, p. 131).

This mismatching would not have such grave consequences were the programs created to meet the needs of these students successful. The statistics suggest that, with few exceptions, they have not managed to assist minority students to graduate from college at rates comparable to those of Anglos and Asian Americans. Worse, the dominant theme of the programs created to assist these students is remedial—their emphasis is on assisting students to survive, not excel.

A significant departure from this trend was reported by Treisman (1982; 1985) in his creation of the Mathematics Workshop Project, a component of the University of California, Berkeley's Professional Development Program (PDP). Since 1978, Black and Hispanic undergraduates in this honors program have earned higher mean grades in calculus at Berkeley than nonworkshop minority students and have graduated from the university at rates roughly comparable to those of Anglos and Asian American students. The program was created in response to concerns about the low achievement of Black undergraduates at Berkeley in mathematics but its unique format grew out of research that was undertaken by Treisman to explain why Black students were having such intense problems in their adjustment to university life.

Treisman's research departed significantly from the typical educational research paradigm. The major question he sought to answer was not, "Why do Blacks do so badly in mathematics?" but rather, "Why are Chinese students so successful in a subject that non-Chinese minority students find so daunting?" He assumed, quite plausibly, that Blacks might enjoy the same levels of success of the Chinese if a means to promote successful study habits and a productive approach to mathematics could be determined.

For many years, these two groups have been at very different points in the academic pecking order at Berkeley: Chinese students have traditionally been the most accomplished mathematics students at the university while Blacks have been the least accomplished. For example, in 1975 only two of the 21 Black students who enrolled in the first course (Math 1A) of the three-term calculus sequence managed to complete the last term in the sequence (Math 1C) with a grade higher than *C*. Since calculus is required for most of the academic majors minority students at Berkeley pursue (for example, architecture/environmental design, business, engineering, all of the natural sciences, and pre-medicine), this pattern of failure for Blacks has typically had devastating consequences for their academic persistence and graduation.

In 1975 Treisman first interviewed 20 Black and 20 Chinese students about their study habits and their methods of preparing for examinations. He subsequently observed them around the clock—in their homes, on dates, as they interacted with family and friends—for almost 18 months to obtain some sense of how their adjustment to campus life and to the study of mathematics differed.

- Among Black students, he found a pattern of cultural, social, and academic isolation. Many of these students had come from high schools where few students attended college. They had achieved success in secondary mathematics by becoming extremely self-reliant and by becoming relatively isolated from the non-academically oriented social life pursued by other students in their schools. At the university, these habits of isolation—studying

long hours alone, resisting the temptation to hang out with friends—persisted. Unfortunately, such patterns proved harmful to their adjustment to the university: most of these students became lost and confused by the blistering pace of first-semester calculus. They were unwilling to seek help from other students or from many of the remedial programs created to assist minority students. They saw these programs as having been created for poorly prepared, weak students, and their pride simply wouldn't permit them to admit to others that they were struggling. Thus:

> The freshman year at Berkeley was a time of rude awakening and disorienting surprises, even for many Black students who had attended academically reputable, predominantly Anglo high schools. Even though these students were relatively well-prepared academically, the pace and intensity of competitive first-year mathematics and science courses coupled with the unexpected social isolation they encountered prevented many of them from getting their bearings or developing adequate study habits; thus, few did well in their courses (1985, p. 22).

- The twenty Chinese students in his study, by contrast, almost immediately upon their matriculation at the university, found friends and classmates with whom they studied regularly. Twelve of the 20 formed informal study groups that became a vehicle for mastering mathematics and for becoming acquainted with the ways and means of life in the university.

> Composed of students with shared purpose, the informal study groups of Chinese freshmen enabled their members not only to share mathematical knowledge but also to "check out" their understanding of what was being required of them by their professors and, more generally, by the university. These students learned quickly, for example, that the often-quoted rule of thumb for estimating the number of hours that one should devote to study—two hours for each class hour—was seriously misleading. The Blacks whom I had interviewed devoted approximately eight hours per week to homework and study for their four-unit math course; the Chinese devoted roughly fourteen hours per week to these same tasks (1985, p. 13).

Treisman was particularly struck by the efficiency with which Chinese students within these groups mastered critical concepts in the course, concepts that, by contrast, left many of the Black students in his study bewildered. Black students, Treisman observed, were frequently stumped by a problem whose solution consumed hours of their time—often without success.

The Chinese students, when confronted with a similar problem, were quickly able to consult others in their study group. Typically, if no one in the group had come up with a solution, group members concluded that the problem was difficult enough and significant enough to warrant consulting the teaching assistant for assistance.

Black students, by contrast, almost never sought out such assistance, particularly from the TA (teaching assistant), because they were fearful they would be exposing an embarrassing weakness that would cause them to lose face in the eyes of others in the class.

It became apparent to Treisman that group study offered many options that would be particularly useful to Black students at the university. First, study groups would provide an efficient vehicle for mastering the challenges of calculus. The interaction of students as they struggled with difficult, challenging problems appeared to have clear benefit for students who were prone to getting stuck. Secondly, study groups would provide students with an opportunity to combine their social and academic lives, and in so doing, combat much of the social isolation that Treisman had observed among the Black students in his study.

In order to avoid the appearance of being "just another remedial program", Treisman and the staff of the Professional Development Program billed their Mathematics Workshop program

as an honors program. The "honors" label was not difficult to sell. PDP is sponsored by the university's Academic Senate under the auspices of a standing committee of the Senate, the Special Scholarships Committee. Created in 1964, this committee has counted some of the university's finest scholars (including two Nobel prize winners) among its members. Having such a committee sponsor an honors program, therefore, was absolutely consistent with student expectations of how the university functions.

The workshop's honors focus was not meant to suggest that its participants were selected because their superior academic credentials: rather, the workshops would require that each student would strive to earn honors-level grades as a condition of his or her participation.

One clear-cut benefit has been derived from this emphasis on honors. The workshops attract highly motivated students who see a direct relationship between working for high grades and achieving their career or graduate school objectives. Thus, since the creation of the Mathematics Workshops, PDP students typically put twice as much time into studying each night as is suggested by conventional campus wisdom. This increased "time-on-task" is believed to explain, in part at least, why workshop students do so well.

The work students are asked to complete in each workshop is intended to be of a more formal nature than the work Treisman observed among the study groups of the Chinese students in his study. However, the basic principles that made these informal groups so successful—the intense discussion and debate between students around difficult problems in mathematics—were retained and elaborated upon. These features remain a distinct component of the program today.

The current version of the program centers around workshops that enroll approximately 20-25 students each. Each workshop meets for two hours twice a week. Each workshop session consists of both individual and group work that is centered on the problems contained in a "worksheet." Worksheet problems typically include:

> (1) old chestnuts that appear frequently on examinations but rarely on homework assignments; (2) monkey wrenches—problems designed to reveal deficiencies either in students' mathematical backgrounds or in their understanding of basic course concept; (3) problems that introduce students to motivating examples or counterexamples and that shed light on, or delimit, major course concepts or theorems; (4) problems designed to deepen the student's understanding of and facility with mathematical language; and (5) problems designed to help students master what, in workshop parlance, is known as "street mathematics"—the computational tricks and shortcuts known to many of the best students, but which are neither mentioned in the textbook nor taught explicitly by the instructor (1985, pp. 42-43).

Students work on these problems alone at first, then together in a group of four or five other students, all of whom have been working with the same problem(s). The major objective of the group work is to have students communicate with other about their efforts to develop solutions. This communication may be facilitated in a number of ways: (1) students may be asked to present their problem solutions to others in their group (or if the situation warrants it, to the entire workshop); (2) two or three students may be asked to edit another student's work, paying particular attention to issues of mathematical accuracy (for example, was the correct form followed?), and to the elegance and clarity of the student's conclusions; and (3) students who appear to be well advanced in their work may be asked to tutor slower students until everyone in the group has arrived at the same level of expertise.

The advantage of these approaches is that the art of communicating complex ideas and concepts is an important means through which students organize and clarify their thoughts. As Treisman observes, "By continually explaining their ideas to others, students acquire the same benefits of increased understanding that teachers themselves regularly experience." If students find it difficult to express themselves, they become immediately aware of the inconsistencies in their understanding. Moreover, their efforts to make themselves understood—particularly in the

face of pointed, thoughtful probing by the listener(s)—may also lead them to explore facets of a particular concept that might not otherwise have occurred to them. Discussing the solutions to worksheet problems also provides students with an opportunity to practice the skills and to exhibit the mastery of course concepts they are expected to demonstrate on quizzes and examinations.

Students are not alone in the workshops, however. A workshop leader—typically a graduate student in mathematics or physics or some other similarly quantitative field—will be responsible for the preparation of the worksheets and for directing the activities of workshop students. Leaders are taught to be unobtrusive. Their major task is to ensure students are communicating effectively about the work at hand. "Towards these ends, the leader circulates among the students and listens carefully to their discussions. When he suspects that students are not listening carefully to one another, he intercedes, perhaps asking a student to restate something he has said more precisely or to explain in more detail the steps by which he arrived at the solution to a certain problem" (1985, pp. 44-45).

One clear-cut advantage of the group study format used in the workshop is that anyone listening to the conversations students are having about their work has a unique glimpse of the mathematical thought processes of each of the speakers. As students discuss their struggles with the material, they are literally making their problem-solving algorithms public. At the same time, these conversations provide the workshop leader with numerous opportunities to determine the degree to which students have mastered important material and key ideas. If students are unclear about the work, their problems will quickly become manifest in their verbal interactions. As leaders overhear what students are saying, they can pinpoint the nature of the difficulty and respond accordingly.

The workshop, therefore, is an ideal instructional setting: it offers students an opportunity to practice the skills they will be expected to demonstrate in quizzes and examinations; it forces students to communicate with each other in a fashion that promotes greater mastery of difficult concepts as well as familiarity with the language and syntax of mathematics; and finally, it provides instructors with a vehicle for monitoring the progress of students as they master course materials.

Data on student achievement suggests that the program has been extremely successful:

- Black students at Berkeley are at greater risk of academic failure and are more prone to leave college before graduation than any comparable group of students. Significantly, 55 percent of the 231 Black students who were enrolled in the workshop program between 1978 and 1985 earned grades of $B^-$ or better in calculus; only 21 percent of the 284 nonworkshop Black students who took calculus during this period earned comparable grades. The mean final calculus grade for workshop students was 2.6 ($N$ = 231); the comparable mean for nonworkshop Blacks was 1.9 ($N$ = 284).

- The workshops also had a dramatic impact on student failure in mathematics: during the period between 1978-85, only 8 Black workshop students in 231 (3 percent) failed calculus; by comparison, 105 of 284 (37 percent) nonworkshop Black students failed the course.

- Perhaps the most significant impact of the workshops was on the mathematics achievement of poorly prepared students (that is, students who entered the university with SAT Mathematics scores in the lowest percentile (200-460) of the score distribution). The mean final grade in calculus for Black workshop students with poor mathematics preparation (2.2; $n$ = 56) was 0.4 grade points higher than that of nonworkshop Black students (1.9; $n$ = 42) with "strong preparation" in mathematics (defined as students with an SAT Math score above 550).

- Participation in the workshops was also associated with high retention and graduation rates. Approximately 65 percent of all Black workshop students who entered the university in 1978 and 1979 (47/72) had graduated or were still enrolled in the spring semester of 1985. The comparable rate for nonworkshop Black students entering the university in those same years was 47 percent (132/281). The proportion of workshop students earning degrees in science and/or mathematics-related fields was 44 percent—the comparable rate among nonworkshop students was 10 percent. Comparable rates of achievement and persistence have been reported for Hispanic workshop students as well.

The persistence of these students is consistent with the model proposed by Tinto (1975) and later elaborated upon by Pascarella and Terenzini (1980) and Fox (1986). The "Tinto model" asserts that students are most likely to persist at colleges where they find an appropriate social and/or academic niche within the campus community. Significantly, therefore, the social circles that PDP workshop students form in workshops frequently become the nexus for social networks that will persist through the student's senior year, and in some cases, beyond.

Treisman's success with this approach extends beyond the boundaries of the Berkeley campus. Successful adaptations of the workshop program—defined as programs whose Black and Hispanic students have earned final mean grades in calculus of 2.7 or better—have been created at UCLA, UC San Diego, UC Santa Cruz, and Cal Poly Pomona. Similar secondary-level adaptations have been created for high school students in Albany, Richmond, Stockton, and Orange County, California.

These adaptations are by no means exact clones of the Mathematics Workshop program at Berkeley, but they all share key features in common. Treisman was interviewed for this report and made a number of observations about his work and his approach to the creation of programs for minority students in mathematics that are presented below.

First and foremost, he noted, at the college level there is much to be learned by studying successful students. As he demonstrated in his observations of Chinese undergraduates at Berkeley, successful students typically have a "bag of tricks" for dealing with institutional bureaucracies (for example, how to navigate the financial aid mess, how to locate helpful teaching assistants, how to approach faculty members if you have a "dumb" question), as well as useful strategies for succeeding academically (which campus classrooms are open all night, which questions always appear on so-and-so's examinations, etc.). Where possible, Treisman comments, these pieces of received wisdom need to be incorporated into the design of programs that serve students (at all educational levels) and should be integrated into the academic and personal advising students are given by program staff.

> What should not be overlooked here is the fact that every minority student who gets an "A" in a mathematics course that other equally (or better) prepared students failed may have learned something that we should pass on to others. Too much educational research concentrates on explaining the variance in performance when, in reality, it is the unexplained variance—typified by the kids whose success can't be explained by race, SES, prior levels of preparation for mathematics, or time-spent-on-task—that may hold the answer to some of our knotty questions about how to design programs that promote student success.

Treisman's second observation was related to the mathematics curriculum and to the philosophy that guides successful instruction. The most successful teaching techniques, he claims, are those that attempt to have students approach mathematics the way mathematicians do, by looking for and examining patterns.

In too many instances, mathematics instruction fails to provide students with an opportunity to explore mathematics or to play with the patterns that fascinate and entrance mathematicians. Instead, the curriculum concentrates on rote procedures and on getting the right answer. "Students are taught, in other words, to focus on one of the end products of mathematics—the

answer—and not on the potentially fascinating process we engage in to generate that answer."

In the Stockton Summer Math Institute, a project Treisman directed in 1987 with support from the Hitachi Foundation, the search for pattern was placed at the core of the curriculum of a summer program for 9th-graders. For example, in one of the courses offered, students were introduced to variables as "pattern generalizers" and were given an opportunity to use variables to understand arithmetic progressions.

> Students had hands-on experience counting the number of elements in individual entries in a progression and in all entries up to a certain point in the progression. Then the power of variables was illustrated by showing how to find general expressions for the nth term and for the sum of the first $n$ terms of the progression (Stanley, 1987, p. 3).

Not surprisingly, the program involves working with interesting problems and working in small groups of the type used in PDP's Mathematics Workshops. Preliminary reports of the achievement of Stockton Summer students, the majority of whom were minority students, strongly suggests that there is considerable merit to this approach. At the beginning of the program, the mean percentile score of participating students on a test of mathematical problem solving skills was 27; at the end of the program the mean was 78. Student attendance and morale were described as "excellent," and observers feel that the model has tremendous potential as a tool for assisting students to make a successful transition from middle school mathematics to the college-track algebra course in high school.

Treisman's final observation is related to teachers and their role in mathematics instruction. He points out that in all too many schools with predominantly minority enrollments, mathematics is taught by teachers who are not trained for it and who may have been assigned teaching duties in the subject against their will. Efforts to reform teaching techniques and the content of the curriculum pass these teachers by, Treisman observes, because they have neither the time, the opportunity, nor the interest in learning how to teach the subject well. If change is to occur, a number of important alterations must be made in the way we try to affect how teachers teach mathematics.

The Stockton Summer Math Institute provides key insights to the nature of these changes. For example, teachers who participated in the institute were actively involved in the development of the institute's curriculum and in the preparation of teaching materials. In many teacher training programs, teachers are treated as "students": they become passive learners who have little or no opportunity to bring their own classroom expertise to bear as they learn new techniques and ideas. Stockton Institute teachers, however, adapted the materials they would use in the classroom from a variety of texts and teaching materials, guided in large part by their own sense of what they knew to be effective methods for presenting topics to their students. "In many of the previous efforts at mathematics teaching reform, instructional material sat on the shelf unused because teachers weren't given an opportunity to adapt the stuff for the unique circumstances they confronted in their own classrooms. If curriculum materials are developed on the assumption that they should be "teacher proof"—that is, able to be used without any direct involvement of the teacher—is it any wonder that teachers ignore them?"

Organizing students into study groups also proved to be an effective means of assisting both students and teachers. For students, it provided the same opportunities to discuss problems and to critique work that undergraduates in the Mathematics Workshops experience. Similarly, for teachers, the opportunity to observe students as they attempted to complete classroom assignments provided a means for determining both how well the curriculum was working and how well individual students were doing.

From these observations, Treisman concludes: (1) mathematics is something that students must do, not as a set of rules they must memorize, but rather as an activity in which they must be actively engaged; and (2) instruction works best when students are given an opportunity to communicate with each other about their work and when teachers are in a position to observe, and, where necessary, intervene, in that communication.

Treisman is a mathematician first and a teacher second. His philosophy of teaching reflects a desire to provide students with opportunities to do the things mathematicians do, namely, to search for and examine patterns. As W.W. Sawyer writes:

> ...to make mathematics you must be interested in mathematics. The fascination of pattern and the logical classification of pattern must have taken hold of you. It need not only be the only emotion in your mind; you may pursue other aims, respond to other duties; but if it is not there, you will contribute nothing to mathematics.

Using our understanding of mathematical processes in designing instruction is also recommended by Scheffler (1976) who underscores the importance of using "the logical, or normative, analysis of mathematical operations and methods, as helping to set the aims of mathematics education."

Accordingly, one sees in these programs a greater concern with the process of doing mathematics—designing classroom opportunities to observe what students are doing with mathematics problems—and less focus on the products of students' labors—that is, the answers they come up with. Secondly, there is a concern with maximizing opportunities for teachers to observe students at work, doing the kinds of problems and exercises that elicit the skills and abilities we are most interested in having students acquire. Finally, group work has the potential to influence the dynamics of peer groups within the schools. At present, in all too many schools, academic achievement, particularly in mathematics and science, is not valued by students. If mathematics classrooms succeed in helping significant numbers of students experience success in mathematics, and if that experience is not limited simply to a few, select individuals, perhaps we will eliminate the word "nerd" from the vocabulary of our young and will reverse the negative attitudes toward mathematics that all too many students bring with them to high school and college.

Treisman's work by no means represents the only successful effort to improve the performance and achievement of underrepresented students in mathematics and science. Reviewed for this report were studies by Morning and colleagues (1980), Campbell and Schwartz (Stevens Institute of Technology, 1986), and Gordon (1986) that examine programs that encourage minority students and/or women to enter careers in mathematics, science, and engineering. Programs are cited in each that have managed to promote high levels of achievement in science, engineering and mathematics for underrepresented students. These programs share many features in common with Treisman's efforts and with each other, not the least of which is an attempt to build on students' strengths and not to concentrate exclusively on students' weaknesses.

Moreover, Treisman is not the only innovator to use study groups successfully to influence student achievement (e.g., Webb, 1982). Friederson (1984; 1986) reports success in using cooperative learning techniques to improve the test taking performance of minority medical students and minority nursing students; similarly, Carmichael (1979) and Whimby (1980) report success in improving mathematics and science problem-solving skills among students at many levels (and in a variety of subjects) using group study approaches.

Finally, and most significantly perhaps, Treisman's work helps to place much of the research in mathematics education in some much needed perspective. Much of what has been reviewed here has focused on the structural barriers (both personal and systemic) that inhibit (or promote) student success in science and mathematics courses. What has been suggested here (1) is that students succeed when the proper conditions for success are provided and (2) that we do, in fact, know something about what those conditions must be.

It has been suggested, for example, that the most important factor in promoting the success of students in mathematics may very well not be race, gender, SES, aptitude, school attended, or number of mathematics courses taken. Students of all races, from a variety of schools and social backgrounds, and at all levels of the mathematics ability distribution have done well in

math workshops. The issue in their success, Treisman has noted, is not the student's background or "native ability" for mathematics, but rather our ability to design instructional settings that promote excellence. Workshops students, Treisman is fond of saying, provide us with an "existence proof"—they demonstrate how much can be achieved if the proper conditions are created and maintained. They also demonstrate that mathematics excellence can be achieved by minority students if it is demanded of them.

Creating conditions that promote excellence is largely the province of the schools. If we recognize, as Sowell (1986) observes, that the nation once produced high quality Black schools whose instructional programs were comparatively free of gimmicks, then perhaps we can recreate these conditions for all students. The virtues of creating collaborative learning/group study opportunities, for example, have certainly been extolled at great length here. Are there other measures—specifically related to the use of media—that can assist in the quest to improve the science and mathematics preparation of the nation's students?

## VII: CONCLUSION: MEDIA AND ATTITUDES TO SCHOOLWORK

Earlier in this report, considerable attention was devoted to the impact of the media on attitudes. The problem of understanding how television or any other medium affects students' attitudes to science, it was noted, begins with the difficulty of defining the exact nature of such an attitude. As Munby notes, surveying attitudes to science is partially a measurement issue (how can we design appropriate instruments?) and partly an issue of definitions (how are we to define attitudes to something as vast and complex as science?). As a solution Munby suggests:

> We ought to ask if the affective domain itself is a useful basis upon which to construct a fresh analysis of the concept "attitude of science." It might be more useful to start with the view that whatever personal preferences and attitudes people might have, these ought to be formulated wisely and thus grow out of the knowledge and understanding of science which is the business of science education to foster (1983, p. 156).

If the use of media is to have any significant impact on efforts to increase the participation of women and minority students, a campaign to change "attitudes to science" is probably unlikely to succeed. (1) Students' attitudes are not the problem, it is their failure to succeed in acquiring the skills in school—particularly in mathematics—that will put them "on track" (literally) to science and engineering careers. (2) When students are successful in school, those positive experiences typically promote positive attitudes to school and to schoolwork. These attitudes become the foundation for future school successes since students are motivated to do well. If students are motivated, they are likely to work hard, and if they work hard, they are likely to continue to succeed. If they continue to experience success in their efforts, that success has a high probability of persisting throughout their school careers.

The foregoing fits Liska's (1984) description of a reciprocal model of the relationship between attitudes, intentions, and behaviors. As he wrote: "Clearly, a reciprocal effects model is warranted, theoretically and empirically, where behavior directly affects attitudes, attitudes directly affect intentions and behavior, and intentions directly affect behavior" (1984, p. 67).

I would propose that we test a reciprocal impact model using viewers of the TV show *3-2-1 Contact* as subjects. That series appears to be a useful example of a way to utilize the media in support of science education. Its objectives are modest. It aspires to make kids curious about science in the hopes that their curiosity will translate into greater attention to science subjects in general and science schoolwork in particular (Mielke, 1987). The techniques used to ensure that the program would appeal to the target audience were well thought out and rigorously carried out (Chen, 1981; Mielke and Chen, 1983). The show is supported by science

clubs (Contact Science Clubs) and a magazine and generally seems to serve as the perfect complement to the science education students receive in school.

The attitudes it seeks to influence are comparatively modest (to incite curiosity), but can have significant impact on school-related behaviors. If students are inspired to read more or to ask questions or to be more attentive, then the ultimate impact should be felt in the academic achievement of Contact viewers in science classes.

A longitudinal look at these viewers would answer a variety of questions, particularly if, following Liska (1984) and Liska et al. (1984), there is a reciprocal relationship between attitudes formed by viewing *3-2-1 Contact* and grades in school science and mathematics. There are a number of reasons why I believe this is the most reasonable study for OTA (or, some other federal agency) to consider:

- Cross sectional studies will not provide a means for determining how attitudes and school behaviors change over time. Since *3-2-1 Contact* is a series that is consciously designed to build up a faithful viewing audience, its impact is likely to be greater than one-shot movies and shows (for example, a dramatic presentation about the life of the Curies). Such shows may impress students and favorably dispose them to seek more information about a particular topic, but it is unlikely that one will observe a long-term impact on school behavior.

- The literature describing health education campaigns that seek to promote such behaviors as dieting, exercise, or smoking cessation (see for example, the research cited by Salmon, 1985; Chaffee and Roser, 1985; and Baggaley, 1985) all suggest that media effects are modest. In and of themselves, they do not appear to drive viewers into health spas or away from the cigarette habit. As Baggaley wrote, "The public is resistant, or even oblivious, to attempts made by the media to persuade it of new beliefs or a new course of actions" (p. 236). Rather than seeking the means to "change attitudes to science" on the part of students who have a history of being indifferent to science in schools, it seems more reasonable to determine whether constant viewers of *Contact*:

  a) have a demographic profile that suggests the target audience is watching;

  b) differ significantly in the amount of homework they do, in their grades in science and mathematics, and in their career goals than their nonviewing peers, and

  c) remain the same or change over time with respect to their demographic makeup, their school achievement patterns, their viewing patterns, and so forth.

One can determine, as well, what images viewers enjoy and perceive as compelling. Comparing consistent viewers with inconsistent viewers and/or nonviewers with respect to favorite episodes, characters, topics, and a host of other issues would assist enormously in charting future shows or other public information campaigns. As is done in the entertainment industry, such market research would also be invaluable in designing additional programs to reach groups that are not currently tuned in.

There is little to be done to counteract the images of science that students see in entertainment shows. Gerbner's (1987) suggestion that a "science media coordinating council" be created to work with network executives to create realistic images of science for media use is timely, but unlikely in the immediate future to affect the deluge of negative images of science the public receives each week. The real issue, as I suggested earlier, is to complement what goes on in the schools and to continue to arouse students' curiosity in the world around them. The battle to keep students interested in science will be won—ultimately—in the classroom, not on the TV screen.

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# THE RELATIONSHIP OF BLACK INNER-CITY STUDENTS' PERCEPTIONS OF ABILITY TO EXPECTED AND ASSIGNED GRADES IN SCIENCE

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The Soviet Union's launch of Sputnik I in 1957 changed America's national priorities. The United States entered and gained a lead in the space race in the 1960s as a result of a concentrated effort to educate our youth in science, and then to recruit individuals with strong skills in science and technically related fields (Butts, 1981).

The need for people with these skills (Bloch, 1987) is even clearer today as this country envisions forging ahead in its space program, developing a strategic defense system, improving the flexibility and uses of artificial intelligence (computers), and finding cures for the epidemic diseases AIDS and herpes. Recent research continues to show that the number of Blacks, compared to the number of other minorities in the field of science, is disproportionately small (Paldy, 1988). Research has shown that early academic preparation and success in mathematics and science greatly influence a person's decision to select science or a technically related field as a career (Clarke, 1988).

If one is interested in inducting more Blacks into the fields of science, one should examine factors contributing to the early success of Blacks in science (Carson, 1988).

Several investigators feel that academic achievement of students depends in part on students' feelings of capability (Brookover, Erickson, LePere, Hamachek, & Sharter, 1965; Cottle, 1974; Doherty & Dawe, 1985; Mitchell & McCollum, 1983; Zervos, 1980). Investigators also link self-esteem to educational and career success (Berne, 1987; East & Lerner, 1987; Yogev & Ilan, 1987). Students who believe that they can succeed at a particular task (for example, science) are likely to succeed (Caplin, 1969; Marsh, 1988).

The origins of such self-concepts can arise from many factors (Eshel & Klein, 1981; Shavelson, Hubner, & Stanton, 1976; Gurney, 1987) but surely include measures of past as well as internalized appraisals of the expectations of *significant others*. Among these significant others, parents, teachers, and classmates are known to be especially important (Brookover, Patterson, & Thomas, 1962; Kemper, 1966; Shibutani, 1961). The appraisal of teachers and classmates during classroom instruction and the nature of the classroom environment as perceived by the student become influencing factors on academic self-concept (Beckerman & Good, 1981; Cornbleth, 1980).

In addition, as the intensity of commitment to the study of science may be related to the student's *locus of control* (internal or external), a description of the student's appraisal of locus of control is a potential mediator of success (Ebling, 1979; Haury, 1988; Long, Okey, & Yeany, 1977; Holden, 1979).

## PURPOSE OF THE STUDY

This study focused on the relationship of the following variables to the criterion variables *expected grade* and *assigned grade in science*:

- students' self-concept of ability in science
- their perceptions of the way that two significant others (namely, their science teacher and their classmates) viewed their abilities in science
- ratings of the students' abilities in science
- the students' locus of control scores
- students' perceptions of the classroom climate

## METHODS

### Subjects

**Population.** The study was conducted among Black eighth-grade students in an inner-city intermediate school in the Crown Heights section of Brooklyn, New York. The eligibility of this school for Title I funds and for free lunch programs (80 percent of the students are eligible) indicates the low socioeconomic status of the student population.

This population was chosen because of so many students, particularly in the large urban centers such as New York City, Washington, DC, and Chicago, who are Black, attend inner-city schols, and represent a large pool suitable for intervention measures to develop future individuals for recruitment into the scientific and technical community.

Eighth graders were chosen for the following reasons:

- Students in the eighth grade have completed or are completing the fundamentals of at least three of the natural sciences; namely, chemistry, physics, biology, and earth science.
- Students in the eighth grade, potential entrants to high school, can participate in decision-making processes that allow them some freedom in their selection and

programming of higher-level science courses (that is, science for majors or nonmajors) for their high school career.

- Students in the eighth grade select high schools that they feel will improve their preparation toward their career goals.

The academic experiences, cognitive development, and responsibility that these students share make them suitable subjects for this type of study.

**Sample.** A sample ($n$ = 101) was taken from an eighth-grade population ($N$ = 580). Because the school groups students according to ability levels, students from each the ability levels (Level 1 or upper ability, Level 2 or average ability, and Level 3 or low ability) were selected.

## Instruments

Three self-concept-of-ability scales were adapted from Brookover, Patterson, and Thomas (1962) to measure the following:

- *Self-concept of ability in science* (SCAS); "How I See My Ability in Science."
- *Perception of peers' ratings of student's ability in science* (SPRA-Classmates); "How I Think My Classmates See My Ability in Science."
- *Perception of science teacher's ratings of student's ability in science* (SPRA-Teacher); "How I Think My Teacher Sees My Ability in Science."

*Locus of control* was assessed via the Nowicki-Strickland scale (Lefcourt, 1976; Nowicki & Strickland, 1973). *Students' perceptions of the classroom climate* were assessed with the Classroom Environment Scale (CES) (Trickett & Moos, 1973).

Instruments were first pilot-tested for reliability ($N$ = 40) using Pearson product moment correlations of scores obtained through test-retest administrations held two weeks apart. Correlation coefficients of .63 ($p < .001$; significant at the .001 level) were obtained for all instruments.

As in the pilot study, all instruments were administered twice with a two-week interval between test administrations, to the subjects in the main study ($N$ = 101).

## ANALYSIS AND FINDINGS

Cronbach alpha coefficients were used to assess the internal consistency of the scales, whereas test-retest stability of responses was assessed by Pearson product-moment correlations.

The *alphas* ranged from .85 on the perception of ability scales to .64 on the locus of control scale. Pearson $r$s for test-retest scores ranged from .70 to .86 ($p < .001$) on all the instruments.

Tests of internal consistency for the Classroom Environment Scale (CES) ranged from a weak .04 to a strong .74 value. Test-retest $r$s ranged from .27 ($p < .01$) to .50 ($p < .001$). These results indicated that this instrument was not reliable for measuring the perceptions of classroom climate for this sample, so further research using this scale was terminated.

Significant differences were found when the means of the scores of students in the highest academic grouping were compared, using $t$-tests, to those in the lowest academic grouping for the SCAS and SPRA-Classmates scales ($p < .02$), and SPRA-Teacher scale ($p < .05$) (see Tables 1-3). No significant gender differences were found.

**Table 1. Self-Concept Of Ability In Science (SCAS) Scores *(How I See My Ability In Science)* by Academic Ability Level**

| Academic Ability Level | SCAS Scores | | | | | | |
|---|---|---|---|---|---|---|---|
| | 16-20 | 21-25 | 26-30 | 31-35 | 36-40 | Mean | SD |
| Level 1 (upper) ($n$ = 41) | 4.9% | 12.2% | 24.4% | 46.3% | 12.2% | *30.3 | 4.7 |
| Level 2 (average) ($n$ = 40) | 0 | 20.0% | 57.5% | 17.5% | 5.0% | 28.7 | 3.7 |
| Level 3 (low) ($n$ = 20) | 0 | 12.5% | 60.0% | 25.0% | 0 | *27.4 | 3.9 |

*The difference between the means of Level 1 and Level 3 was significant at $p < .02$.

**Table 2. Perceptions of Their Classmates' Ratings of Their Abilities In Science (SPRA-Classmates) *(How I Think My Classmates See My Ability In Science)* by Academic Ability Level**

| Academic Ability Level | SPRA-Classmates Scores | | | | | | |
|---|---|---|---|---|---|---|---|
| | 16-20 | 21-25 | 26-30 | 31-35 | 36-40 | Mean | SD |
| Level 1 (upper) ($n$ = 41) | 4.9% | 9.8% | 31.7% | 41.5% | 12.2% | *30.5 | 4.8 |
| Level 2 (average) ($n$ = 40) | 0 | 12.5% | 60.0% | 17.5% | 10.0% | 28.9 | 4.1 |
| Level 3 (low) ($n$ = 20) | 10.0% | 20.0% | 45.0% | 25.0% | 0 | *27.4 | 3.9 |

*The difference between the means of Level 1 and Level 3 was significant at $p < .02$.

**Table 3. Perceptions of Their Science Teachers' Ratings of Their Abilities In Science (SPRA-Teacher, *How I Think My Science Teacher Sees My Ability In Science*) by Academic Ability Level**

| Academic Ability Level | SPRA-Teacher Scores | | | | | | |
|---|---|---|---|---|---|---|---|
| | 16-20 | 21-25 | 26-30 | 31-35 | 36-40 | Mean | SD |
| **Level 1 (upper)** ($n$ = 41) | 2.4% | 14.6% | 31.7% | 39.0% | 12.2% | *30.2 | 4.80 |
| **Level 2 (average)** ($n$ = 40) | 0 | 15.0% | 60.0% | 15.0% | 10.0% | 29.8 | 4.10 |
| **Level 3 (low)** ($n$ = 20) | 0 | 35.0% | 45.0% | 15.0% | 5.0% | *27.6 | 4.57 |

*The difference between the means of Level 1 and Level 3 was significant at $p$ = .05.

**Table 4. Locus of Control Scores by Academic Ability Level**

| Academic Ability Level | Locus of Control Scores** | | | | | |
|---|---|---|---|---|---|---|
| | 6-10 | 11-15 | 16-20 | 21-25 | Mean | SD |
| **Level 1 (upper)** ($n$ = 41) | 41.9% | 43.9% | 12.2% | 2.4% | *11.7 | 4.18 |
| **Level 2 (average)** ($n$ = 40) | 32.4% | 35.3% | 26.5% | 5.8% | *13.4 | 4.21 |
| **Level 3 (low)** ($n$ = 20) | 5.3% | 36.8% | 52.6% | 5.3% | *16.0 | 4.18 |

*The difference between the means of Level 1 and Level 3 was significant at $p < .001$; the difference between the means of Level 2 and Level 3 was significant at $p < .05$.
**Low scores represent an *internal locus of control*, high scores an *external locus*.

**Table 5. Multiple Regression of SPRA-Teacher, SCAS, SPRA-Classmate, and Locus of Control On Assigned Grade For All Students**

| Variable | *r* (Simple) | *R* (Multiple) | $R^2$ | Change on $R^2$ | *F*-ratio[a] | *p* |
|---|---|---|---|---|---|---|
| **SPRA-Teacher** | .57 | .57 | .33 | 33% | 48.40 | .001 |
| **Locus of Control** | -.34 | .60 | .36 | 3% | 11.40 | .05 |
| **SCAS** | .47 | .63 | .39 | 4% | 5.86 | .05 |
| **SPRA-Classmates** | .54 | .63 | .40 | 1% | 1.47 | NS[b] |

[a]Test of overall regression of the four variables $R^2$ = .40. $F$ (4, 88) = 14.74. $p$ < .001. This $F$-ratio represents the test of significance for the standardized regression coefficients; it is a test of the variance uniquely accounted for by the indicated variable. $F$ (1, 88).
[b]NS = not significant.

**Table 6. Multiple Regression of SPRA-Teacher, SCAS, SPRA-Classmates, and Locus of Control on Expected Grade For All Students**

| Variable | *r* (Simple) | *R* (Multiple) | $R^2$ | Change on $R^2$ | *F*-ratio[a] | *p* |
|---|---|---|---|---|---|---|
| **SPRA-Teacher** | .64 | .64 | .41 | 41% | 72.16 | .001 |
| **SCAS** | .58 | .69 | .48 | 7% | 12.32 | .01 |
| **SPRA-Classmates** | .54 | .70 | .49 | 1% | 1.76 | NS[b] |
| **Locus of Control** | -.07 | .71 | .50 | 1% | 1.76 | NS |

[a]Test of overall regression of the four variables $R^2$ = .50. $F$ (4, 88) = 22.39. $p$ < .001. This $F$-ratio represents the test of significance for the standardized regression coefficients; it is a test of the variance uniquely accounted for by the indicated variable. $F$ (1, 88).
[b]NS = not significant.

Significant differences (at the .05-.001 level) were found when the means of locus of control scores were compared by *t*-test for students in the highest, average, and lowest academic groups, as shown in Table 4. A *t*-test for expected grade was significant at the .001 level. No other significant differences were obtained.

Pearson correlations (simple *r*) of the above perception scales (SCAS, SPRA-Classmates, SPRA-Teacher), with the criterion variables expected grades and assigned grades in science, showed strong positive correlations between each of these independent variables and the two criterion variables (see Tables 5 and 6). Students' perceptions of their science teachers' ratings of their ability in science accounted for the highest variance ($r$ = .64 and $r$ = .57) for the correlations between SPRA-Teacher and expected grade and between SPRA-Teacher and assigned grades. These results are consistent with other investigators' reports. This consistency suggests a strong relationship between students' self concepts of ability and academic performance. The negative correlation between locus of control scores and assigned grade supports findings of other research that associates an internal locus (lower locus of control scores) with academic success (see Table 5).

Multiple regression analysis of SCAS, SPRA-Teacher, SPRA-Classmates, and locus of control was undertaken to ascertain which predictor variable(s) may have the most influence or how, together, they improve predictions on the criterion variables (see Cohen, 1975). Multiple regression analysis was performed using the SPSS format in which the program selectively placed each variable into the equation. Students' perceptions of their science teachers' ratings of their abilities in science (SPRA-Teacher), locus of control, and students' perceptions of their own abilities (SCAS) accounted for 40 percent of the variance shared among these predictor variables and the criterion variable assigned grade (see Table 5).

Students' perceptions of their science teachers' ratings of their abilities in science (SPRA-Teacher), students' perceptions of their own abilities in science (SCAS), students' perceptions of their classmates' ratings of their abilities (SPRA-Classmates), and locus of control accounted for 50 percent of the shared variance among these variables and expected grade in science (see Table 6).

## DISCUSSION

The salient point to be derived from this study is that this group of Black inner-city eighth-graders is no different from other groups of children in terms of the mechanisms that impinge on self concept and academic success in science. The science teacher who has been identified as the most important significant other to the pupil must demonstrate confidence in the students as potential learners. As Bloom (1977) states, "when an individual works and studies in an environment in which... external appraisers judge him as adequate, he develops a general sense of adequacy, at least with school activities."

Teachers must display high expectations for the student's success. It is essential that teachers convey to their pupils expectations of quality, which should be spelled out in the syllabus and also implied in the teachers' attitudes and demeanor. Once students perceive that they are expected to succeed, they set about trying to measure up to the expectation.

Teachers need to stimulate students' interest in science by providing activities beyond that which is given in the syllabus. Trips, films, projects, and hands-on activities can enhance students' interest in, and consideration of, science as a future career.

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# PROCEEDINGS OF THE SECOND BLACK SYMPOSIUM ON SCIENCE, ENGINEERING, AND TECHNOLOGY CAREERS

July 20 - 22, 1989

# SECOND BLACK SYMPOSIUM ON SCIENCE, ENGINEERING, AND TECHNOLOGY

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*Vernon Jarrett was educated at Knoxville College, and holds honorary doctorate degrees from Chicago State University and Lake Forest College. He has taught history and journalism at Northwestern University, the City Colleges of Chicago, and Roosevelt University.*

Thank you, Dr. King. You know he is a general, don't you? I mention you as a general because I am here to participate in what I hope is a declaration of war on ignorance and mediocrity in the classrooms, in the big urban centers of America, and even in the smaller communities and in the suburbs. Now the recent statistics show that even non-African American students are wallowing in a malaise when it comes to education. I am here, also, to speak from experience. I am glad that you brought up my hometown of Paris, Tennessee, because the rule book says that I am not supposed to be here. I am supposed to be a waiter at the old Benjamin Franklin Hotel. I am supposed to be a bellhop. And, certainly I am not supposed to be on the editorial board of a major newspaper. I am not supposed to be on television giving commentaries every other day. Because, I am an African American with ancestors that I knew who were born in slavery, one having escaped from slavery. That is not supposed to happen.

At the high school that I attended, the facilities were not even second class. They were fourth class. I can recall when we celebrated the opening of that high school with much fanfare and ribbon cutting, and each room had a potbellied stove in it. We young males had to take turns going out and getting coal. I can remember when the football team didn't have shoes so we bought some brogans - those are plow shoes. We went to the cobbler and had him tack on some cleats in order for us to play football. I can recall when our little public library did not permit Black people to even stand in front of it. It wasn't a matter of integration, of being able to check a book out but not being able to sit down and read it. Then, you couldn't even check a book out of the library. I can recall that when my brother was working on his master's degree at Fisk and

on his doctorate at the University of Chicago he was not permitted to check a book out from that library. I recall that a very gracious, although patronizing, White lady, a member of one of the "finer families" as they used to say in Tennessee, had to intercede in order that he might check out a book on Henry Lanier. Isn't it interesting that despite all of this, here I am. I guess in a sense back home in Paris, they call me a "high profile celebrity," which is not supposed to have been the case.

*"I come here with a proposition that at some point those of us who have had access to a little glory and success haven't been doing our job."*

When you look back at the chances of my brother getting a Ph.D., you wonder what is he doing with a Ph.D. degree? They didn't even have a high school when he was a student. The school was one room which was next door to the Black dentist, and the restaurant, and the little pool hall. It was in a little building called the Afro-American Building that was set aside off the little town square in Henry County. You see, we were calling ourselves Afro-American long before Jessie.

The significant thing though is that there was my brother getting a Ph.D. from the University of Chicago, and graduating with such a record there that Oxford University would invite this man from Henry County to come over and spend a year lecturing to Englishmen on English literature. Now all of that should make us ask: what in the hell are we doing today having young Blacks who can't speak English, period, in big cities where we have all sorts of libraries, all sorts of museums? Chicago is an unimaginable town when it comes to the education that you can get on your own without having a teacher. If you just wanted to visit the Field Museum you could trace the history of man visually almost back to eons before Christ. Then there is the Museum of Science and Industry. My grandfather would have had a ball there even though he couldn't read and write. You have got the Chicago Historical Society and the Museum of Fine Arts in most big cities, and yet ignorance is at an all time high. Now something is wrong!

I come here with a proposition that at some point those of us who have had access to a little glory and success haven't been doing our jobs. It is not so much that we have sold out the lesser brother, to use a vernacular of the revolution. It is that we have been so busy enjoying and experiencing whatever successes we've had, and paying some dues in order to maintain them that we just haven't gotten out into the streets and done for those behind us what was done for us. It is not an accident that I am standing here. I can tell you why and it is because of the people in the Christian Methodist Episcopal (CME) Church, Mount Zion Baptist, Quinn Chapel, and African Methodist Episcopal (AME) Church. They told us about the history of what Bishop Paul Quinn and Bishop Lane of Lane College did to get an education. When I was probably four or five years old, I have been told this story for I could hardly remember things back that far, reportedly I sat on Bishop Lane's knee, this ex-slave who founded Lane College. Huston-Tillotson College was founded in 1875 which is the same year that my college, Knoxville College, which also gave my dad an education, was founded. So there were some traditions that were not all negative. I never knew any wealthy Black people. There were some we called wealthy, but when you really got around to it, they were not.

I grew up in a town where only two Black people could boast of having a flush toilet. All had outside toilets, and if you think that is a joke try one in February, especially when it is windy and you have to sit there roughing up the Sears and Roebuck or Montgomery Ward catalog for toilet paper. In the summer it may be the Christmas present paper that your mother had saved for that purpose, but only for company. Yet, I was reciting Chaucer's Canterbury Tales in the ninth grade, the way Chaucer spoke it. Isn't this interesting? This kid here who was a houseboy part-time at some of the so-called finer White homes in Paris, Tennessee but did not go to work on Saturday morning and in the afternoons, felt inferior to the White kids who went to Grove High School, which sat up on a high hill like a castle. It was presented to our city by the E.W. Grove Chill Tonic founder - you know, the quinine man. It did impress us as being something like a cathedral - one of those European cathedrals. We didn't know a whole lot about the Catholic church. I thought that "catholic" meant another race. I had no idea what a Catholic was; they weren't too popular in our hometown. We had three Jews that I knew. Two of them professed Judaism but kept it at low key, and

another one acted as though he had never heard of Israel outside of the old testament. You got this little education imperceptibly that had rubbed off on you and you had to raise questions over and over. My brother and I have done this.

I started asking questions as a journalist. I hope that I don't look this old, but this is my 40th year in journalism, and I have interviewed probably some of the leading Black achievers in the country. They all have come up with this story about how something went on in the community that other people didn't know was happening that made it possible for a Percy Julian to become the gentleman who gave us cortisone on a mass basis, or who developed the primary medicine and the treatment of glaucoma, or who developed a foam that the Navy used during World War II on ships to reduce the hazards of fires, and who himself was a multi-millionaire having owned and sold two or three chemical plants in Mexico, the Caribbean, and Latin American. I have talked to these men and one could look back and say, "What is Percy Julian doing being such a scientist when his grandfather had two of his fingers cut off when they discovered that he had learned to read?" And, "What was Dr. Benjamin E. Mays doing being the scholar that he was and coming out of a place called Epworth, South Carolina?" (It didn't just happen; he deliberately was a scholar.) This was a place that he called, "A little mud hole on the side of the road."

*"You have to use television, you have to use radio, and you have to do something to ignite that spark in us that our ancestors had that made them educate themselves without too much professional tutoring."*

In 1975 I interviewed Dr. Mays in his living room, and I think I have about two hours of that on tape. It turns out that one day when the circuit pastor didn't make it on time someone suggested that little Benny, who was the only person there besides his oldest sister who could read, get up and just simply read the Bible to occupy time until the circuit pastor could get there. So here is eight year old Benny Mays coming up to the podium, opening the Bible to the fifth chapter of Matthew, and reading with such eloquence, innate eloquence, and with such feeling and interpretation that the ex-slaves stood up and started waving their handkerchiefs the way they do today at a football game or a basketball game. He kept reading, and he never turned back.

I had a chance to hear this story, and stories of other experiences, from my grandmother who eavesdropped when she was a little girl. She did live that long and even though I was only five or six the story never left me of how she learned to read in Hardamon County, Tennessee. This was the place that my mother went for me to be born, the summer of which year I shall not reveal. My grandmother learned to read by eavesdropping when the tutor came out to the big house to teach "little misses." She hid in the bushes outside the window and listened and wrote in the dirt whatever she could perceive. When the tutor left she was the first one in to clean out the trash to make sure that nobody else got to it such as the older slaves. She copied everything on those scraps of paper. I have a niece in New York who has a letter or two of my grandmother's. The writing in those letters corresponds with that of the writing on the Declaration of Independence and some of the other great documents. That was my grandmother who never had a day in school.

What am I building up to? That we have a tradition that we have almost thrown away. We have just ignored it completely. It is the tradition of saturation education that is even projected by the uneducated. We can have all of these little esoteric meetings we want to. We can have one conference, one workshop all over the country, all we want to, but until we do a saturation job, forget it. The numerical aspect of the problem is just too big for us. You can't reach enough people. You have to use television, you have to use radio, and you have to do something to ignite that spark in us that our ancestors had that made them educate themselves without too much professional tutoring. Frederick Douglass had probably one of the greatest minds ever. If you read the life and times of Frederick Douglass, and I hope you have, you would have to

marvel at a man who never spent one day in school. His vocabulary, his choice of words, his profound - even psychological - analysis would compare with some of the great psychiatric minds like Freud, Adler, and the rest of them. Unbelievable! I am going to read a few passages from him. You would have to rate him as one of the all time great thinkers for his ability to see the shades and differences of human reaction to slavery, even the modern type of slavery that we may be enduring today and don't know it.

I am here speaking, and I am recognized as a writer, not because of the few years I spent at Northwestern after I left Knoxville College and the University of Tennessee. I really didn't learn too much. I learned a lot about Chicago. But, my writing skills and confidence developed when I was in the eighth grade. This is why I was interested in Dr. Mays and did my essay on Toussaint L'Overture. I didn't know where Haiti was. I didn't even know too much about Napoleon whom the teacher said Toussaint defeated in battle. I didn't know how to pronounce Toussaint L'Overture - I don't know it today. I call him some of everything. But, I do know that a little boy became excited enough to write an essay, and some people who didn't know any more than I did applauded me and told me, "Boy, you can talk." And, now they say, "You can talk too long." But, they say,"You can really talk."

***"I was a hero on my little college campus because I could write and rap. Even though I had a football scholarship I was editor of our campus newspaper."***

I am thinking of that old gentleman named Mr. Dumas. His sons called themselves "Dumar." They were learning about Alexander Dumas. But, old Mr. Dumas was an ex-slave, too. I remember one day he heard a group of us little Black kids "playing the Dozens." I know none of you in here knows what that means. That means when you talk about somebody's ancestry. But, you don't do that in vulgar terms; you use poetry. If you couldn't rhyme you were out. You always had to talk about somebody's mother, and it had to rhyme. I can remember some of them. I was an expert at it and I could do it fast, which predicted that I might be a good journalist one day, because you have to turn stuff out fast. I remember Mr. Dumas who, although he was illiterate, was a thinker. He had a philosophy that all mankind and all animal life, and all vegetable life blended into each other. We thought he was a nut. Sometimes he would just sit in a bunch of bushes and weeds in the alley and you could hardly see him there. So he heard us one day practicing the Dozens. I was the Henry County champion for two years. Our Dozens team was getting ready to meet the other Dozens team from Depot Hill. You know all of the little Colored communities had names - Depot Hill, Methodist Hill; there were Buzzards, Black Bottom, and Death Bottom. Death Bottom was so bad that even the toughest White cops didn't want to go down there on Saturday. During the week, yes, they would just shoot up in the air at the top of the hill. But they didn't want to go down there because this was when Black people were supposed to be "crazy." Forget all about intimidation.

Our little team was called "Liable" - that was my neighborhood. It got its name because they say in the olden days if you went down there on Saturday nights, you were liable not to get back. So we were the Liable Dozens team. We didn't have basketball courts and they didn't build a gym. We were getting ready to take on Depot Hill and so we were practicing the Dozens. Can you believe the quickness with which we could compose words? These were little boys just making up stuff. This would go on and on until somebody ran out, and then you declared a champion.

But, old man Dumas was sitting in the weeds back there listening to us rehearse until he could take no more. Then he did what is not being done today: older people stopping young people and putting something on their minds. Mr. Dumas saw us. He saw the grammar school principal's son; my dad was the principal. Sitting there he saw George Palmer, the son of the number one plasterer in town and one of the best paid Black people in the community. There was a whole bunch of us. And, he caused terror by just walking out there with his walking cane. He said, "I am not going to call your mama and your dad like you think I am. I just want to talk to you. Can't you boys do something other than low rate the name of Black women?" Then he told us how the Black woman was the connecting link, the cement in our whole history. If it wasn't mother then it was a surrogate mother, an aunt or a grandmother, who kept us together and nursed us and

gave us a sense of continuity and unity. We sat there and listened - trembling. We didn't stop playing the Dozens that minute, but later on we did. Then he looked at me and said, "Boy, the way that you can think up all of those dirty rhymes you ought to be a writer." He said, "Anybody that can do it that fast, you are better than Paul Lawrence Dunbar." Now, remember Mr. Dumas couldn't read, but he had us thinking that he could. He could recite from Paul Lawrence Dunbar; isn't this interesting? He told another one, "You ought to be a Booker T. Washington." So he let us off the hook. We went over and won our little championship game that evening, but it kept putting something on our minds.

Those people who raised money by selling pies and cookies and sent me to Nashville to compete in the West Tennessee Oratorical Contest didn't know what they were doing, but they did something. That is the point, *they did something.* When I returned from the contest having done "Spartacus to the Gladiators" and lost, they still welcomed me back home. The whole town came out and gave a going away party for my brother and Oliver Tig when they graduated from high school (as valedictorian and/or salutatorian). They celebrated them! This is partly how I conceived the idea of the Afro-Academic, Cultural, Technological, and Scientific Olympics (ACT-SO)[1]. What we are doing is celebrating academic achievement.

I was a hero on my little college campus because I could write and rap. Even though I had a football scholarship I was editor of our campus newspaper. Those were the days when we really almost idolized academic achievement. Paul Robeson was celebrated not simply because he was one of the first All-American football players, but because he was Phi Beta Kappa, spoke several languages, and delivered the class oration at Rutgers University. We knew that Charles Drew was a track star. He had been a track star as well as a distinguished chemist in college. We knew that Ralph Bunche was an athlete - so athletic achievement and scholastic achievement went hand in hand. That is gone. Today you can be absolutely semi-literate and then take pride in only one dimension of your life.

***"What I am trying to say is that unless there is a climate out here that saturates the Black community with education the way we ha ve been saturated with basketball and football, you can forget it."***

I am standing here because of my brother who became my college teacher. Lord help us! I go to college, and I look up and here is my brother teaching English. I was kicked off the football team because he did not give me the proper score that I thought I should have had. I remember getting ready to go and play South Carolina State one night and the coach came by and looked at me and said, "You are a pathetic sight." There were a bunch of us celebrating. We were getting ready to take a trip with the football team, and he said, "You are a pathetic sight. Anybody who couldn't make it under his own brother. It is awful. Here is a man who couldn't even make proper grades in English under his own brother and you have got the nerve to want to be on a debating team." I am glad that he did it. I didn't speak to him for a year, but I am glad he did it. And, this is something that we used to do with each other. We didn't play games; we had a discipline over each other. If you were a college student and you came back home (even if you hadn't been in school but a few months) for Thanksgiving, the community said that you had to show up at church and give a little talk. The pastor would single you out, "Today we have so and so's son back home from Lane College or Fisk University (a few people went to Fisk, but Fisk was too expensive) or Tennessee State (the "party college") or anywhere, it didn't matter. You came back and you had to make a presentation. Sitting there waiting for you was a jury of people who acted as though they all had Ph.D. degrees. They may not have gone past the third grade but they were waiting for you to mess up. Through some instinct they could tell when you were using poor English. You had to speak better than they and you couldn't say, "A uh, like

[1] The goal of the Afro-Academic, Cultural, Technological, and Scientific Olympics (ACT-SO) is to mobilize adults as well as to encourage Black youth to achieve in high school. The educational level of this program is high school. ACT-SO is a project of the National Association for the Advancement of Colored Peoples (NAACP). For further information you can contact ACT-SO, 7 East 63rd Street, Chicago, IL 60637, (312) 684-4500.

you know." You had to get up and speak proper English and enunciate words clearly, and show some respect for the English language, or else some of the sisters in the church would start punching each other and talking about your mother's judgment in letting you go to college in the first place. They would say, "She is wasting her time with him. He has been there for a month." Here it is only Thanksgiving, and you had to sound like a professor.

What I am talking about is a climate, a climate that was inspiring enough to make you want to learn what you didn't even have in your high school. I am not saying this is a substitute for equality. What I am saying is that one Saturday when I went to the home of the family my mother worked for and that little White girl from Grove High School was there, I was ready for her. We used to have word contests, vocabulary contests, and I would run out of the kitchen. Then we got into Shakespeare, who could quote Shakespeare the most. I could hear her mother up in the front, "Why don't you leave that little nigger alone and let him finish those floors before company gets here?" And, she [the little girl] got boned up for me, too. I remember her coming back and she tripped me up on something from King Lear. Then I said, "Who cares about Shakespeare? I can recite stuff the way they spoke before Shakespeare did his little old mess." She said, "What are you talking about?" I said, "I am going to recite Canterbury Tales the way Chaucer said it." She said, "No you can't do that." I said, "Bet ya that I can." We were just kids back then. Then I started quoting from Canterbury Tales. Everybody knows that a lot of Black high schools used to teach the writings of Chaucer. [Quotes Chaucer and laughs.] Her mother had to go to the bathroom.

***"We have lost the capacity to fantasize success. This is the danger we face today."***

This climate is missing today in urban education. In 1977 I went to Dr. Benjamin L. Hooks, Executive Director of the National Association for the Advancement of Colored People (NAACP), with an idea. I gave him the name. He was just coming to the NAACP and he wanted something new. He accepted it because he is from Memphis and he remembered the same types of experiences. Where you have such a hunger for education that you read a lot. I used to hate reading. My mother wanted to make me read an hour before I went out to play, and I would sit there just being evil. I wanted to use some of the words some of my friends had been using about her when they were playing the Dozens. I just hated that woman for making me sit there on a nice bright day when I wanted to go out. I held the bottom side up. But, later on somebody set a little flame in my heart and in my head, and she didn't have to make me read anymore. Right now I can't stop. I have books that I brought here. I sat up last night until one o'clock reading. I have to read. I have a respect for it. I was number 25 in my class out of 70 students who graduated in high school, so don't put me in the genius category. What I am trying to say is that unless there is a climate out here that saturates the Black community with education the way we have been saturated with basketball and football, you can forget it. You can give a scholarship here, you can give an award there, you can get some corporations or some foundations to give you some help, but it is a drop in the bucket. Four hundred and ten thousand students in Chicago - you don't have to tell the majority of young males to "go out and practice your basketball, son," but if it was skating, you would have to tell them that. So just don't think that it is a propensity for sports. Basketball has caught on and captured the imagination of so many young Blacks that a lot of them are staying in school today who will never make it through high school as a basketball player, but they are there.

One night I decided that I had to get this program underway. At two o'clock in the morning, three blocks from my house and in a misty rain, there were three or four of these little kids who should have been home but were practicing basketball. I mean with all of their hearts - insidious practice. They were dribbling between their legs, and passing behind their backs. These are little grammar school kids. Then they would get up and simulate the dunk shot. It didn't get half way up the basket - there was hardly a basket there. But, they were going through all of this. Then the rest got tired and there was one left out there. He dribbled, and he dribbled, and he dribbled, and then he posed. The astounding thing I want to tell you is that during that whole basketball game there was no basketball! It was a whole game of fantasy! It is the

same type of fantasy that I used to have turning on the radio late at night after Joe Lewis fought. I used to fantasize being in Chicago, not necessarily as a journalist, but doing anything. Just fantasizing. I used to fantasize me and Earl Hines. I would be in the dark playing the piano. Then I used to fantasize blowing the saxophone. Then I used to imagine that I was Duke Ellington from the Cotton Club. We have lost the capacity to fantasize success. This is the danger we face today.

One of the brightest young people that we discovered was through our ACT-SO program. I can refer to him as long as I don't call his name, I don't want to embarrass his parents or the kid. He won a gold medal in Chicago, and we took him to Dallas. Here was a little boy whose mother didn't know he was taking classical music. This is a symbol of what can happen and is going on and we don't take advantage of it. His mother thought he was hanging around the church in the choir. He didn't have a piano in his home, but he played Chopin like he owned him. I used to call it "Chop'n." I hope that I don't make that mistake now. As you know, Chopin is real fast and glittery and if you have some talent it really shows it up. This kid was so great that when we took him to Dallas and I asked him to perform, the crowd stood up and cheered him in the middle of the performance. He couldn't believe it! He had an asthma attack and they had to take him out. The same kid still couldn't believe that he could do anything. When we came back to Chicago an association of teachers had a meeting there, and I wanted them to hear this high school prodigy. I had to promise him before he played that he would not make a mistake. I had him on television and he called me five times before we were to tape that show. He said, "Mr. Jarrett, are you sure this is going to be a tape?" I said, "Why?" "Will I get a chance to do it over when I mess it up?" The only thing that he could think about was the probability of messing up.

***"What has stopped us is the propensity to become conditioned to things the way they are until we think that maybe this is right."***

Benjamin E. Mays, let me remind you, got his college degree in mathematics from Bates College, an exclusive college. Mathematics! He went into the other fields because that is where most Black people were going to get a chance to express themselves. He had confidence. I don't remember my brother in Paris, Tennessee ever not feeling that he was a brilliant scholar. I can think of Black people that were almost bright to the extent of arrogance under the worst of circumstances. So I don't want to hear all these arguments today about cultural deprivation. It is good to bring it up to put other people on the spot, but it has never stopped us. What has stopped us is the propensity to become conditioned to things the way they are until we think that maybe this is right. And, all Black kids and maybe all White kids today in America are getting an inferiority complex about the Japanese. Anything the Japanese do today is supposed to be great. I remember when it was considered second rate. But, today if it is Japanese or Asian, "Yeah it is all right." And, maybe that is why the Asian students are doing better. They feel that what they do is right. I think that we play basketball better because we have concluded that maybe God endowed us with the ability to play basketball a little better. Well, I've got news for you if any of you have any children. In the 1920's one of the most famous athletic figures in our collegiate history, named Alonzo Stag, said that Black people did not have the muscular alignment or the psychological equipment to play basketball. So consequently he didn't invite Wendell Phillips High School to the Annual Holiday Basketball Tournament for High Schools in Chicago. In other words, forget about Black people and basketball.

Thomas Jefferson said that Black people couldn't carry a tune well. I think you should read his notes from Virginia. I can remember when it was assumed that all Black people could sing and dance, and some of us capitalized on that. When I first worked in an integrated situation in Chicago at the Christmas parties, for some odd reason people called on me to lead off with the carols. They just assumed that I could sing, and I can't sing a lick. I have been in integrated settings where maybe there are two or three Black couples and the rest are White and every movement, every awkward movement that some brother did out there was considered exhibit A of African symmetry and rhythm. Of course, all you had to do is tell one brother that and he would be out there all night long giving dancing instruction. Just like another friend of mine, at the

end of all Christmas carols you could hear her voice after everybody else was through. She was a high pitched soprano and couldn't sing a lick either, but she was rhapsodizing.

So what we have done and what you are going to see after we get through here is an attempt to make academic achievement in vogue. I think that is the only way you can do it, make it the "hip" thing to do, where we celebrate an academic achievement the same way we do football and basketball players. To hell with what the major media may want to do, let's celebrate them ourselves. So consequently on the film strip you will see a little girl who is a grocery store clerk in Chicago. She is dressed up and singing an Italian opera to people who thought we couldn't even do English. We have a young man out of Los Angeles who is in college now who won only third place when we had the competition in New York in bio-chemistry. But, he was so captured by the applause he received when three thousand people stood up and cheered him that he went home and boned up on what the Russians had discovered about micro-biology in outer space. The Russians, you know, concluded that the surface of a virus thickens in outer space and, of course, an antibiotic has a more difficult time penetrating. So little Mark Christian, who won third place in our competition nationally, went home and developed a theory about this. Someone suggested in jest that maybe you ought to enter this into NASA and the Mathematics Teachers Regional Contest for young high school science students. The others said, "No man you ain't going to make it. Those little Asian kids, those little boat people are going to wipe you out. If they don't do it the Jewish kids will." Mark entered it anyway, helped with some coaching from the teachers and other successful people who were out at the King-Drew Magnet High School. And, guess what? He wiped out everybody in the whole region! Then he went on to compete nationally. Now, NASA has his experiment on docket to go up in outer space to be tested.

***"I think that is the only way you are to do it, make it the "hip" thing to do, where we celebrate an academic achievement the same way we do football and basketball players."***

Let's get down to something else that we are talking about that basketball did from which we ought to learn. That is the ripple effect of success. One Black person who knew Mark very well and whose lip was hanging out - named Robert Jones - was sorry he didn't do it. I think he went to one of the Compton high schools. Robert decided that if Mark Christian could do that and he had only won third place, he (Robert) ought to be able to do it because he had won first place the year before. So guess who became the next national NASA champion? Robert Jones. Robert Jones decided that he could do it - we are talking about doing science. There is a young man from Atlanta, Georgia with whom we have been working, and I want to get a little credit for that because I didn't know who the kid was when I wrote about him. When he was in the seventh grade I did a column on this seventh grader who had an SAT score high enough to get him into Harvard. I never saw him; I just wrote about him. Previously, I had spoken at a little graduation out there, and some teacher mentioned the kid and showed me the scores. I was short on a column so I went there and wrote a column - just like I am going to do about your president's speech. Three years ago his mother sent me a copy of that column written back in the 70's and she said, "My son is in Atlanta now with me. We left Chicago, and he is competing in New York in your ACT-SO Program." This kid had invented, guess what? A portable means of measuring carbon monoxide that the city of Atlanta has bought. He may be a millionaire before we know it. We got him on page four of the New York Times. Now guess what the ripple effect is doing down in Atlanta?

Last year, or was it year before last, four ACT-SO competitors out of one class were invited to enroll at MIT. Now I understand that they never have offered that many invitations to students in one class at the suburban high schools. We have got some young people who are not just simply playing music by ear, they are composing it and putting it on paper. Because we tell them this is what you have to do unless you want Elvis Presley to steal it and forget about you. Put it on paper the way Quincy Jones does it, the way William Grant Still did it. If you are an architect, take some kids out on an architectural tour of Chicago. Let them go all the way - tell them about Mies Van der Rohe, and tell them how you may improve on it. This is the home of Sullivan. The greatest architects of our time and we are <u>not</u> taking kids on these tours.

In Chicago, in February, there will be an exhibit featuring the distribution of terra cotta art. They found it in Mexico even before Columbus. We are organizing some teams of artists to take kids down there and tell them about African Art. Just walking around with a corn row, the knowledge is going to slip between these corn rows, and wearing high heels as though it is going to elevate you is not the story. These kids can have all of the red, green, and black flags on them they want to, it means nothing until they capture the real sense of worth in their history.

Those people who praised my brother when he came back and who look upon me as a son are no longer there. Then, people said, "This is our boy." This is when the Black community had a sense of one. This is when all Black adults were the surrogate of all Black children. That is how we survived, a little simple thing like that. Don't tell me what we can go through. How many people in this country (of the past generation) had the experience of government where the Constitution itself had at least three clauses in it to denigrate you? Calling you three-fifths of a man! And, another clause insisting on a Fugitive Slave Act was written into the original Constitution of September 1787. A Fugitive Slave Act ordering the capture of Black people is in the Constitution. Another clause that said that you couldn't end the African slave trade until 1808. This was written. How many people in this country have had this experience? I don't care if all the folks from Europe brag about how they lifted themselves by their boot straps. Not a single one of them ever had a national law passed authorizing their capture and then rewarding their captors if they tried to escape to freedom. Not a single one. Nobody but Blacks had state laws pervasive from 1890 through 1910 where every southern state constitution was rewritten to denigrate Black people and to backup the Supreme Court's decision of 1896, which said that you can have "separate but equal," which meant unequal. If you look at the history of the Supreme Court they started work on undoing the Civil War as early as 1873. All of you just go right on through 1896 up to 1899 looking at the Supreme Court's actions - including The Slaughter House case.

***"We, ourselves, can cause a revolution because the most revolutionary act that I think any of us can commit is to keep our own sense of traditions in history in tow."***

There is one thing that Mr. Frederick Douglass gave us that I am going to read to you which I think some of us have been mesmerized by. That is acceptance of what might be a neo-type of slavery. Let me read what Brother Frederick Douglass said in his book, An Analogy of the Life and Times of Frederick Douglass. I am talking about what we are accepting and don't even know it. Frederick Douglass said, "That I have found that to make a contented slave it is necessary to make a thoughtless one. It is necessary to darken his moral and mental vision and as far as possible to annihilate the power of reason. He must be able to detect no inconsistencies in slavery. He must be made to feel that slavery is right and he can be brought to that only when he ceases to be a man." Freud, Adler, Jung - none of them ever wrote anything more profound than that. That was Mr. Frederick Douglass, ex-slave.

Frederick Douglass left us something else and that is the capacity to lecture to each other, to discipline ourselves, and to make sure that if there is to be another racial tragedy it will not be ours. It has to be someone else's. Frederick Douglass, speaking to Black people said, "You cannot make an empty sack stand on end. A race that can not save its earnings, which spends all it makes and goes in debt when it is sick can never rise in the scale of civilization, no matter under what laws it may chance to be. Put us in Kansas or in Africa and until we learn to save more than we spend we are sure to sink and perish. It is not in the nature of things that we should be equally rich in this world's goods. Some will be more successful than others. And, poverty in many cases is the result of a misfortune rather than a crime. But, no race can afford to have all of its members victims of this misfortune without being considered a worthless race." So pardon me, brothers and sisters, therefore for urging you, my people, urging upon you the importance of saving so that your children may have a start in life when you are gone. This was the frame of mind of our ancestors. I want you to know that while George Washington and Ben Franklin and all of those distinguished gentlemen of history were writing the constitution at Constitution Hall and finished it partially in September of 1787,

just five blocks away nine Black men were holding another meeting in a blacksmith's shop - the founders of the African Methodist Episcopal Church. They founded what is known as a Free African Society, can you imagine this? Having the nerve to call themselves a Free African Society of Philadelphia. Absalom Jones and Richard Allen - two ex-slaves whose patience was exhausted with the discrimination in St. George's Church.

One of the most heartwarming things that I have ever experienced is to read the little constitution and by-laws of the first Free African Society. There were provisions in it for education, where they put in so many pence a week for the education of young Black children -particularly those who had been orphaned by parents who didn't quite make it through the Underground Railroad. They also had a clause in there negating the whole idea of using alcohol as an escape clause - today we are fighting dope and alcohol.

And, then came Mr. W. B. Du Bois. I am pronouncing it right because I knew the man. It is not Dubose like some of you elitist would try to pronounce it. He called himself "Du Bois." Du Bois explained to us what we are up against, but, you don't let that get you down like some people today who spend so much time on the issues and justifiably so. My White friends on the Sun Times say that I am absorbed in racism and that that is all I think about. Well, I happen to think about something else or there wouldn't be an ACT-SO Program. Du Bois explained to us what we are up against. Let me read what this man was saying in 1903. "After the Egyptian and Indian, the Greek, and the Roman, the Teuton, and the Mongolian, the Negro is a sort of seventh son born with a veil and gifted with a second sight in this American world. A world which yields him no true self consciousness, but only lets him see himself through the revelations of the other world. It is a peculiar sensation - this double consciousness, this sense of always looking at one's self through the eyes of others. Of measuring one's soul by the tape of a world that looks on in amused contempt and pity. One ever feels his twoness, an American, a Negro. Two souls, two thoughts, two unreconciled striving, two warring ideas in one dark body whose dogged strength alone keeps it from being torn asunder." Now, after recognizing all of that he proceeded to be a scholar despite what White America said about him. In the Philadelphia Story he gave us the first scientific sociological study of an urban community ever made, the pioneer in scientific sociology. In his treatment of the slave trade, which became a part of the African classic, he gave us the purest form of research in the treatment of American history. And, the old man went down fighting when he died in 1963 in Ghana. Guess what he was doing? Writing an African Encyclopedia.

***"So, Frederick Douglass put it correctly, 'We may not get everything that we pay for in this world, but we must certainly pay for everything that we get.'"***

So what we are doing here today is saying, "Yes, let's point out all of the deficiencies. Let's point out how we are being cheated - meanwhile let's get to work to save the children." This is the same thing about which Douglass exhorted people over a hundred and twenty years ago. I hope you take the time to look at what we are doing with ACT-SO. You are going to see something that I finally convinced Channel 7 to do. We are treating young kids from the ghettos of Chicago the same way you treat Academy Award winners. You ought to see the way that audience reacts. Now we have thousands of kids who can't wait to compete in science. Some are calling themselves playwrights. Kids writing music by putting it down, and whether their school system does it or not, they are doing it. We, ourselves, can cause a revolution because the most revolutionary act that I think any of us can commit is to keep our own sense of traditions in history in tow. What we are talking about here is not anything new. I have to say this because, Dr. King, I am tired of going to community meetings where the first thing to come up when someone has a bright idea - someone will get up, they even now changed it the way you use certain expressions in a very proper fashion, "Yes, and I know where we can get Fawnding." They called it "Fawnding." "And, I know who can write, who is good at writing proposals to get Fawnding." It is not just plain old "Funding, get me a grant." But, the implication is that we can't walk across the street until some company has given us some money. I think one of the wisest investments that NASA could make would be into the propagation of the propagandizing of all Americans, not only the Blacks and the Hispanics, but some of the White ones too who are so ignorant in comparison

to the Asians that it is pathetic. We ought to all be ashamed. I can feel this sort of shame, and I am not White. I am embarrassed when I understand that on Waikiki Beach in Honolulu all the major hotels are now owned by the Japanese. In recent months I haven't stayed in any hotel in Los Angeles that the Japanese didn't own. I am not going to San Francisco anymore, but I imagine that the same thing applies out there.

I recall Pearl Harbor, I was very young of course, 1941. I heard Roosevelt on the radio say, "This day shall live in infamy forever." Talking about what they call "Black December the Seventh." I call it "Japanese White December the Seventh." Guess what? They had the anniversary last December 7th, I am driving in my car, not my car I had to borrow my son's car, I am driving in my Toyota, I turn on my Panasonic radio, I hear Roosevelt say the same thing. I go home and sit in front of my wide screen Sony, and here comes Roosevelt, "This day shall live in infamy forever." I won't tell you the language I used. It starts out with, "Son," and so forth. So what I am trying to say is this is for America.

I don't think America lost when they gave me the capacity to write and to express myself. I don't think America lost when it made it possible for me to inspire my son to become a young surgeon. This is his third month now in surgery. You ought to see how I swell up when I hear about my son having done four operations in one day. I say, "Gee, I wish my father was here to have heard about this." My parents never got a chance to see me on television. My father was happy that I could even make the Chicago Defender. I wish Ms. Jenny Booker, my first grade teacher, and the people in the church that she organized could see me now. Because, it was this woman who created my tendency to fantasize as a kid. She used to line all of us little boys and girls up and give each one of us a name. "You are Sojourner Truth, you are Harriet Tubman, you are Benjamin Banneker." Yes, we knew about Benjamin Banneker and his almanacs and his clocks, and his having helped lay out the city of Washington, D.C. I am not too happy with what he did, but he did it. Then she got to me and she said, "Your name is Robert S. Abbott." I didn't know who Mr. Abbott was. I couldn't read well enough to read the Chicago Defender. But, she made everyone of us walk out there and stand straight and tell who we were. I had to make a speech telling my classmates in the first grade why they should read my editorials in the Chicago Defender. Is anybody doing that to the kids today? For all I know she and Mr. Dumas launched my career. For all I know. At least they put something on my mind. There are fertile minds out here who need just a little stimulus. I never took any real journalism courses. I am not supposed to be on the Editorial Board of a newspaper (there are only a handful of Black ones in the country who are there). And even after I get on there I am not supposed to have the guts to sit up there and disagree with them by name. I call their names when I don't like what they write. Now, from where did that confidence come? It came from feeling in the first place that you know what the hell you are doing as a professional and that you have got some people out there behind you because you are still speaking - they are speaking through you. So, Frederick Douglass put it correctly, "We may not get everything that we pay for in this world, but we must certainly pay for everything that we get."

Let's go from these meetings to the streets, go to the sororities and the fraternities which are doing nothing. Go to the NAACP which acts as though it doesn't have a program. Go to the Urban League, and above all let's turn every vacant church and unused Sunday school room during the week into a playground of the mind.

Thank you.

# CASET/NACME SURVEY MINORITY ENGINEERING STUDENTS: PERCEPTIONS OF THE COLLEGE ENVIRONMENT AND FACTORS RELATED TO PERFORMANCE

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## BACKGROUND

The CASET/NACME survey was a joint venture of the Center for the Advancement of Science, Engineering, and Technology (CASET) and the National Action Council for Minorities in Engineering, Inc. (NACME). The purpose of the survey was to gather information on student perceptions of their college experiences and future professional development. The intention was to evaluate student preparation for college, motivation, perceived effectiveness of minority support systems, and other factors in relation to college success.

Under the direction of NACME, the CASET/NACME student protocol was developed and administered by Minority Engineering Program (MEP) directors and engineering deans. The questionnaire was distributed and collected in the fall of 1988 and the spring of 1989. All respondents were underrepresented minority students currently enrolled full-time in Bachelor of Science in Engineering (BSE) programs, certified by the Accreditation Board for Engineering and Technology (ABET). Ultimately, 1206 questionnaires from 64 institutions were included in the final survey sample. The data analysis which follows proceeded from a descriptive analysis of responses to individual questionnaire items to the identification of major variables impacting on student success in college. Finally, implications from the findings for improving minority representation in the engineering profession were drawn, and these will be discussed.

QUESTIONNAIRE

## General Description

The questionnaire consists of 95 items, which may be organized into six logical groups: background information; selecting, attending, and leaving college; deciding on engineering; financing a college education; the college environment; and miscellaneous factors relating to college success.

## Descriptive Data

Selected descriptive statistics from the aggregated data, highlighting findings within the six groups of questions, are presented below.

- **Background**

The sample generally reflected the national demographics of underrepresented minority students in engineering. Approximately 60 percent of the sample was male and 40 percent female. In terms of ethnicity, students were 67 percent African-American, 32 percent Hispanic, and 1 percent American Indian. This breakdown conforms with national freshman enrollment figures, which are 60 percent African-American, 37 percent Hispanic, and 3 percent American Indian, for 1987-88.

Parental level of education (see Figure 1) was similar for both mothers and fathers: about one-eighth of the parents (12%) had no high school, one-fourth (26%) had some high school, another fourth (26%) had some college, one-fifth (19%) graduated from college, and one-eighth (13%) had post graduate education. Nationally, however, parental level of education is higher than for this sample. In 1987-88, for all SAT test takers, about 24 percent of the parents had post graduate education, 27 percent had baccalaureate degrees, while only 4 percent had no high school (see Figure 2).

**FIGURE 1**

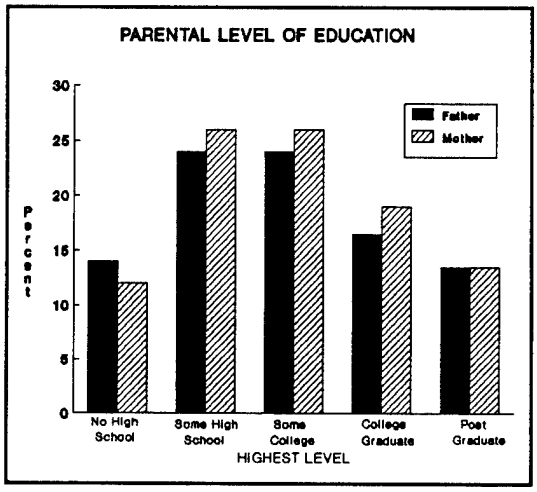
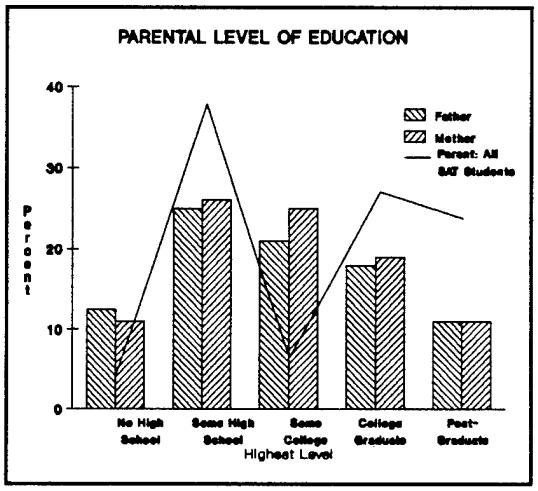



**FIGURE 2**




With respect to achievement, almost everyone in the sample had a final high school average above 80 (B). Mathematics SAT scores, though, were spread more widely and were evenly distributed, from the 400 (11%) through the 700 (11%) range, peaking somewhere in the middle between 550 and 650 (33%) (see Figure 3). College Grade Point Averages (GPAs) were between a C+ and B+ for 56 percent of the sample, while 20 percent were between a C and C+. Only 8 percent were above a B+. (About 15% of the students, mostly freshmen, did not yet have GPAs.)

In summary, the students in this sample were similar, in many respects, to underrepresented minority engineering students nationally, but differed from all college students in certain respects.

- **College Choice**

In relation to college choice, almost half of the sample (49%) indicated that the representation of students of their own ethnic group was not a factor, and another third (35%) responded that it was a factor, while another third (35%) responded that it was not too important. Of those who thought that it was important (12%) or very important (5%), 86 percent (170 students) were African-American and 14 percent (28 students) were Hispanic (see Figure 4).

Also, the majority of students (58%) were attending the college or university that was their first choice. Almost another quarter (23%) were at a school that was their second choice.

**FIGURE 3**

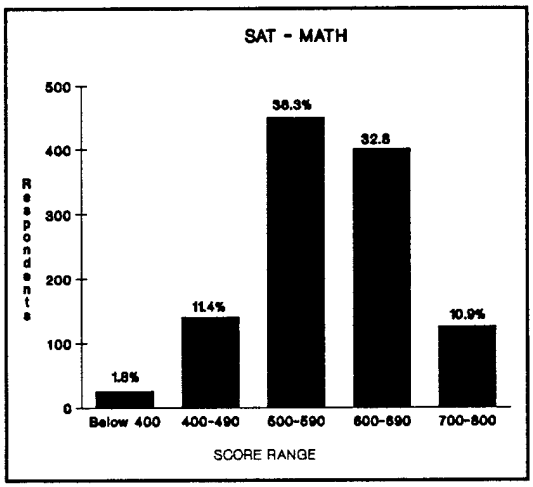
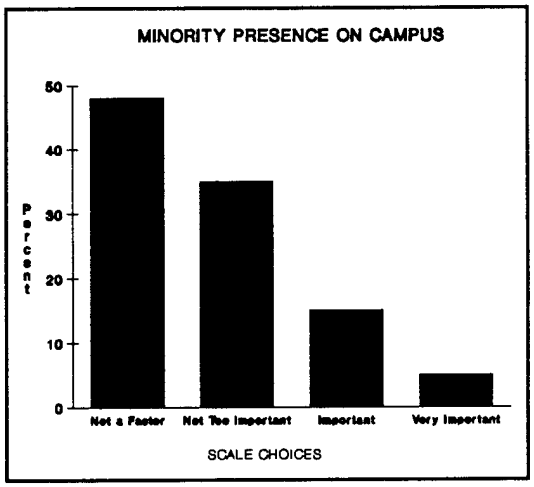



**FIGURE 4**




- **Engineering Decision**

Ratings for individual items revealed that the students' career decisions were very strongly influenced by their own interests/aptitudes (74%), perceived job opportunities (53%), and salaries (46%) (see Figure 5). Of those students who had participated in a precollege program, about one-third (34%) cited it as a most important influence, but nearly one-quarter (24%) indicated that it was not an influence.

More than half the sample (54%) claimed not to be influenced by any of the following factors: friends, a professional engineer, a visit to a college campus. Around three-fourths of the sample (74%) thought that the media and science fairs played no role in their decision; 63 percent claimed that contacts with industry were of no influence. For 28 percent, parents/family were not influential.

In relation to high school counselors, nearly one-half of the students (49%) indicated that the counselors were not influential in their engineering career decision, while only 10 percent felt that they were very important in the decision, and nearly 5 percent felt that they were a negative influence. Though small, this last percentage is more than twice the percentage who cited a negative influence for any other factor, such as high school teachers, friends, and media.

- **Finances**

About half of the students (56%) sampled had problems meeting college costs. Of those, almost 30 percent identified the problem as serious.

For most students, financial support was spread among a number of factors. Many students cited summer employment (62%), college employment (44%), and the NACME grant (43%) as a source of some support. Nearly 40 percent of the students indicated that they received no parental support and 25 percent cited family as contributing less than one-fifth (20%) to their costs. More than half (52%) answered that loans were not a source of support at all (see Figure 6).

**FIGURE 5**

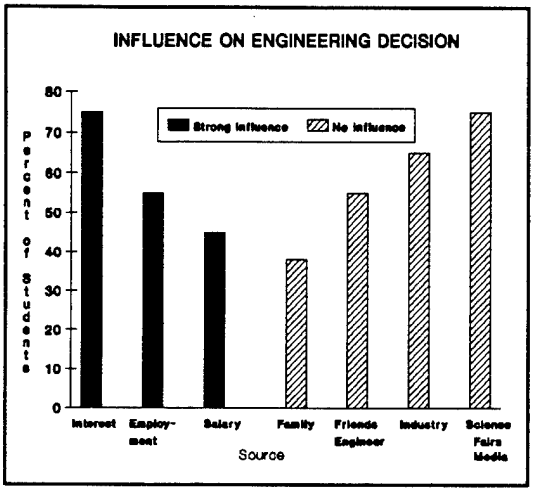
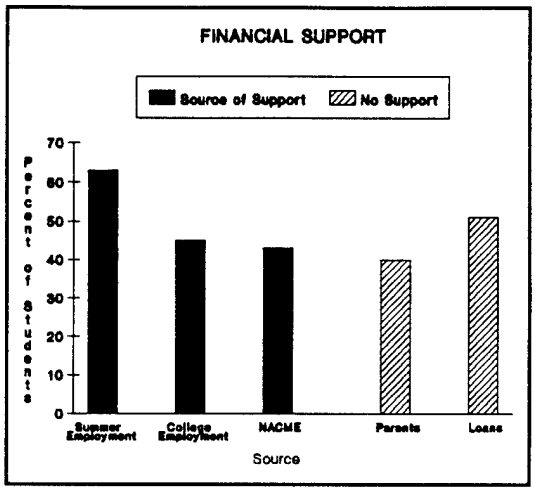



**FIGURE 6**




- **College Environment**

Items related to the college environment were rated for degree of helpfulness in supporting academic/personal needs, on a 5-point scale. While students generally cited most factors as "very helpful" or "helpful," there was some variation in the response pattern. The source of support cited by the highest percentage of students (54%) as the "most helpful" was peers/friends. Peers/friends was also rated as being "not helpful" by a significantly smaller percentage of students (2%) than any of the other items rated "not helpful."

About 15 percent of the sample indicated that the minority engineering program office staff was not a source of support. Non-minority faculty members and faculty advisors were among those cited least frequently as "very helpful," though the former was cited very frequently as being "somewhat helpful."

Specific services provided by the MEP were also evaluated. Orientation, tutoring, monitoring, and special social activities were most frequently noted (30% to 40%) as being used and being helpful. Interestingly, about a third of the students (33%) did not respond to the individual MEP items.

- **Miscellaneous Findings**

Students were asked to indicate the degree of agreement/disagreement with a number of statements not readily grouped under one or two topic areas.

The large majority of students (79%) felt that they were satisfied with their choice of an engineering major and college. The majority of students (78%) also indicated satisfaction with their basic reading and mathematics/science skills, as well. Nevertheless, satisfaction with academic preparation for college was cited by a smaller percentage of students (59%) and 27 percent of the students rated themselves as not well prepared. In addition, 34 percent responded that they were not satisfied with their academic progress to date, while only 8 percent felt strongly that they were satisfied.

In relation to facing special problems as a minority student, 45 percent of those responding indicated that they had faced a problem to some degree (see Figure 7). In this respect, it should be noted that nearly half of the underrepresented minority students who comprised the sample (49%) had never been taught by a minority faculty member, excluding foreign nationals (see Figure 8).

**FIGURE 7**

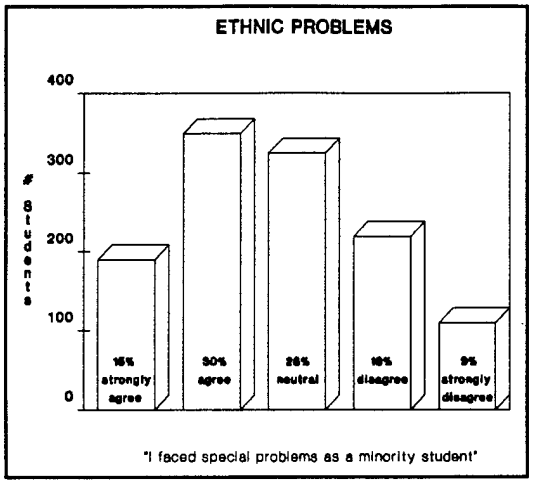
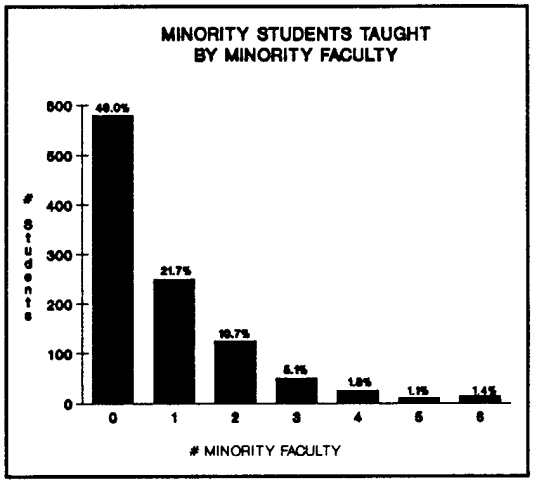



**FIGURE 8**




- **Factor Analysis**

Before determining the predictors of student success, a factor analysis was performed to reduce the amount of information contained in the questionnaire, combining many of the individual items along dimensions with more general meaning. Nine such underlying themes or factors were identified in the students' responses (see Table 1).

**TABLE 1**

| QUESTIONNAIRE RESPONSE ITEMS UNDERLYING FACTORS | |
|---|---|
| • Ongoing MEP Services | • Goal Commitment |
| • Preparation for College | • Academic Integration |
| • Social Integration | • MEP Crisis Services |
| • Commitment to University | • Minority Presence |
| • Financial Need | |

The **ongoing MEP support** scale measures students' satisfaction with the MEP services that supported their academic and social development on an ongoing basis at their university. It included the employment assistance, orientation, tutoring, special social activities, monitoring services, and the minority program office staff.

The **preparation for college** scale measures how satisfied students are with their preparation for college. It included the items rating satisfaction with basic reading, mathematics and science skills, and degree of understanding of college when graduating from high school.

The **academic integration** scale measures students' integration into and satisfaction with the academic environment at their university. The individual items comprising this scale are helpfulness of college staff other than faculty, faculty advisors, non-minority faculty, minority faculty, and graduate teaching assistants.

The scale entitled **commitment to the university** measures students' general satisfaction with various aspects of college life at the university as a whole. It includes satisfaction with social life, satisfaction with choice of college, special problems as a minority student, academic progress, and initial college preference.

The **social integration** scale measures student activities outside the classroom. Included are extracurricular activities, community activities, college athletics, and student organizations other than professional societies.

The **crisis MEP support** scale measures students' satisfaction with the MEP services that supported them in an emergency situation. These services were advocacy (assisting relationships with faculty or college staff), mediation (help with another person), and emergency loans.

The **minority presence** scale relates to classroom instruction by minority faculty and the importance of minority peers/friends on campus.

Finally, the **financial need** scale measures how difficult it has been for students to finance their college education. Scores on the scale are determined by how difficult it was to finance their college education and their awareness of sources of financial aid prior to beginning college.

These underlying themes or factors in the grouped individual response items parallel those found in studies of college retention with more general populations. These factors, along with some of the individual student background items, were used in an analysis to predict Grade Point Averages (GPAs).

## MULTIPLE REGRESSION ANALYSIS

Student success was defined as college GPA. A multiple regression analysis was performed in order to account for variation in students' GPAs; that is, what variables were influencing or impacting upon the GPA which students obtained while in college?

The variables considered in the analysis included the nine factors mentioned previously, as well as student background variables. Results of the analysis indicate that, in order of importance, high school GPA, student commitment to the university, math SAT, financial need, minority presence on campus, and precollege preparation are all significant predictors of college GPA (see Table 2). Ongoing MEP services, academic goal commitment, social integration, and MEP crisis support, as well as gender, did not add significantly to the ability to predict college GPA, i.e., student success.

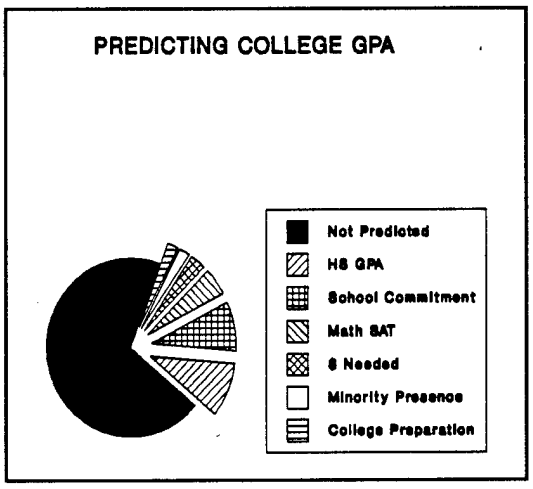
Nearly one-fifth (18%) of what determines students' GPA could be accounted for by the six significant predictor variables cited above (see Figure 9). While this percent is in the range of what had typically been found in previous studies for predicting GPA, it does not account for the majority of variation in GPA. Nevertheless, it identifies particular factors that have an important influence on student performance. We also suspect that the relationship of the predictor variables to GPA would have been stronger if not for two

statistical artifacts of the analysis: the previously noted larger number of missing responses to the items relating to MEP services and the limited range of values for GPA scores.

**TABLE 2**

| VARIABLES PREDICTING COLLEGE GPA | |
|---|---|
| • High School GPA | • Financial Need |
| • Commitment to University | • Minority Presence |
| • Math SAT | • College Preparation |

**FIGURE 9**




## SUMMARY OF THE FINDINGS

The survey sampled students who were typical of underrepresented minority students in engineering. Students' perceptions indicated that: sources which could influence the choice of an engineering career, such as high school counselors, media, and industry, were often not operative; students were relying less on loans and more on employment in order to meet college costs; friends/peers were the most helpful sources of academic and personal support; African-Americans were much more likely to experience ethnic problems on campus than Hispanics; most minority students had little, if any, contact with minority faculty.

An in-depth analysis of student success revealed that stronger commitment by students to their university, fewer financial and ethnic problems, greater representativeness of minorities on campus, and better preparation for college (both in terms of academics and of what to expect at college) correlated with higher GPAs.

## IMPLICATIONS

The findings from the survey should not be surprising to professionals in the field; rather, they should be viewed as empirical support for the particular efforts that need to be made to increase minority representation in engineering.

The findings indicate that there are several courses of action which need to be taken. Further support is needed for scholarships and grants to attract and maintain minority engineering students. This is particularly important since it was found in this study that students who had fewer financial problems were more successful.

Additionally, minority engineering support programs at the college level need to be established, but it is also necessary to evaluate the effectiveness of existing programs in order to maximize their effectiveness. As indicated by the students in this sample certain services, such as tutoring and monitoring, were helpful. However, overall, MEP services did not seem to impact much on students' achievement.

Greater exposure to scientists and engineers at an early age is important in motivating young people to consider these career choices. Nevertheless, students did not perceive engineers and industry as supporting their decision to become engineers.

Finally, faculty training in understanding cultural differences is crucial to maintaining minority students in engineering programs. As found in this study, when non-minority faculty are perceived as helpful, they tend to have a positive influence on students' performance. However, they are not seen frequently enough to be helpful.

# GIRLS CLUBS OF AMERICA: OPERATION SMART[1]

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*Her professional experience includes the design and directorship of the Women's Executive Center of the YWCA in Washington, work at the University of Washington School of Medicine Department of Psychiatry, and work in public schools and private practice. She has served as a Mental Health Consultant for Project Headstart and consultant to many organizations and departments including the Justice Department, Department of Labor, National Urban League, and CETA. She was recently appointed to the Minority Initiative Advisory Committee of Tennessee Department of Mental Health and Mental Retardation. Her professional affiliations include the National Institute of Women of Color and the American Association of Blacks in Energy.*

It is really a pleasure to be able to be with you today and to explore some strategies for empowerment of our Black youth: educationally, academically, economically, and socially in the nineties. I really feel wonderful being here because everybody with whom I have talked has had some kind of linkage with someone that I know through my years of work and travel.

I was especially inspired by the afternoon speech and the one this morning, and remembering that those were the people who were my role models while growing up in the American Methodist Episcopal (AME) church, and then in the Black Episcopal Church in Denver. I did not have Black female engineers, chemists, or similar people whom I could aspire to be like, but we had principals, social workers, and nurses. I was thinking today that I would share a personal vignette. I remember that I liked very much to build things, because my father was a carpenter. He ran on the railroad, and he was always fixing things - and he fixed them very well. When he passed away about nine years ago, people came to his funeral and talked about many of the structures that he had helped build, or of which he had been a part. Being a Black man in the depression and not being able to go to a school of architecture, he was a frustrated architect. He decided that he was going to build things and he did so just out of sheer intuition and, I think, fortitude. I was always aware of his building and making things. I think deep down inside I wanted to do that, too.

I remember not doing well in mathematics and I remember the fourth grade teacher telling my mother, "Well, if she doesn't get it now, she never will." I remember my mother having to fight with the public

[1] Operation Science, Mathematics, and Relative Technology (SMART)

schools in Denver to get a textbook. Back then you couldn't just go and buy a textbook, so she found a way to get a textbook, and she helped me at home. I remember in the ninth grade and then in the tenth grade wanting very much to do better in mathematics, but I think I had what is now called "mathematics phobia". But, I knew I wanted to build things. When I got to the tenth grade I remember signing up for a drafting class, because I thought that might get me close to it. I was not quite sure what an architect did, but I thought I might want to be one. They assigned me to a fashion design class because girls could not take drafting. My name was JoKatherine Holliman and I hated the Katherine, so my name was Jo Holliman. I didn't have the wisdom to stay in boy's gym classes and take all the classes that the boys did until I was in my thirties. I just wanted to tell you that.

***"In going to Howard University I learned something, and I think I learned the same thing from growing up in a Black community, as well. That something is, whatever I did I must do exceptionally well, and that was not the limit - that was only a springboard to be able to do other things."***

I am fifty-one, and in the '40s and the '50s there were no people to say to me, "So you are getting a C or B- in mathematics, you are getting a B- in chemistry. That is okay. Let me tell you what you can do." I've talked to many of my friends who are peers, in their fifties, and we are all either teachers, social workers, or nurses. I think that is very significant when we now look back and our daughters are in other fields, and we wonder what happened to us. We have to think about those counselors who said, "You should be a social worker and you should be a teacher." And, we did.

I think that it is so wonderful now to be in a world where there are groups like yours and people like you who are working to really open up the horizons and expand the knowledge of the women who are growing up, and to let them know that there are a lot of things that they can be.

I guess I have departed from the subject. I just want to say that through my life I have been a very good social worker. I have been a social worker for over thirty years. In going to Howard University I learned something, and I think I learned the same thing from growing up in a Black community, as well. That something is - whatever I do I must do exceptionally well and it need not be the limit, but can be used as a springboard to do other things.

Now, I didn't become an architect, and I didn't become an engineer, but I did have the opportunity to build a 16 by 32 foot addition to my house in Washington, DC, with a contractor. My father came out about two months before he died and he looked at it and said, "You did okay." To me that was worth a degree in architecture, because even though I am a social worker, I always wanted to know what it would be like to build something. So what I am trying to say is my work with these girls and what we are trying to do in Girls Clubs is to say to them, "That they must persist in science and mathematics, and ask questions. And, if one person doesn't answer that question, there has got to be somebody else who will."

Before I start I want to do what I usually do and lay a framework. I mentioned last night, in my introduction, that I had been a manager in the Public Affairs Division of the Tennessee Valley Authority (TVA), which is a government owned corporation. Eighty to ninety percent of the people there are engineers and they are mostly White males. It was distressing to me when I would travel in the community to be an advocate and a broker for the services of the Tennessee Valley Authority to the elderly, minorities, rural poor, and women that I was always running into Black youth who did not know what the TVA was. They didn't have a conception of engineering. They weren't asking the right questions. Then, I was assigned directly to the General Manager and Board of TVA. So being at a pretty high level, hearing the discussions while sitting in on the meetings, I would look around and there were never Black faces. There were very few female faces. I would think to myself, "We have got to change this. I don't know if I can change this now, but I am going to figure out a way."

When the TVA began to change its mission and began to focus on nuclear energy and really downsize and eradicate almost all of the things that former President Franklin D. Roosevelt tried to put into the Tennessee Valley Authority to empower the people in the Southeast, I said, "I have got to get out of here." They wanted to put me in Public Relations and I said, "No, there is something else that I need to do."

At that point I entered the nonprofit sector and began to work with the Girls Clubs. I thought after thirty years there should be a way that I could take all of my experience and put it to good use somewhere. But, I began to run into some very startling statistics. I will take you from some statistics to the model of Operation SMART, that which we are doing locally, and try to have a dialogue with you and invite your focus on what we are doing. Please feel free to ask me any questions.

My husband has been with the Urban League for over twenty-five years, and I have many colleagues and friends myself in that organization. There is an interesting document that is published by the National Urban League, the Research Department Factsheet, and I use it frequently. This one, May '89, is on the African-American woman. I want to share some statistics with you because this has to do with the girls about which I am going to talk and the girls you are going to see on the slides.

*"In general, African-American females are dropping out of school at the same rates as African-American males. Close to 16 percent of both males and females in the 14 to 34 year-old age group are high school dropouts."*

In 1988 the number of African-American females was at 15,874,000, which represents 52.4 percent of all African-Americans, 6.5 percent of the total United States population, and 12.6 percent of the total U.S. female population. It was interesting that African-American females live longer than African-American males by an average of eight years. However, they have a considerably shorter life expectancy than White females. The latter disparity has closed some since 1960 when the difference was 7.3 years. Almost two-thirds of African-American women are presently married or have been married (41 percent have been married). The reason I am giving these statistics is that they have to do with life, with health, with status, and with work, because African-American women are going to work at one point or another during their lives. So it is very important when I talk with young women to say to them, whether they are ten, six, or nineteen years old, "You are going to probably work the rest of your life. So let's get busy and talk about where you are going to work, how you are going to work, and how to work as smart as you can." In 1988 about half of all African-American families were headed by a female. Of these households only 11.2 percent were single, while 25.5 percent were married with their spouses present.

In the area of enrollment, although we have realized significant advancement over the years, the educational status of our women remains a matter of deep concern. It is of even greater concern for the young women who are now ages six through eighteen, these are the girls with whom I deal.

In general, African-American females are dropping out of school at the same rates as African-American males. Close to 16 percent of both males and females in the 14 to 34 year-old age group are high school dropouts. The corresponding figures for Whites are 12.1 percent and 10 percent for males and females respectively. Enrollment of African-American women in institutions of higher education increased notably between 1970 and 1986, by about 41 percent. However, while they are better represented in such institutions than their male counterparts, African-American women are still underrepresented compared to their proportion of the general population.

This is important because we are talking about encouraging young Black women to go into nontraditional fields. If these statistics are what they are, we have our work cut out for us in terms of how we are going to energize them, stimulate them, and get them to thinking about persisting in science and mathematics, because the odds are not very great.

Employed African-American women are still concentrated in less prestigious, low-paying occupations, and in the lower-paying positions within occupations. About 48 percent of African-American female workers are in service occupations and more than two-thirds of those are in technical sales. In administrative support fields they hold the lowest paying clerical jobs.

*"Employed African-American women are still concentrated in less prestigious, low-paying occupations, and in the lower-paying positions within occupations."*

I don't think that this information is very new to you. But, the reason I like to start with the numbers is because this sets a framework for us to really explore what we can try to do to put the fields of science, mathematics, and technology within reach.

There is another report, which I recommend, called, *Stalling Out: The Relative Progress of African-Americans*, which Billy Tidwell wrote this year. It is very good and I recommend it to you. I want to talk about it a little and quote him. He says that, "At the same time it is necessary to point out that the dropout rate among African-American high school students is still greatly disproportionate. These youths are virtually certain to be seriously handicapped in the competition for economic security. Furthermore, the quality of education received by African-American students who do finish high school is often very deficient." Now, this has been brought out today and yesterday in our discussions. Racial comparisons of performance on the SAT and similar academic tests confirm this fact, as we have discussed. Nevertheless, our measurement of change and the relative likelihood of graduating from high school produce an exceptionally positive result.

We talk about college enrollment and incentives. The proportion of African-Americans enrolled in college in '67 was 67.5 percent of the population. It grew to 75.9 percent in '85. So, the college enrollment gap closed by 8.4 percentage points during the period for an average increase. I feel that if this rate grows and the progress continues, 55 years would elapse before any racial parity would occur.

I have girls from six to eighteen, how old will they be in 55 years? I am very concerned, and I think that you all ought to be concerned, because we are looking at children who will not be in a society that has reached parity. They are going to have to compete and the competition is going to be very rough. The skills that they possess aren't as good or as high as we would really like them to be. So for that reason I am going to take you into Operation SMART, which I feel is an exciting concept.

I think that when we look at strategies, this is one strategy that we are using for survival. I think that Vernon Jarrett pointed out that we are in a "war." We feel everyday that when we go to work and look at our girls, that we have got to help them win that "war." They can't always fight it themselves, but we can fight it for them. On the back table I brought a lot of materials about Operation SMART. It is good material, because it will give you an idea of what we are trying to do for exploration, equity, empowerment, and cooperative learning through inquiry.

I am going to show you some slides from the national office and I will tell you about the history of Girls Clubs. I want you to see what they are doing so it can capture your interest while I talk. SMART stands for Science, Mathematics, and Relative Technology. The things that we say to the girls are, "Listen. Feel. Think. What is it? Can you see it? Can you feel it? What are the vibrations? What are sound waves and how does sound travel? Have you ever wondered why and how and what?" The girls in Operation SMART ask questions all of the time, because inquiry is the key to learning, to taking initiative, to becoming an independent thinker and person.

Operation SMART was established because the jobs of today and tomorrow require a background in mathematics and science. Too many girls drop out of these courses while in high school and cut off their chances for decent, fulfilling jobs. As you can tell by the statistics that I read, these girls, if they don't learn to inquire, to explore, and be persistent, are not going to get the jobs. But, we are trying to give girls a fun, positive, and challenging experience so that they find the wonder in the world around them, stay enrolled in mathematics and science classes, and surpass their own and others' expectations.

Operation SMART is about mathematics, science, and technology. Girls dissect frogs, they work with computers, they deal with birds' nests. It is about learning how to use scientific equipment. Research shows that girls are interested in scientific equipment, but they have had much less opportunity than boys to pursue that interest.

***"Operation SMART was established because the jobs of today and tomorrow require a background in mathematics and science. Too many girls drop out of these courses while in high school and cut off their chances for decent, fulfilling jobs."***

Let me tell you a funny story. I am going to have to read it to you because it is a darling story. Ten-year old girls were out in the backyard of the Schenectady Girls Club fixing their bicycles in a bike repair class. Three eleven-year old boys walked by and said, "Hey, what are you doing?" Challenged one of the boys, "That is not girls' work!" Wrench in hand, one of our girls looked up and scowled, "It is so girls' work! Are you going to be around every time I need to fix my bike? No way!" When a girl leans over her bike, oil can in hand figuring out exactly where to lubricate it and gets to the back gear she comments, "It looked complicated because it was all greasy and yucky and dirty. At first I didn't want to do it. But, dirt ain't that bad, after all. It is kind of fun when you fix the wheel and you feel good about yourself because you know that you can fix it."

This is the one with the nests. [Referring to slide] This is the one to which we refer and state that by looking at nature, by looking at the things that are immediately available to you, it does not matter if you are in a club or a neighborhood or community that says that "We don't have a thousand dollars for a microscope." There are ways that you can get smaller pieces of equipment or get them donated. I will talk about partnerships later. But, even a Girls Club with a shoestring budget can equip itself with a science lab.

SMART is about using tools. Learning how to fix things herself, to do things for herself, the whole issue of powertools is very exciting to a girl. These are things that girls see on field trips, or they may be aware of; they may see them on television, and for them to actually have those tools, under supervision, and to use them is a very empowering kind of experience.

Astronomy is another subject. I am sure every city in which you are has some kind of facility where girls can go and explore that. They can make telescopes. The whole issue of space is important. We are in a wonderful setting right now, especially for that, and I think that it is something that can be encouraged.

Here in this situation [referring to slide], we see a girl that is paired with someone as a mentor, as a partner. But, one of the important things is to let the girl be in an atmosphere that is not a classroom. This type of atmosphere allows her to ask questions as she is discovering things; one that is anxiety free; one that doesn't place a lot of pressure on her. Although discipline and expectation are very important, we feel that in our organization we can be supportive of the classes and whatever the kids are doing in class, but we can help them do it in a much more casual and informal atmosphere.

This one [referring to slide] has to do with a circuitry board which is exciting. Many people don't know what a circuitry board is.

Here is another situation [referring to slide]. She probably uses Pac-Man which her T-shirt denotes, and now she may know how Pac-Man works.

This slide has to do with cameras. This is where mentoring comes in. I will tell you later how we use mentors in our community to work with the girls one-on-one.

This is a cam-video recorder. We have a video recorder at our Girls Club and in any program that we have we usually have two or three girls assisting us. They are now learning to operate it for any of the programs that we have. Because it is important to have that hands-on experience. This is learning they can then take somewhere else.

Here is another powertool situation. This is a stethoscope. This is enjoying a computer. [Referring to slide] We have a newspaper back here that our girls printed on our computer given to us by the Apple

Corporation. It is really important when they can do some hands-on activity, see how it works, and see what they have produced. There is a great feeling of self-esteem!

This is a situation [referring to slide] where the girl is breaking something down with a hammer. It is interesting that there is an expectation that girls are soft and nice and neat and don't want to make a mess. Just see these girls with a hammer! It is really wonderful.

Here is another situation [referring to slide]. This one is working on a car. We are trying right now in Chattanooga to find some people to donate some cars, and we seek to work with our technical college so that our girls can get into an auto mechanics class.

This is building a structure. [Referring to slide] There is an interesting story about this one because we tried this. We gave the girls these round dowels and asked them to set up a structure. At first they set them up in squares and everything collapsed, and they kept doing it over, and over, and over. Everybody was working on a stick trying to make it stand. Then somebody said, "What if we tilted them?" It was really interesting because they were then able to build something that stood. That may seem very simple and very elementary, but the idea of exploring it, giving them something, seeing how far they can go with it, there being no penalty if they make a mistake, and no one is saying, "You are dumb; you can't do it." They stayed with it until they accomplished it.

Here is another one with liquids [referring to slide]. This is the one who fixed her own bike [referring to slide].

Well, I want to go on and tell you more about SMART. A long range priority of our Girls Club is to increase their academic capabilities. I will tell you something about Chattanooga and its academic standards in a few minutes. Nationally we implemented this program to assist in the effort to involve girls with an interest in mathematics and science and to encourage their participation in these areas during the school year, and as they plan their careers.

The specific goals are five-fold:

- To design models, develop materials, and establish programs of informal science and mathematics education for girls;
- To demonstrate how mathematics and science concepts can be integrated into all program areas and activities of Girls Club and other informal educational settings;
- To provide the girls, especially low income and minority girls, with access to community resources that can further their interest and skills in mathematics, science, and technology;
- To explore how formal and informal educational settings can enrich and supplement one another;
- To involve the public, private, and voluntary sectors in the professional and academic communities in the development of the programs.

We do a lot of target programs and try to stay in touch with the schools. You all, I think, share this same feeling about school counselors. Many of the schools which our girls attend are so impacted with a lot of behavior problems, truancy, and absentee problems that the counselors don't concentrate necessarily on career preparation. So a lot of girls fall through the cracks. One of the things that we try to do is track our girls from kindergarten through high school. At the beginning of each year we try to get to know that counselor and let her know what we are trying to do at the Girls Club. We get in touch with the teachers and try to match some of their homework with some informal science and mathematics experiences at the Girls Club. We realize that what happens at school may be difficult because the class size might be 32 or 40 kids and there may be problems at home. After school they can come to us and maybe some of those concepts that they learn during the week at school can be put in a setting that is fun, that is entertaining, that is innovative, and some of it will translate so that they will see it as being valuable for them.

We try to establish those connections by encouraging the girls to stay in mathematics and science. We do a lot of tutoring and a lot of preparation for test-taking. We try to provide activities that emphasize problem solving, decision making, reflection, and critical thinking. I happen to feel that if you know how to process something, you are almost there. No matter what it is - whether it is what subject you are going to study first or what television show you are going to watch first - whatever you do involves a process.

I don't know how many of you touch the lives of young kids, but they don't automatically progress. They would rather say, "I don't know," or nothing at all. So if you can just take the time and say, "Think it through. Of what does this remind you?" Do a lot of translation if you have to. Teachers find it very difficult to do that on a daily basis, but in our setting we really try to help them with those kinds of things.

As I mentioned before, the hands-on computer operating experience, for us in Chattanooga, was a dream of many people who were there before I came to the Girls Club. We went out literally begging and finally we have a computer literacy lab through donations from about 20 people. While we don't have really sophisticated computers, we do have clones. We bought clones that were similar to the ones used in the public schools. We are able to get their software and we are able to use it so that whatever they use at the Girls Club they can use at school. I was horrified when I came to the Girls Club in October of last year and found that our girls used the computer in school one-half hour, maybe every two weeks. Now that is not going to make them computer literate, so we are trying to beef that up. During the summer we have something that we call "Computer Camp" and they come everyday. Because we are a United Way Agency, that is not a high priority budget item, so we are having to find volunteers, we are having to find people from the technical college. Consequently, there are often different people there everyday, hopefully doing the same thing, reinforcing computer literacy. It is a hard fact, but we have to have the materials there so that the girls are not phobic about the machines and about the keyboard.

The day before I left, Monday, some first grade kids came in. I think they were very anxious and one of the girls said, "I don't know nothing about computers and I would rather be back playing." I said, "When you come out I want you to come by my office and tell me what you learned." She rolled her eyes and she didn't really want to be a part of that. Anyway, after an hour she came in and said, "I don't know what it is called but I think I am going to be programming next week, 'bye!" Eight years old! Now, if we can keep her interested, if we can make her feel successful - she felt so good after she left. I have 1,400 girls and I don't know if all of them are going to feel that way, but it is guaranteed she will go home and tell her parents, many of whom have not had an experience with the computer. They might have to learn from their children, as I had to learn from mine about computers.

They will talk to each other. If we make it interesting, particularly if we have snacks at the end of the session, they are going to remember that we have good snacks when we have computer training, because food is important. We have food in our budget, snacks in our budget, and they don't like Granola Bars. We thought that would be very nutritious but they said, "Forget it! We want M&Ms." Anyway whatever you can use to make it fun and constantly rewarding. A certificate - you can't believe how much a certificate with a person's name means to them. Many of you have Ph.D.'s and all kinds of degrees, and I know your offices are spread out with diplomas. We forget that when we give an eight year old a certificate with her name on it, it means a lot, and the strokes that come from that are important!

It is important to establish link-ups with social science museums in implementing kitchen chemistry lessons that use food to reveal science concepts, and then they can eat the food. We have found this to be fun, and I enjoy those classes, too.

Let me tell you, very quickly, about the city in which we are living and what we face. Chattanooga is a city of about 170,000. Nearly one-third of the people are classified as minorities, primarily Black. Results of standardized testing in Chattanooga schools showed the same negative trends in science and mathematics scores that have been published nationally. With the economic future of the city and surrounding counties dependant upon a change from a manufacturing to a new technology-based economy, it is imperative that efforts be made to encourage the minority community to be part of this change. We have found, and I have only been in Chattanooga for six years, that it had been an industrial town. It was a shop town in that many people left school at the sixth and seventh grades to work in the factories. We are now finding that with the industries closed and technology coming, there are many people ill-prepared for jobs, their children are ill-prepared, the educational level is very low, and the city is doing a turn around as we speak.

Female minorities in Chattanooga face the double challenge of sexual and racial stereotypes that discourage them from careers in the technical areas. One of the resources that we have used is the Tennessee Valley Authority (TVA), which has an Energy Center. It is a science museum in the heart of the downtown Chattanooga business district. Surrounding it are the historically Black residential areas and schools with students who need encouragement to stay in school and enter technical careers. The Energy Center specializes in hands-on science learning in a class size environment, plus learning in a walk-through museum area. We are working on writing a proposal so that the girls can be in a program designed to do hands-on work with the engineers with TVA. They will have demonstrations, they will be in workshops, and we hope that at the end of a period of time that they will build something electrical. They are going to call it whatever they want, but we are going to use all of the materials that are available there.

*"We have found that based on gender roles girls have been exempt from alot of things that involves mathematics, science, and technology, so we are trying to remedy the situation by offering work sessions in auto mechanics, science labs, and projects in ecology, nature studies, recycling and energy study."*

Selected instructional sessions will be videotaped to assist in program evaluation. They will meet and work with successful female engineers or scientists from the TVA. They will take field trips. Field trips are very important. And, in the goal of promoting positive attitudes, interests, and role models in science, the main tasks for the girls are to construct this electronic equipment and illustrate a scientific principle. Now we are leaving this very broad because we want to take them through some very elementary things and say, "If you could, what would you build? If you could, would you build anything that is related to electricity?" And then we see what they decide. They may come up with something that is just amazing, but in going there to try and build it, whether they can build it or not, they will have learned why they couldn't build it, why it wouldn't work. If they do build it, it is a new invention.

We want to demonstrate science to the four-to-six-year olds through science demonstration evenings. We want them to have this hands-on physical environment to motivate them and hold their attention so that, hopefully, when they go back to school they really won't be bored, they won't be disruptive.

Let me tell you, very briefly, the other things that we have done. We have found that based on gender roles girls have been exempt from alot of things that involve mathematics, science, and technology, so we are trying to remedy the situation by offering work sessions in auto mechanics, science labs, and projects in ecology, nature studies, recycling and energy study. Those are very low cost projects, and we can get a lot of donations. A lot of people like for us to pick things up so that we can do an ecology project. Our members have been especially interested in space study, particularly after learning about the female astronauts and the women who have helped to eliminate the gender barriers that have existed in this new career area. So, if you go into a Girls Club you see large pictures of women doing all kinds of unusual things. This helps to keep these images with them all the time. A picture is worth a thousand words!

Prior to the development of Operation SMART, through the national Girls Club, we had utilized an in-house program using 4-H. 4-H is an interesting organization because it has offered for a number of years a lot of the science-based things, particularly agricultural things, that we used. With the SMART Toolkit, we now have basic information appropriate for all of our age groups.

When the girls decided, during National Girls Club Week this year, to use the theme, "Girls Care About the Earth," they studied air, water, and land to see how these elements interact. A major aspect of this project was emphasis on individual responsibility for helping to maintain a healthy environment. They measured daily water usage, made water charts, and planted trees in an effort to learn how to conserve for the future. They visited local weather stations and the nature centers, and wrote essays that showed that they, too, cared about the earth.

We find in working in an environment that is predominantly Black that the community has a missionary kind of concept, "Those poor Black girls, what can we do to help them? They are not going to succeed.

Teenage pregnancy is fourth in the State, they are going to be pregnant by the time they are 15." They have a lot of stigmas placed against them!

One of the other things that I got out of growing up, and I am sure that you did, was that your parents said to you, "Whatever you do you must give something back." So every time I go to a Girls Club or every time I talk to a girl I say, "What have you given to your school, to your family, or your community?" To further instill this I felt that during Girls Club Week it would be very important that these girls give a symbol back to the city. We are getting ready to build an aquarium that is going to be second in size to the one in Baltimore. It is going to be giant-sized. It is just going to be huge. The whole city is involved in building the aquarium. The aquarium is the greatest thing going. Not many Blacks are involved in the building of the aquarium. It has been a decision made by the people on Lookout Mountain. They have decided to utilize the river and get tourists in.

I thought that it would be nice during "Girls Care About the Earth Week" if our girls donated trees to the riverwalk that is going to lead to the aquarium. Everybody said, "But, what does that have to do with Girls Clubs?" Well, I called up the head of the aquarium Corporation and told him that the Girls Club wanted to make a presentation and he said, "Fine, what are you going to donate?" I said, "Some trees." Then I thought, "I am an United Way Agency, I don't have a budget for trees."

It is interesting that when you ask people, people are more than happy to help. I went to a landscaping company and it gave us 12 rosebud trees. The girls, who were between the ages of six and eight, presented Bill Suther, who is head of the River Park Association, with these trees. The trees will carry tags on them that say, "Donated by the Girls Club."

There is a lesson in this. There are girls who live in the housing developments. Seventy-five percent of our girls live in public housing; they have never been downtown; they have never been to the river; they don't have a concept of where they fit into the future of the city. I hope that when they go down to the river front or years later they can look at that tree and say, "I had something to do with that." I don't know if they will all become botanists, but they will have an appreciation for what was done.

I think we have been talking about giving our children a connection, not only to their past, but to the community in which they live. In this way they won't feel that they are just recipients of charity, but they are giving something back. Every one of the girls in the Girls Club has to donate at least 10 service hours a month to something. They either wrap gifts at "Kids on the Block" at the stores at Christmas or they give toys; they donate time at the hospital. I just feel that even if you are poor you can have pride and you can feel a sense of giving. This was a very monumental thing and people were very thrilled that these girls feel good about the earth, that they want to make an investment.

Moving on, we have encouraged girls to play with cars, trucks, handtools, and other traditional male-oriented toys. Lego Corporation donated Lego Building Sets so that the girls would have an opportunity to design and create in a nonthreatening environment.

We have a donor, a very wealthy White woman, who donated a doll house collection to us. Now, if you can imagine, she made all of these things by hand. It is an antebellum mansion. She has reconstructed her beach house in Largo, Florida. Also, she has redone her family store. It is just beautiful. We have a museum now that is probably better secured than any of our facilities, because a wealthy woman thought this would be nice for the girls. Well, I guess I am too much of a feminist and I thought, "What in the hell are they going to do with a doll house?" I mean, there is no connection. However, she left a certain amount of money for an award to go every year to a girl who did the best doll house. Well, to me that was reinforcing dolls and girls, and all of those kinds of things, and I gritted my teeth. But, my grandmother taught me a very interesting thing. She said, "Whatever is given to you, you can make it into something else. Don't say no. Don't stick your lip out, but make it into something constructive." So for years they have been giving this Doll House Design Award.

This year we gave the Miniature Design Award and we followed it up with the girls being mentored by female architects. So when they look at that doll house they can see walls, they can see structure, they can see form, and then the doll houses that they construct are more in line - they are not trying to create something traditionally antebellum. They are creating something in which they want to live, something that they see is useful. So, for the first time the designs that the girls submitted this year were more theirs because we called it "Miniature Design," instead of "Doll House." I don't know whether this seems important or not, but these are little things. You have to take a term and translate it and you have to work with what you have. Thank you.

# COMPUTER DELIVERED INSTRUCTION AS A MODEL FOR INCREASING RETENTION OF SCIENCE, ENGINEERING, AND TECHNOLOGY MAJORS

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*Dr. Alston has received many awards, including the NAFEO Research Achievement Award, and grants, including a Minority Access to Careers (MARC) Grant and a Breadloaf Cross-Age Tutoring Grant. He is a member of the New York Academy of Sciences and other professional societies.*

I would like to thank Vernon Jarrett for his inspirational talk this morning, and to tell you that I came away with two solid pieces of information. One: Yes, it is true we have to get involved with Black youth. I think it is important for us to realize that that means changing, to a large extent, from the traditional way in which we are going about educating and getting minorities and women involved in pursuing science, engineering, and technology (SET) careers. The second thing came from when Mr. Jarrett was asked the question of how to get the churches involved. You have to "trick" kids into education. You have to trick them into appreciating education and, in particular, in the SET careers, you have to really trick them into being persistent. In every state where I have gone to a mall somewhere, I see arcades packed with youth. You will see a large group of Black youths in there. I believe that, given the kinds of manipulations they are performing on these Atari games and the like, those kids have a tremendous ability that is going untapped as far as their educational ability is concerned.

My talk will be about computer delivered instruction (CDI) as a model for increasing the retention rate for science, engineering, and technology majors. When I was first approached by the Center for the Advancement of Science, Engineering, and Technology (CASET), I asked them to generate some information from their database on any published information on the use of computers in education as applied to instruction. They sent me about four or five references, and the articles proved to be a tremendous support. The first thing I saw on CDI was that it was not being implemented or applied at any Historically Black Colleges or Universities (HBCUs). There were some developments going on at Houston Community College, where CDI was being used to educate adult learners. And, of course, the leader in that field, Duke University, was doing a lot of innovative types of things with CDI.

I think it is important for all of us to realize that not only are our youth going to be able to read, write, and do math, but they are going to be able to express that particular information electronically through some form or another of advanced technology. That is the state of the future when it comes to information. We all realize to a large extent that information is knowledge, and I have set this up somewhat as a chemical reaction with the "E" here being analogous to an enzyme [slide]. Those "enzymes" can have various functions and names and, of course, one of them is going to be *education* and one of them is going to be *economics*. They are going to play a very critical role, not only in how information is being produced, but how it is made available to the population, the masses. As Vernon pointed out this morning, there was a time when Blacks could not stand in front of libraries. Now, computers are beginning to house information whereby, let us say, libraries - as we now know them - will become extinct in the future.

*"I think it is important for all of us to realize that not only are our youth going to be able to read, write, and do math, but they are going to be able to express that particular information electronically through some form or another of advanced technology."*

We feel that moving our kids into CDI will provide a mechanism for our being able to retain them. I think it is important to realize that it is one thing to put a student in front of a computer, but it is another thing to be able to help that student know and realize that the source of information being made available to him or her can be unlimited. So, we are going to talk about a small portion of what computers are able to do today.

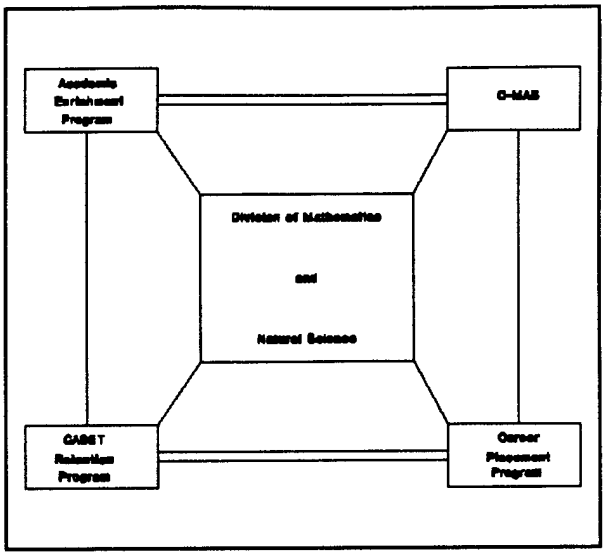
I would like to say that there are two different kinds of computer applications. One is being referred to as CAI, which stands for Computer Aided Instruction. The other is CDI, which is the acronym for Computer Delivered Instruction. I define computer aided instruction (CAI) as a pre-programmed piece of software which does not allow manipulation by the instructor or individual. CAI has a series of questions and the student can go through that particular mechanism so many times. The student has only *A*, *B*, *C*, or *D* choices to answer a particular question. When the student answers that question correctly a bell goes off or something starts jumping up and down to reward the student. Computer delivered instruction (CDI) is different in the sense that it is software which allows the faculty member or individual to generate the type of instruction he or she wishes in order to enable learning to take place.

**EXHIBIT I**

As a part of this particular instruction at Benedict, we decided that one of the things we wanted to do was concentrate on the math aspect of it. I will say a little bit about this as we go on. But, this was pretty much a mammoth task that was undertaken as a part of the CASET Intervention. In spite of all the problems encountered, we have had a very good working relationship with CASET. I think, as you will see toward the end of this presentation, that we have generated some interesting results which, I feel, will prove this to be a successful model as a strategy for increasing retention. I would advise you also, at this early stage, that if there are any of you who might like to plan this type of intervention, that you would do well to have thoroughly capable consultants. You could find yourself with real problems if you do not have some of the basic background in computers and their capabilities. The software manufacturer may tell you that the software is going to do one thing; then, you get it and it does another thing, or it does not meet your application needs.

I am going to say a little bit about the structure and function of this particular program, and then I can show you some results. We have just finished this intervention over the summer. We were involved in the first and second sessions of our summer school, and this semester we are working with two separate classes.

At Benedict College we have a Division of Mathematics and Natural Sciences. As Director of the Center for Mathematics and Science, I was faced with the problem of where to place the CASET Intervention. Should it be a separate entity, or should it be placed with an existing program? Although Benedict College has an organizational structure on paper, as do a lot other institutions across the country, including a retention program (Exhibit I), I think that when you really look at the various programs the college sponsors, you find that all they are is paper structures. More and more emphasis is being placed on beefing up those particular programs. So, we finally decided to include this intervention as a part of the retention program. A CASET consultant came to Benedict for a couple days, and we really hashed all of this out. This helped me a great deal, and the intervention is now beginning to catch the eye and interest of a lot of the faculty members within our Division. I feel that they ultimately will incorporate this idea in their own instruction. I believe that this particular intervention will be institutionalized by our school.

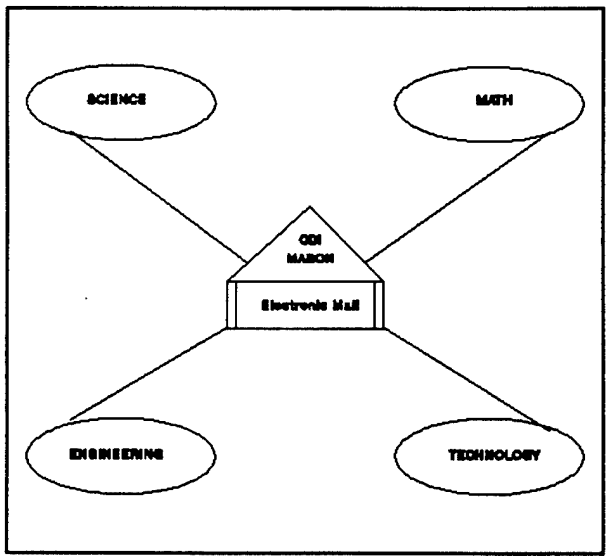



Now, one of the things that we wanted to do was look at all of the areas, as we began to work out the bugs. I am very hopeful that as CASET writes its final report, some of what these interventions have been able to find out in reference to problems and troubleshooting can be useful to other institutions which have infrastructures similar to Benedict College. You know that something that is going on at Duke University is going to be totally different from how that particular operation functions at an Historically Black College or University (HBCU), and particularly a private HBCU.

We wanted to concentrate on the mathematics area, although this program is set up in the full realm of our science, engineering, and technology of CDI. CDI operates in conjunction with Math and Science On-line Network (MASON) (Exhibit II and IIB). It all involves utilizing a technical word processor and electronic mail. At Benedict College we have a VAX 11780 mainframe which utilizes the DMS operating system. The technical word processor that we use is a Digital product, referred to as Whips Plus. This technical word processor allows us to generate a full realm of mathematical, and, in some cases, scientific symbols. What you have to understand is that all of the information being looked at and worked on by the students, by me, and by the technicians involved in this process is accessed through a visual monitor of information that we generate and send to each student's account.

**EXHIBIT II** **EXHIBIT IIB**

Right now, we have a control group and an intervention group. We had a lot of problems during one of the first sessions in determining what is a control group, what is an intervention group, and why we need a control group. However, we now see that both of these are necessary in order to effectively itemize your results. In the first session of summer school the intervention took place with a college algebra class. The control group was simply a group that received its homework assignments in the traditional manner. The instructor comes into class and says, "Okay, homework assignment number four is due Monday," or what have you, and, "This will be problems 4, 5, 10," and the like. This class is taught by the usual instructor. The intervention group is the group with which I work. I provide the students their homework via the computer. They have to go to the computer, with each student having an account; they log in, and they have a message from me indicating that there is a homework assignment. They are able to access that assignment from the mainframe.




The students are able to realize a lot of side effects from this particular program, which we probably will not even measure. I will mention two of them. First, they learn to use a technical word processor. Those of you who work with computers know that if you learn how to use one word processor, you can use almost any word processor, because all of them have some of the same basic functions. Second, they learn how to use electronic mail. In any setting into which these students might move after Benedict College, they are going to have to be able to move information electronically. Even when you go to a Burger King these days, at the drive-through window they have one person who puts the order into a computer, this goes back to where the cook is, and then the order is prepared to come up. Everything is being served up digitalized, these days.

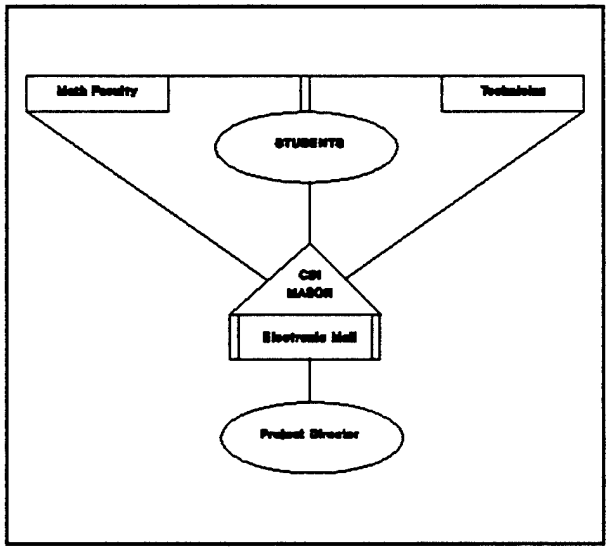
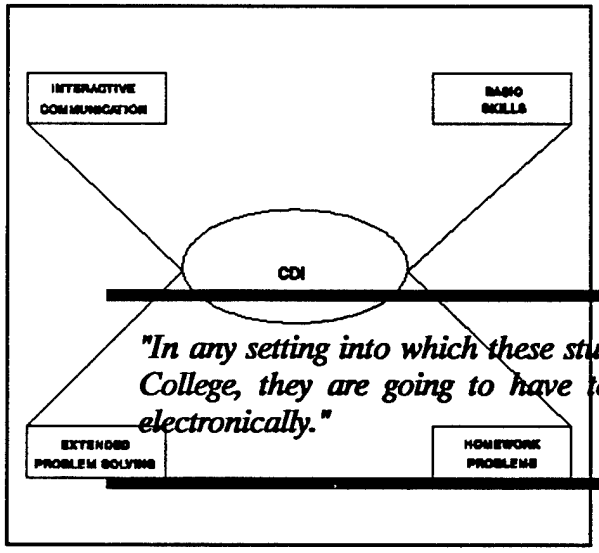



**EXHIBIT III**




*"In any setting into which these students might move after Benedict College, they are going to have to be able to move information electronically."*

Students are able to receive a tremendous amount of help in improving some of their basic math and science skills with this program. How is it done? We send them their homework assignment and they get their homework problems. Then they send us back messages indicating when they have completed that assignment. One of the things that the computer will do for you is automatically put the date and time on the information; thus, the faculty members do not have to worry about saying to the student, "That is due today before I leave." When the faculty member comes back in the morning, there are several assignments under the office door, without the computer, and there is no indication of when the students delivered that information. With this program, that is no longer a problem.

Students then wait for us to print out the information, grade the assignment, and give it to the faculty member. Then we send the students' information back, indicating how many problems they have gotten correct and how many they have wrong. We work with those students through an extended problem-solving mechanism whereby we provide hints on where they went wrong in solving a given problem. This goes on until the student comes up with the right answer. We do not provide the students with the right answer, but we give examples and do other little things to help them continue to think about the correct way to go about solving that particular problem (Exhibit III).

At this junction one of the things we have been able to do, and that we see as a tremendous benefit in the future, is deal with a class with a large variety of students with different abilities. A student who is very proficient in math can continue to move on. He or she has gotten that particular problem or assignment right, and you send the next one. So, the student can continue to move at his or her own pace. We continue to work with the student who is having problems. All of this is done through a separate wall. There is very little interaction with the students other than if they are having some problems such as forgetting their password. But, the students are not put down. For those of us who have been on faculties for a long time, it goes without saying that at some point a student might come to your office when you are in a rush and you have no time for that student. You have no idea what the impact of that might be on a student at a given time. You do not know where he or she is in his or her thinking. Maybe if the student could just get one little hint about the problem, he or she could be on the way. Of course, some other things go on, but with this particular system that is removed. I can tell you that we find our students who are involved in the intervention are out-performing the other students.

I would just like to interject that, as the Project Director, the majority of this program takes place with my being involved in training the students. We provide time in the computer center, whereby we bring groups of students in, and through a period of two weeks all students know how to access the system, access their homework assignments, and input their particular work.

Question from the floor:

It sounds like what you developed is an expert system.

Well, it is not an expert system, but it has potential for becoming a way to better provide students with information; in this particular case, homework. I do not like the term "expert."

Question from the floor:

What level of students are in the program?

We are talking about students who have taken college algebra, calculus, or trigonometry over for the second or third time. We are talking students with low GPA's.

Question from the floor:

Is it presupposed that the student has a computer at home?

No. Most of these students have not logged on to a computer before. The college algebra course is taught during the freshman or sophomore years. Although they are science, engineering, and technology (SET) majors, they really do not get into the hard courses until the second semester of their sophomore year. I believe if you look at any SET curriculum the majority of the students wash out in college algebra, trigonometry, and calculus. So, there is no need for a student, in this particular case, to have had any experience with a computer. It is a very, very user-friendly system. We developed it such that it is pretty much menu-driven. I was told that I would have problems training them, but they learned as well as the better students.

Question from the floor:

Is this a lot of work for the individual faculty member?

At this level it is not.

Question from the floor:

I mean at the level where he or she is interacting with the student via the computer, if the student has to go on. That means that he is interacting in an individual sense with that student.

CASET funds me to have a data processing technician, so the only thing that the faculty member has to do is provide the technicians with the homework assignment. They then input it, and they are the ones who interact with the student if any interaction is necessary. We download the homework assignment; the faculty member gets a printout - you know in a normal homework assignment where the students are writing, you may not tell the difference between a square root sign or some other sign - it makes it very easy for them to grade their assignments. The technician will grade the assignment if the faculty member wishes. That was one of the problems that we had, which I reported to Dr. Kay. Most of them wanted to do their own grading. I am not speaking in terms of putting a grade on the paper but, just putting a check by what was right or wrong. However, the faculty did not even want that to take place.

Question from the floor:

That is what bothers me. It is the process. How do you know that the process - not just whether the answer is just right or wrong, but the process involved. It is not only the answer that is the most important thing.

Here, again, that is like another aspect that we realized in this particular project. Some faculty members only grade the right answer, and we cannot do anything about that.

Comment from the floor:

I agree; that is style.

Some faculty members will grade steps of the problem, so if they are doing the grading that is up to them. Or, they will tell us how to grade. This project in no way interferes with what the faculty member does, other than allows us to use the intervention in that particular classroom.

Question from the floor:

I guess what I am having difficulty saying is, How can one see process with your methodology?

I will say a little bit about that in a minute.

Question from the floor:

Am I being correct in assuming then that all of the steps that a student takes in solving the problem are not really used?

I will say a little bit about that in a minute.

Question from the floor:

They do not show their work?

That is not true. Here again that is up to the faculty member. If the faculty member requires the student to produce the steps, the student has to produce the steps.

Question from the floor:

The technician then must incorporate that, so when the instructor says he wants you to show all of your work, then that is part of the assignment.

The CASET program is set up whereby we have to meet with the class twice before we are actually able to start the intervention. We have papers that they have to sign which will release their academic information to the CASET program and they also have a protocol that CASET developed which they have to complete. All of this has to be done prior to the intervention taking place. Then through our interacting with the faculty members in the classroom we state what has to be done prior to anything taking place. So we have to work out with the faculty members what they want, and the students are told up front what is required. We reemphasize that a couple of times, but that is all done by the faculty.

Question from the floor:

What is the time period between the time they turn in an assignment and get it back graded?

All of that is controlled by the faculty member. During the summer there was probably a two-day turnover rate. Education or academics is a strange kind of monster. We try to make it as comfortable as possible for both the project and the faculty. If we are thought of as an outside force to change the dynamics of their classroom, the project would have no success at all.

**TABLE 1A** **TABLE 1B**

I am going to tell you why I feel this mechanism of computer delivered instruction (CDI) has the potential for working. Basically, it is because there is a minimum of four levels of recognition. I want you to think about the traditional way students are assigned homework. They are told to go home and do the homework at the end of chapter two. They go home, open up the book, do the problems or the assignments, turn it in, the instructor grades it. That is pretty much it. In this project, when the students go in and access their assignment, that assignment then appears on the video monitor. That is the first level of recognition, which is like opening up the book to look at the problem. Then second level of recognition comes in. While those problems are on the monitor, the student writes down the problems. Very few students are going to stay there and try to work ten problems while on the system. So they do not even know that they are doing this, but they are writing them down. They then take those problems home and work them. That is another level of recognition. The second level of recognition is the one that the traditional manner misses. Students do not have to write them down because they have them in the book. Students have to concentrate on writing them down because they have to be sure that they are getting this information correct. The third level: With this information written down, which the student would normally pass in to the faculty member on paper, the student then has to input that back into the computer. The fourth level of recognition, or beyond that, can be intertwined into how many problems they have gotten right or wrong.

Now, in the college algebra class this is what the data looked like. This was the number of students that we had in the college algebra class (Tables 1A and 1B). The comparison number is the control group. The faculty member said the homework was going to count for 20 percent of the final grade. We were able to find that there was a good correlation between how these students performed on their homework and how they actually perform on their exam.

Keep in mind that this intervention allows us to continue to interact with their problem-solving ability if they have a problem. So, in this particular case, we had good success with the students in the intervention group doing better on their homework assignments and therefore generating better grades in that course.

As a Project Director, to get these programs to work, I have to talk with faculty members, Department Heads, Division Chairs, and ultimately the Vice-President for Academic Affairs. The Service Agreement that CASET has for people to sign is serious. The President signs off on that. So far, I have not had to go to the President in order

**COLLEGE ALGEBRA**

| INTERVENTION NUMBER | GRADE |
|---|---|
| 2 | B |
| 9 | A |
| 8 | B |
| 1 | C |
| 7 | A |
| 3 | B |
| 5 | A |
| 4 | C |
| 6 | B |
| **COMPARISON NUMBER** | **GRADE** |
| 519 | C |
| 515 | C |
| 525 | A |
| 524 | B |
| 516 | C |
| 521 | C |
| 526 | C |
| 520 | C |
| 527 | C |
| 517 | F |
| 528 | C |
| 518 | C |
| 523 | C |
| 529 | C |
| 522 | C |

to be able to do anything as far as getting people to say this has to be done. But, even at that level with my involvement, it is not an easy task.

The next piece of information was the drop-out rate. Now, I am showing you the number of students who actually completed the program in both cases. The number of students who dropped out of each class was greater in the comparison group than in the intervention group. My interaction with the students came by way of training and being available to them, and I have students now who pass by me on campus and smile. That makes me feel good because all I did was introduce them to the CASET Intervention and they know from that intervention that they were helped. So, that was the results from the first session and we were encouraged by the results.

In the second session we were working with trigonometry (Tables 2A and 2B). This particular instructor grades a lot harder than the first instructor. I did not mention that in both cases each faculty member (college algebra and trigonometry) is a foreign national. Those of you who are in college academics know that a lot of our kids have problems understanding information being presented by individuals who really are having some problems with the English language - this project removes that.

Here is an indication of the drop-outs. All of the students who started in the CASET program stayed with it. In the comparison group there were thirteen students who started, and all but three of those (ten) dropped before the end of the project. I do not mean that they just stopped participating in the CASET intervention, but that they dropped out of the course altogether. The intervention students stayed in the program (this is an encouraging aspect). I do not think that you can draw a lot of conclusions from just one or two comparisons. I am hopeful that the intervention we are running this semester, and the one that we will be running next semester, will generate comparable results, that will enable us to say something definitive about this particular intervention being successful.

**TABLE 2A**

**TABLE 2B**

Question from the floor:

Could the benefits of this program be applied to actually teaching the course itself? Not necessarily the whole course, but broken down and concentrating on screen lessons.

**COLLEGE ALGEBRA**

| INTERVENTION NUMBER | HOMEWORK 20% |
|---|---|
| 2 | 16 |
| 9 | 18 |
| 8 | 18 |
| 1 | 18 |
| 7 | 19 |
| 3 | 19 |
| 5 | 18 |
| 4 | 18 |
| 6 | 16 |
| **COMPARISON NUMBER** | **HOMEWORK 20%** |
| 519 | 16 |
| 515 | 11 |
| 525 | 17 |
| 524 | 14 |
| 516 | 16 |
| 521 | 15 |
| 526 | 11 |
| 520 | 11 |
| 527 | 16 |
| 517 | 7 |
| 528 | 13 |
| 518 | 10 |
| 523 | 18 |
| 529 | 13 |
| 522 | 15 |

At Houston Community College and some of the other institutions in the country, that is exactly how it is being done. It is called Long Distance Education. Basically, these are adults who have a computer at home or at their jobs; they dial in, access their instructions and homework, download that in some way, do their assignment, and then send it back. So, yes, it can be done, but there has to be responsibility - here again, at that level, you are talking about responsibility. I would not encourage that at the freshman and sophomore level, because one student did not even turn in any homework. That particular student logged in, accessed his homework, but did not turn in anything.

Question from the floor:

How do you see the drop-out rate? How do you read that?

Basically, I believe that students involved in this intervention know that they are getting something, even if a student chooses, as in this particular case, not to learn or do the homework assignment. If a student logs on to the computer and goes through the mechanism, that student knows that he or she is getting something - something he or she would not otherwise have. So, that is one aspect. The other aspect, as I said at the beginning of the presentation, is they then begin to start looking at the computer as a resource for information. They start sending each other messages, making dates on the computer. We access it all. And, I think, with some further refinements in this type of program, the benefits could really be significant. It appears that you ought to have a control for the study itself. In other words, you will have comparison classes.

As I said before, almost any student in America can play an Atari game. There is some form of attraction to the computer. No one knows what it is. But, at the level where we are, I believe in our ability to assist the fast student. However, we attempt to help all students. As soon as that student sends in the problem we download it, give it to the instructor, and then we send the next problem set. So, they get the feeling, "The more work I do, the more work I get," and the really highly motivated students are going to actually put information in faster sometimes than you can get it. They can really keep you working late at night. In that way you are helping those particular individuals. With the slower students, we are continually working with them. We send back hints to some students about problems with which they are having difficulty while they are still working on the assignment. We try to help them better understand that particular problem. So it is like an on-line tutorial. That is probably a better word.

Question from the floor:

TRIGONOMETRY

| INTERVENTION NUMBER | GRADE |
|---|---|
| 30 | C |
| 31 | D |
| 32 | F |
| 33 | F |
| 34 | C |
| 35 | F |
| 36 | B |
| 37 | D |
| **COMPARISON NUMBER** | **GRADE** |
| 541 | C |
| 542 | C |
| 543 | D |

The question I have is about physical access. What hours can kids get to the computers, and are there a lot of terminals?

So far we have not had any problems with access. The computer center stays open in the summer until 9:00 p.m., and during this semester it is staying open until 11:00 p.m.

Thank you very much.

TRIGONOMETRY

| INTERVENTION NUMBER | HOMEWORK % |
|---|---|
| 30 | 52 |
| 31 | 22 |
| 32 | 29 |
| 33 | 8 |
| 34 | 31 |
| 35 | 0 |
| 36 | 44 |
| 37 | 24 |
| **COMPARISON NUMBER** | **HOMEWORK %** |
| 541 | 41 |
| 542 | 37 |
| 543 | 32 |

# THE HIGH SCHOOL FOR THE ENGINEERING PROFESSIONS: Houston Independent School District

**Franklyn Wesley**

**Principal**
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*Franklyn D. Wesley is principal of the Booker T. Washington High School and High School for the Engineering Profession in Houston, Texas. He has introduced several innovative programs there, including modular flexible scheduling, individualized instruction, and mastery learning programs.*

*He has received many teaching awards, including National Outstanding Industrial Education Teacher (Ford Motor Company), Outstanding Secondary Education (Omega Psi), and Outstanding High School Teacher (Texas, Prairie View A&M University). The first Black National Merit Scholar from Houston came out of his programs.*

*Franklyn Wesley earned both his B.S. and M.S. degrees from Prairie View A&M University. He has worked as an engineer for the Western Electric Company in Chicago, and as a consultant building and evaluating technical education programs for Prairie View A&M University, Harvard University, Purdue University, University of Illinois, Indiana University, Texas Southern University, the National Consortium for Black Professional Development, and others. He is a member of several professional organizations, including Epsilon Pi Tau International Honorary Professional Fraternity, Phi Beta Sigma, and the Afro-American Advisory Council. He is on the Board of Directors of the Worthing Scholarship Foundation, Houston Principals Association, and other organizations.*

The High School for the Engineering Professions (HSEP) located at Booker T. Washington High School is a secondary school with a major emphasis on applied mathematics and science. It is oriented toward providing a superior academic foundation for highly gifted and talented college bound youths who may wish to major in engineering. The students are not, however, locked in to only one possible career. The curriculum includes strong components in communication skills, the humanities, and constitutes an excellent preparation for law, medicine, business, and any of the other sciences.

The "school within a school" design was chosen because it is not economically feasible for a school of only three or four hundred students to have its own cafeteria, gymnasium, or offer music programs, athletic programs, or art programs which are an important part of any student's experience in high school. By placing this specialized high school on the campus of Booker T. Washington High School, it becomes possible for the HSEP students to select

electives in the overall school program and to participate in athletics and other all school activities. The principal is assisted by an instructional coordinator, counselor, and specialized selected teachers. The primary objective of the school is to develop resourceful, self-motivated, well-rounded graduates who can analyze new situations, make well thought-out decisions, and communicate their ideas effectively. We want to further young men and women who will be responsible, well-adjusted citizens in the complex society of 2000 AD. The emphasis dictates that the curriculum be oriented toward the discernable needs of the future rather than those of the past. The school's curriculum is based on the philosophy of Bloom's Taxonomy of Educational Objectives.

If students are to become problem solvers, they must be working at the application level and start working at the synthesis analysis level. Thus, the 100 percent level at HSEP is to represent demonstrated performance at the analysis synthesis level and the 90 percent level is to represent demonstrated performance at the application level.

Instruction is difficult for students when they first arrive, since the graduates do not have grades like this in the schools they have attended previously. However, after approximately two months, all students both understand and start to function within this system.

Courses in HSEP are not based on the Carnegie Unit, thus making time one of the variables. They are based, instead, on proficiencies defined within a given subject matter. Thus, Algebra I encompasses not necessarily two semesters of work but rather the completion of distinctive proficiencies. Since the system stresses the development of competency on the analysis synthesis level, the courses require that the students strive to master the competency at this level. If a student does not achieve this level on the posttest to a given unit, the student counsels with the teacher, does prescribed activities, and retests on a second version of the posttest. Even though the student may not master the proficiencies of the retest, he/she does move forward with a stronger foundation than he/she would have if he/she had not gone through the retest procedures.

*"Courses in HSEP are not based on the Carnegie Unit, thus making time one of the variables. They are based, instead, on proficiencies defined within a given subject matter."*

In conjunction with the advice of the Dean's Advisory Council and with educational research on the causes of educational deficiencies of minority students, the courses were planned to have a heavy emphasis on hands-on experience, particularly with the sciences and the engineering courses. Laboratory experiences were deemed vital by the Advisory Council and are required from the very first course in physical science. Engineering Lab A is another example of providing opportunities for "tinkering" with the equipment and materials not previously encountered by urban minority students. This course emphasizes becoming familiar and comfortable with such devices as the robotic arm and the internal combustion engine. Students learn to conduct and write laboratory experiments similar to those they will be doing in later engineering courses.

An equally important component of the HSEP program is the advisory system. While the students are motivated, they do need the personalization that the advisory system at HSEP provides. Each student is assigned to an advisory group of approximately 20 students. In addition to the group meeting each morning in the homeroom, there is a weekly discussion meeting with each advisee. This individual conference gives the advisor a chance to help the

student plan the study schedule, evaluate his/her performance in each course, and discuss any problem which may prevent the student from performing at his/her best. The support which the personal relationship with the faculty member provides is essential to the successful development of the individual.

There are two curriculum options in this program. One is the regular high school program which has six periods per day, as is standard throughout the Houston Independent School District (HISD). In this, the Houston student completes high school work at the end of the twelfth-year. There is also an accelerated option, having seven periods per day in which the student can complete all high school requirements by the end of the junior year. The twelfth year work can then be devoted to advanced placement or enrichment. It should be noted that the curriculum is extremely strong in both mathematics and science and also has several engineering-related courses, such as Engineering Drawing, Engineering Graphics, Engineering Laboratory, and Computer Mathematics. An examination of the curriculum shows that a total of five credits is provided in mathematics and five credits in science. This contrasts with the three units now required in Texas high schools for graduation. Additionally, there are four and one half units in engineering related courses. These courses are: Engineering Graphics, Computer I and II, Electronics, and Engineering Lab A and B.

The following is a brief overview of these courses:

**Engineering Graphics:**

It is an introductory course in the engineering sequence. In this course, students are taught basic graphic communication skills as a means of presenting solutions to problems. They learn the methods by which engineers communicate. Computer Aided Design (CAD) was added to this course in 1986. It has now become the major emphasis in engineering graphics.

**Computer Math 1A:**

It is a course designed to introduce the students to the concepts of algorithms and flow charts as tools in problem solving situations. The student will use the BASIC programming language to communicate with the mini computer, a VAX 11780. Each student will flow chart, write, debug, and run his/her own program. Each student is required to write programs which reflect his ability to solve elementary mathematical problems, to create solutions for nonmathematical problems, and to devise a set of computer instructions for engineering applications.

**Computer Math 1B:**

This course assumes that the student is familiar with flow charting and computer programming in BASIC. The student will be introduced to Fortran IV programming language and a text editor. Computer concepts that are covered include input/output instruction, looping techniques, data files, random number generator, and sorting and searching techniques. Engineering applications also are assigned.

**Computer Math 2A:**

The student having the ability to write programs both in BASIC and Fortran IV is asked to apply the knowledge in the areas of mathematics, science, and engineering. Thus, the emphasis in Computer Math 2A is not language but rather application.

**Computer Math 2B:**

This course is primarily an individual projects course with the topics determined jointly by the student and the instructor. Some of the past projects include data processing graphics on a plotter, file handling, and system programming.

The Engineering Laboratory Courses are designed to introduce students to various engineering fields. Engineering Laboratory A, B, and C consist of a series of 11 modules that provide real hands-on engineering experiences using state-of-the art equipment. The self-paced nature of the modules allows the accelerated students to advance to independent research in two courses, Engineering Projects A and Engineering Projects B.

**Engineering Laboratory A:**

- **Module 1** is entitled "Robotics." Students will program a robotic arm to provide a complex sequence of operations.
- **Module 2** is "Introduction to Electricity and Electronics." Students will be introduced to the AC and DC circuits, semi-conductors, and digital circuits.
- **Module 3** is "Introduction to Meteorology." Students will use real time, local and satellite data, to analyze weather patterns and make weather predictions. They will study the science of satellite communication through the use of a satellite station.

**Engineering Laboratory B:**

- **Module 4** is called "Chemical Analysis." Students will utilize computer measurements and analysis to verify various chemical laws.
- **Module 5** is "Pneumatic and Hydraulics." Students will solve problems in air and fluid flow and pressure.
- **Module 6** is entitled "Structural Analysis." In this course, students will design constructs, and destructively test a truss bridge and a two egg container with hen's eggs.
- **Module 7** is "Aerodynamics." Students will design and construct airplanes and model cars by analyzing data from a wind tunnel.

**Engineering Laboratory C:**

- **Module 8** is "Fundamental Concepts." Students will write a program to analyze two dimensional electric, gravitational, and magnetic fields.
- **Module 9** is "Fundamental Elements." Students will analyze the fundamental circuit parameters of resistors, capacitors, and inductors.
- **Module 10** is "Frequency Response of the Elements." Students will analyze series and parallel circuits contained in resistants, capacitors, and inductants.
- **Module 11** is "Network Analysis." Students will develop computer programs to simulate various circuit configurations and verify the results experimentally.

The International Baccalaureate Program was added to the curriculum in 1988 or 89. The top one percent of the 9th grade students were selected to participate in this program. All of the required advanced courses will be added each year.

The VAX 11780 by Digital Equipment Corporation handles the major share of the work load. It is utilized in administrative as well as instructional applications. Peripheral equipment includes CRT terminals, graphic terminals, plotters, tape drives, line printers, and modems. The instructional programming languages taught are BASIC, Fortran IV, and Pascal. Computer Math Education consists of four required courses, each one semester in length. Two elective courses in Computer Science are also available. There are 60 terminals for student use. Generally, one student per class is assigned to each terminal with other peripheral equipment also accessible. A partitioning arrangement allows a student to use any available terminal, but the student maintains access to his or her private account. A student account can only be opened by the individual student or by the teacher for monitoring purposes.

The uniqueness here is that HSEP maintains its own computer system for all of its applications while some of the other schools may use PCs or rely upon time sharing. The VAX 11780 is used administratively for class scheduling, student tracking, and for survey analysis. The Instructional Management System, which is what we call it, is used to monitor individual student progress through course objectives. This makes it possible for an instructor to grade tests according to objectives, and to keep track of the student's progress by processing the test data. I might add that this is essential if we are going to have any kind of individualized instruction. The system is also capable of producing a number of reports for the benefit of the administrator, for the teacher, for the student, for the parent, and for the counselor. The outcome can help the administrator in assisting the teacher, the teacher is more readily aware of how the student is performing and where problem areas exist, the counselor can quickly determine if a student is achieving on level, and can provide the necessary reinforcement, and the student and parent are aware continuously of course goals and what must be done to accomplish these goals.

Students entering HSEP are primarily selected on the basis of their performance on the Differential Aptitude Test, sometimes called the DAT. This test has two distinctive advantages. It is primarily an ability test rather than an achievement test and it has been used for a sufficient number of years so that there have been extensive longitudinal studies. These studies have identified people who took the DAT and then went on to graduate from various types of professions or vocational institutions. The correlation between the scores they made on the DAT in their junior and high school years and their careers are extremely interesting. Those who have graduated as engineers on the average scored higher than those in any other career in four out of eight categories on this test. Those categories were: Numerical Reasoning, Abstract Reasoning, Mechanical Reasoning, and Spacial Relations.

Industrial participation in this program is extremely beneficial in several ways:

1. To identify speakers for assembly programs who can acquaint these young people with what engineering is all about.

2. To serve as recruiters to encourage able youths to enter the program.

3. To provide field trips so that the students can visit and actually see engineering projects.

4. To examine the possibility of providing meaningful work experience for graduates during the summer so that they can have some practical engineering-related experiences before they enter the university.

5. To provide financial or equipment support to the school district that helps offset the very high financial course costs of such a program as this.

One of the major problems faced by a school district operating an engineering school is the unusually high facilities cost. Since every student takes a laboratory science course each semester, and since engineering courses need expensive equipment, the facility cost is very high.

Some of the program highlights are:

Although the total magnet enrollment last year was just under 400, the students won numerous awards, such as three National Merit Finalists, three National Commended Scholars, twenty National Achievement Commended Students, six National Achievement Semi-finalists, and six National Hispanics Scholars Semi-finalists. The students participated in the United States Academic Decathlon placing second in region and, again, defeating all HISD schools in the contest. In the "Odyssey of the Mind" competition, the students placed first in the region and proudly represented HISD in the state's final in Amarillo. The students placed in the district UIL Literary contest and were semi-finalists in both the National Physics Olympiad and the National Chemistry Olympiad. The school's chapter of the Junior Engineering Technical Society (JETS) continues to be the largest and most active chapter in the United States. Of last year's 101 graduates, every student was admitted to a university and almost every student received some form of financial aid. The graduates received over $2 million in financial aid with many receiving full scholarships and summer employment with major engineering firms. That $2 million represented the highest number of scholarships of any school in HISD. Two received appointments to the United States Military Academy at West Point, two to the United States Naval Academy, and one to the United States Air Force Academy.

The 1988-89 school year was a particularly difficult year for the students and the faculty since the main building was undergoing a major reconstruction project, which includes a new $8 million Space Science building. This building will have state of the art equipment in both space and in sciences.

The Parents Advisory Board assists in continuing the success of the program. The Board is co-chaired by the wives of the Presidents of Texas Southern and Prairie View A&M University and they both have children going to that school. Their first task was to raise $5,000.00 to match a $40,000.00 gift for the city and county to build a park on the campus of the school. This board helped in one of the primary goals to increase contact with parents through mail-out newsletters and increase visitation to the campus.

HSEP has proven to be most effective in preparing students for the academic challenges of college. The rigorous science and mathematics courses supplemented by engineering application courses lay a strong foundation for students to make future professional career decisions. HSEP's continued goal is to have talented and gifted students develop to their highest academic potential.

Thank you.

## QUESTION AND ANSWER SESSION

Question from the floor:

As you designed the modules, they seem to be very heavy in the sciences. In fact, it sounded as if there was little time, if any, for any of the other areas of the curriculum like the humanities and social sciences. How are they faring with respect to those areas on, say for instance, the SATs?

To give you an example, there was a young lady last year who was valedictorian and I believe she had an eight hundred in the area of verbal.

Question from the floor:

That's one example I may consider.

I don't know if I could just break it down according to just the variable in math, only to say that at this point in time the mean SAT score is 1100 so that does say a little something. When the school was originally developed, we had a Deans Advisory Council to which I made a presentation. That was made up of the Engineering Deans of all of the universities in Texas. One of the major pieces of advice that they gave to us was to emphasize communication skills. That is what I indicated also, that we do put a lot of pride in the way these youngsters can communicate both orally and in written communications. They participate in the Olympiad and they would have to be pretty good in the humanities to win in those areas.

Question from the floor:

What percentage of your student body is Black? How do you recruit them? And I would like to know something about the dropout rate.

This is a school within a school. The total population of the school is about 1500. It is down quite a bit. Of those 1500, as I indicated, slightly less than 400 are in the magnet school. We are proud of the fact that the attrition rate in the magnet school is very low. This is one of the areas where we put a lot of emphasis. It certainly has not reached the zero point but it is low and we are proud of that. I'm not sure I can give you the figures, but I would imagine that it would be somewhere between five and ten percent. That usually happens during the first year and usually during the first semester. I would not consider those who leave the program as dropouts. They would normally be put on probation for a semester, and we would then advise them to go back to their home school because they were not academically adjusted to the program.

Question from the floor:

I didn't get the percentage of Black students.

Eight-five (85) percent are Black. The rest of the students are non-Black. When the school first started in 1975, we had a court order of 40, 40, 20. 40 percent White, 40 percent Black, and 20 percent others or Hispanic. We got close to that when the White enrollment in HISD was greater than it is now. It is only 17 percent now so

there is not very much that we can do about getting non-Blacks into the school but we have about 15 percent non-Blacks.

Question from the floor:

I wish you had pictures to show us some of the laboratory settings. My particular question is as far as the programming of the robotic arm, how many work stations do you have?

We have three robotic arms.

Question from the floor

Could you say something about how you secured funds?

We have a number of energy companies that have been recruited to help the school with all kinds of resources (financial resources, human resources, etc.). For example, consider the VAX 11780. The funds for securing that mini-computer came from contributions from companies like Shell, Texaco, companies of that nature. We got donations from those same types of companies for our purchase of the robotic arms. There is a reason why we did not bring the pictures. By January of this year we would be proud to show pictures because we will have some of the finest facilities available. We will have in each laboratory, for example, a space dedicated for research with computers in each one of the laboratories connected by network. It will be something of which I certainly will be proud. I didn't bring you laboratory pictures now because our physical facilities do not speak well of what the kids are doing. The school was built in 1949 (I believe) and the science equipment was of that vintage. I hope you understand what I'm saying.

Question from Marilyn Suiter:

American Geological Institute. I'm interested in getting some more ideas about the demographic profile. You mentioned that 85 percent of the students are Black. Is the remaining 15 percent largely Hispanic?

Asiatic and white.

Question from Marilyn Suiter:

So all three?

Yes.

Question from Marilyn Suiter:

I'm interested also in what percentage of the students in the program are female and if you see any difference in either the performance or participation.

The myth that females are not good as mathematicians has certainly been dispelled a long time ago. For the last ten years, the valedictorian has always come from the magnet school. For a large number of those years, they have been female. The last three were female.

Question from Marilyn Suiter:

I think it is very typical for females to be seen as good communicators. Are they also very competitive, for instance, in the Olympiad?

Yes. There are two things that we do not bother about and those are color and sex. We are looking for performance. Whoever can perform good for us is who we use.

Question from Marilyn Suiter:

Do you have a rough sense of how many of the students are female?

About 55 percent.

Question from Douglas Friedman:

I was wondering about the engineering lab modules that you described. It seems to come at the end of the program for the students. Is it throughout the program?

Yes. Engineering Lab A is a first semester course. Engineering Lab B is a second semester course. So they are semester courses and are spread throughout all the four years.

Question from Douglas Friedman:

They sound like fantastic hands-on experiences and they are often good motivational devices for students who aren't yet interested or thinking about going into areas like engineering. I'm wondering if they could be modified for the general student body as a motivational device.

I don't know. Perhaps they could but we have the problem of the level of prerequisite skills that are required for those courses. The minimum requirement for Lab A, of course, is Algebra 1, and we don't have that always in the regular school.

Question from Douglas Friedman:

I was thinking of them in really modified forms for younger kids who could get turned on to science and math.

Well, we do have some similar things in physical science 1A and 1B. We have tried to get away from the old concept that physical science is similar to what other school districts call general science. We try to get away from the nail and the copper wire concept of magnets and get into something that is a little more imaginative than that.

Question from Douglas Friedman:

How many computer graphic stations do you have?

Three. I'm assuming you are asking about the digitalized. There are ten CAD stations. Those are going to be completely separate labs with 30 stations in them.

Question from the floor:

Have you done any studies of the home backgrounds of those who qualify and those who make it through?

We haven't done any studies. We do know the parents are the most active - they are around all of the time - they are certainly behind the kids and when we have PTA meetings, 90 percent of the parents there are HSEP parents. For example, we needed a little help last night to get word over to the General Superintendent about something we needed in a hurry so we called up a couple of our attorney parents, and they got action for us in a hurry. They also get on my neck if something is not going right.

Question from the floor:

Are you suggesting that they appear to be more middle or upper middle class?

Unfortunately that is the situation. They are the Black Bourgeoisie and I don't like that. I heard recently where you can now determine the probable success of a student by knowing where he lives. That, unfortunately, is pretty much true, and I don't like that.

Question from Dr. Joseph D. Atkinson, Jr.:

What has the impact of different organizations been, particularly the Texas Alliance for Minorities in Engineering and the Gulf Coast Alliance for Minorities in Engineering? How do they fit into supporting the program?

We are involved with all of those. The Gulf Coast Alliance is in Houston and this area is a sub part of that. We have been a member ever since the school started. They work in the middle schools. They take on certain students and act as a mentor for those students. We get a large number of them in our program. They are somewhat recruiters for us. That pool of academically talented and gifted students is dwindling. It has almost dried out. Without their help we would not be able to recruit as many of the talented youngsters as we now get.

Question from the floor:

This is a short, two point question. I am concerned about the success rate of your students. I would really like to know where most of them attend college. Do most of them go into engineering when they graduate and where do most of them go to engineering college if they do graduate?

They go to all of the prestigious universities in the country. They go to MIT, Cal Tech, Carnegie Mellon, Washington, Texas A&M, University of Houston, all over. They also go to all of the service academies too. The largest number I would imagine would be to the big three here in Texas - The University of Texas, Texas A&M University, and The University of Houston.

# LEADERSHIP FOR THE 21ST CENTURY

**Carolyn Sue Smith**

**Managing Director**
**INROADS/ Houston, Inc.**
**711 Louisiana, Suite 170**
**Houston, Texas 77002**

*Carolyn Sue Smith is Managing Director of the Houston Affiliate of INROADS/Houston, Inc., a program to develop and place talented minority youth in business and industry and prepare them for corporate and community leadership. She received her bachelor's degree from Tuskegee Institute in 1965 and began working as a research chemist at Baylor College of Medicine in the Department of Virology and Epidemiology.*

*As Senior Staff Assistant to Congressman Mickey Leland from 1979 to 1987, she coordinated programs including a professional internship program with AT&T for minority engineering students from Texas Southern University. Since 1987, Carolyn Smith has been working as the Council Coordinator for Houston City Council member Rodney Ellis. She is currently a member of the Gulf Coast Community Services Board, High School for Health Professions Community Advisory Board, and the Leland Kibbutz Foundation Board.*

Good morning! It is a pleasure to be here and it is a pleasure to hear about all of the other programs because your programs lead right into the program of which I am presently the managing director. I have brought for you a twelve minute video[1] that will give you a full synopsis of what INROADS is all about. Then after the video I will say a few additional words about INROADS, and then open it up for any questions you might have.

I get so excited about the opportunities that minority young people have with INROADS. At first they told me that I had thirty minutes to do a presentation so I said, "Well the best way to do this is with this video, because if I get up there and start talking, they will only get to hear a little bit about INROADS." So if you will bear with me, I will try to work this fancy electronic equipment and we will see the video and hear about INROADS.

**Presentation begins after video:**

Well, did you enjoy that? As stated in the film, INROADS is a program that develops and trains talented minority youngsters for leadership in corporate America and in their communities. INROADS is a little different from a number of the other programs, in that we not only secure a position for a youngster during the summer, but we have a year-round on going training and development program. We are required to speak with every intern at least

[1] "INROADS Houston", available from INROADS/Houston Inc., (713) 752-2920

once a month. This is even while they are away in school. I have youngsters, I am very proud to say, in colleges that reach across the gamut of United States' colleges and universities - from your MIT's, to your Spelman's, to your University of Texas schools - from one side of the nation to the other. But, wherever the school we are required to counsel once a month with the youngster or as we like to say, "Exchange ideas or have a little rap session."

When we have these rap sessions we try to find out exactly how the young people are doing in their studies. Are they having any problems? What kind of grades have they made on their most recent examinations? What courses are they taking in their curriculum this particular semester? That in itself brings a whole person together with the work opportunity in INROADS, because we are interested in performance and one has to perform well, one has to keep up a certain standard in order to remain in INROADS. We are training what we consider the leadership for the twenty-first century. As was stated as few moments ago, the demographic studies of the past few years show that our workforce is going to be comprised of a very high percentage of Blacks, Hispanics, and women. And, we are doing all that we can to make certain that we have the necessary numbers of talented Black youngsters ready to meet that challenge.

It was so exciting to have the opportunity to be here and hear Mr. Wesley Franklin. I was in school with his son. The High School for the Engineering Professions at Booker T. Washington High School in Houston, Texas, of course, provides a very high percentage of the number of students in our Houston program. As a matter of fact, I am very proud to say that we did a presentation there about a week ago, and I think that we had about 68 youngsters who applied for our program this summer.

I was also excited to hear about the precollege programs. Houston regrettably at this time does not have a precollege INROADS Program. There are INROADS affiliates that have precollege programs which help broaden that opportunity for our minority youngsters. They will have had an opportunity to have more rigorous training and academic responsibilities prior to getting to what we call the "college component," of which I am managing director. In Houston I do hope to eventually organize a precollege component. I am sure that most of you understand that the Houston economy took a big nose dive a few years ago and that was the reason for us having to give up our precollege component.

How does a youngster get into INROADS? Quickly I will go through our process. We start with recruiting from all of the high schools in Houston and the surrounding area. For those of you who are not from Houston, I am going to pass out some brochures of INROADS and you will see listed on the back all of the INROADS affiliates. If you have an interest, there may be an affiliate in an area that is near you. We go to all of the area high schools and request a list of all seniors interested in any of the fields of banking, finance, accounting, straight business, computer science, all of the engineering (chemical engineering, electrical engineering, mechanical engineering), and the technical or natural sciences. These youngsters must have the minimum of a 3.0 grade point average and the minimum of an 800 SAT score.

Now someone mentioned a few moments ago about reaching down for that youngster that possibly is not the middle class or upper-middle class youngster. I put forth every effort that I can to reach out to some of those youngsters who may not be that "middle class," as we call it. Regrettably, we are finding in so many of our schools that the middle class are the more aggressive youngsters, their parents are the more aggressive parents, and therefore they become more familiar with different programs and tend to apply to them more than many of our more economically deprived youngsters. I said that in connection with our 800 SAT score and B average because I try to look at a whole person. I am a firm believer that all of the talent is not necessarily in the 3.0 student or the student who has an 800 or better SAT. If there is a youngster who really, really shows promise and who is close to that ranking area and the counselor or the principal of the school has some feel for the possibility of this youngster blossoming if just nurtured a little bit, then we consider trying to take that young person into the program, where we can.

After we go to the schools, talk about INROADS, tell the youngsters our basic qualifications, we then give those interested an application. They then apply to INROADS. Once they apply to INROADS we read the applications and screen them. Then we call in those youngsters for an interview. - each student has to have at least two interviews with an INROAD staffer. After those interviews we select from that group of youngsters what we call the "talent pool." These will then be the youngsters who will go out to the major corporations and interview for those positions that we have available for that particular year. Our talent pool usually consists of about three times as many youngsters as we are able to place, because we give the major corporations at least three students to interview for the various positions that we may have available. After a youngster interviews with a major corporation, that particular division or company decides whether or not they would like to bring the intern in and, of course, it moves on from there. The student has the opportunity to work during the summer.

Along with that we have some very strenuous class sessions that are primarily taught by executives of the major corporations. These classes are usually held on Saturday, which means that an INROADS intern also has to give up his or her Saturday, from four to eight to twelve hours, depending on that particular Saturday, in order take various core curriculum seminars and courses as we call them. We have courses in assertiveness skills and stress management. We strongly stress communication skills because we find that even with our very talented minority youngsters, often times we have difficulty placing them with a particular company, only because they just do not have the communication skills necessary for the position for which they are being considered. We have classes about the diversity of our society, classes in time management, leadership development, problem solving, and the list goes on and on. These are required sessions that an INROADS youngster has to take during the summer.

So now we have a recruited young person, a young student who has been placed with a major corporation for a paid internship during the summer, and a youngster who is also taking classes and seminars in addition to their regular college required courses.

I will stop here and entertain any questions that you might have about INROADS.

Question from the floor:

You said that the affiliates around Houston have a precollege program?

No, not the affiliates around Houston. We do have some affiliates within the United States. There are 36 INROADS affiliates throughout the United States and some of those affiliates do have a precollege component.

Question from the floor:

At what age are you approaching the kids? I mean, what grade levels are they; are they seniors, juniors, sophomores?

For INROADS Houston there are seniors on our recruiting lists. However, there are varying types of precollege programs with other affiliates. We have one affiliate in northeast Ohio that has the young-Black-male-at-risk type program. They are starting with, I think, fourth graders in what they call a "precollege program" to try and bring them on up the ladder to become a part of the college component.

Question from the floor:

In those programs where they start earlier than the senior year in high school, can students return after one year - can they repeat, I guess that is what I am asking?

You mean when they start in the precollege program?

Question from the floor:

Yes.

Well, yes, all of the INROADS Programs are set up such that we hope that a youngster continues each summer, once they have become a part of the program.

Question from the floor:

I would like to know what is your retention rate?

Retention rates somewhat vary throughout the country. In Houston this year we had a retention rate of about 82% from last year. Usually when we lose a youngster it is because of family problems. We do have a parental support group, so we can try to alleviate some of those problems. Then, of course, there may be a lack of performance with the company with which they work. We were very successful last year with our retention rate in Houston and very successful with our placement rate. We had eleven youngsters to graduate and we were fortunate enough to place eleven youngsters with their sponsoring companies.

Question from the floor:

Was eleven the number that you had in the program? The point that I am trying to get to is - is there a limit to the number of youngsters you can take into INROADS?

No, you mean the eleven that graduated?

Question from the floor:

Yes

No. In INROADS Houston I have 138 interns: 46 percent Hispanic, 54 percent Black, and 50/50 male-female. So we are real excited about our ratio and proportion, shall I say, in all of those areas. At this very moment, or at least when I left the office on yesterday afternoon, I had tentative promises of 114 slots for this year. So we are hoping with the eleven youngsters who graduated that we will be able to place, probably, more youngsters in the Houston INROAD Program.

Question from the floor:

There was one other thing that I may have missed, although I saw some aspects about it in the video. It appears that when you bring these students in for how many weeks training, it seems that INROADS provides some initial training prior to placing them into a company.

Yes, when a youngster comes into INROADS for the first time, and most of them are your graduating high school seniors, (however, we do take some youngsters who may be pre-sophomores or pre-juniors in college, after they graduate from high school, if they are accepted into our college pool) we have three or four

sessions with these youngsters to help them to understand the interviewing process, make sure that they understand how to fill out an application, even though they have done one with INROADS. If there was something on their particular application that was lacking, we take them through assertiveness skills, communication skills prior to their going to the major corporations for an interview.

Question from the floor:

They have to make presentations?

They have to make presentations in these classes, yes.

Question from the floor:

You mentioned that only one in three roughly get placed with companies, is that correct?

No, 77 percent nationally of the INROADS interns get positions with their sponsoring company, or one of the INROADS sponsoring companies.

Question from the floor:

But in your initial recruitment you said that you roughly identify the people who have 800 SAT's and 3.0 GPA's and so on.

Oh, yes, that one in three? We have to give the major corporations an opportunity to have a choice, because actually what we do is recruit the talent and then we send that talent to a company. That company then makes essentially the decision 100 percent as to whether to accept a youngster for an internship. What we do is give each company three students to interview, but we also give each student three companies to interview. So it is a competitive theme, not getting an internship does not necessarily indicate that a students is not highly qualified, but usually it depends on exactly in what that particular corporation is interested. But, our talent pool is set up such that at least we try, and thus far we have been very fortunate, to get enough youngsters who qualify for the INROADS Program in order to have a three to one ratio in our talent pool.

Question from the floor:

So I guess my question was really what you do with the people who possibly aren't accepted?

Okay, those youngsters that don't make it we hold in our talent pool for the following year. When we are ready to recruit for the next year, we send each one of them a letter letting them know that we are in our recruitment season and ask them to express their desire to be considered in INROADS or not. Of course, they will have finished one year of college, and we have to look at their academic standings. But, most of them will come back to be a part of the talent pool.

Question from the floor:

My question is do you have any idea what happens to the 23 percent who are not placed after they complete INROADS? You said that your placement rate is 77 percent.

Some of them go to graduate school, some of them go to work for other companies that are not INROADS companies. I cannot remember but we had, I believe, something like about a seven or nine percent unemployment. The National Board of INROADS, just a few weeks ago, expressed a grave concern because they were not aware of that. These figures I am giving are for the nation, and not Houston. They are really going to work real hard to find out why, or what has happened to those few youngsters who may be unemployed. But, the highest percentage of that 22 or 23 percent are either graduate school students, students who went to work for a company that was not a part of INROADS, or students who just looked at other career opportunities.

Question from the floor:

I would like to hear more about the parent support group?

Okay, parents' support group. We have one in Houston and most affiliates are working very hard to have a parents' support group. What the parents' support group does is, first of all, to support staff in trying to make certain that their youngsters do all that they possibly can in order to remain academically sound, socially sound, and do all of their community projects. The parents get very involved in making certain that they truly understand the role of INROADS, the opportunities that INROADS offers. They have an opportunity themselves to exchange some of the parental concerns facing most parents that have youngsters in college, some of the peer pressures and so forth. Our parents' group meets once a month and they will put together small fund raisers, primarily to raise funds so they can have representatives at the national and regional parents meetings.

Speaking of that, that's something that I forgot to mention. Each year INROADS has Regional Student Conferences. Can you imagine the magnetism of 700 Black and Hispanic youngsters in one auditorium all with grade point averages above a 2.7 and all interested in business and engineering? I mean we had a couple of very high level corporate executives that were the keynote speakers, and you could tell that the magnetism there was so great that they didn't even know how to act or respond. These were kids in the Western Region, the one of which I am speaking. That was held at Rice University this year with youngsters from San Francisco, San Diego, Albuquerque, New Mexico, Dallas, Houston, New Orleans, Denver, Colorado, and it was a very exciting event. That was a concentrated three-days of advanced core curriculum-type courses, as I mentioned a few moments ago. We had 86 facilitators from major corporations through out the United States. That is what we call our "Summer Regional Training Institute," and we have them every summer.

We are not able to visit every college campus, but we try to visit most. As a matter of fact, my staffers are on the University of Texas campus right now with our interns. Between the University of Texas and Texas A & M University we have close to 60 interns. But, we also try to visit every student college campus once per semester during the school year. This is so we have an opportunity to talk with the Deans of the schools, to talk with the student, to meet with other INROADS students to see just how are they doing in school and with their college curricula. INROADS will pay for tutors. All the youngsters have to do is to ask and we will

pay for them to be tutored. So we give the minority youngsters every essential tool, I feel, that they need in order to be a leader and in order to do well in school, as well as perform well on their job.

Question from the floor:

I was wondering how long you have been in operation. Primarily I was thinking in the context of tracking these students after they graduate in terms of their career development. How far do they go and are they having any problems, particularly as perceived as minorities in corporate America?

INROADS has been in operation for 20 years. Our 20th anniversary was in 1990. It started in Chicago, Illinois 20 years ago. We have over 1,400 INROAD graduates or alumni. The sophisticated computer opportunities now are going to give our national office the opportunity to track most of the INROADS alumni. Presently we do know where a high percentage of them are, and a high percentage of those alumni are either working for their companies or in graduate school. Some of them are in graduate school, but a high percentage are working for their companies and are being very successful in their careers. But, we are presently waiting on accurate alumni data. I will be more than happy to share it with you when it comes out, sometime either the later part of this year or the first of next year. We should be getting some very sophisticated data on the tracking of the alumni of INROADS. But, among those whom they are presently able to track had been a very high success rate of remaining employed in corporate America.

Question from the floor:

Do you do any soliciting for internees at universities among the freshmen and sophomores?

Yes. When we visit the campuses we try to find as many students as we can who may be interested in INROADS. We ask in the student unions, or we ask the student associations, or the engineering society clubs, or what have you. We try to contact them prior to our visiting a campus to let them know that INROADS representatives will be there, and that we are interested in trying to recruit students who may already be in college but who are not presently a part of the INROADS Program.

Question from the floor:

Have you been to the University of Houston yet?

This year we have not been to the University of Houston. It is on the schedule, I think if not next week then in about two weeks my staff will be on the University of Houston campus.

Thank you so very much.

# CPEP: DESIGN MODEL OF A PRE-COLLEGE PROGRAM

**Glenn A. Cassis, Ph.D.**

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*Glenn Cassis was appointed the first Executive Director of the Connecticut Pre-Engineering Program (CPEP) in November 1987. He received his undergraduate and graduate degrees from the University of Connecticut. Prior to his appointment to CPEP, Mr. Cassis worked in student personnel administration at Oakland University (MI) and North Adams State College (MA) for more than 13 years. He has been actively involved in several educational, community and civic organizations including the Board of Directors of the Salvation Army, the Berkshire Council for the Arts and the Massachusetts Council Against Discrimination. Currently he is a member of the Connecticut Council of Black Students and Professionals (1st Vice President), the Connecticut Association of Educational Opportunity Programs, the High Technology Council of Greater Hartford, the Hartford Alliance for Mathematics and Science, Leadership Greater Hartford, the Board of Directors of the Urban League of Greater Hartford, and the Bloomfield Midget Football Association (President).*

## BACKGROUND

Since the early 1980's, the number of U.S. citizens choosing careers in mathematics, science, or technology related fields has not kept pace with the demands of industry or education. Add to this trend the demographic data which indicate a drop in the overall birth rate and this country will continue to face a shortage in the technically literate workforce. This shortage will stretch into the 21st century unless something major is done to address the problem. A closer examination of demographics indicates that although the baby boom years have ended, there is a continued growth in the Black and Hispanic populations across the nation. Despite the increase in these populations, the number of Blacks and Hispanics embarking on careers in mathematics, science, engineering, and technology has not been significant. Except for white males, career opportunities for other gender and ethnic groups have not been very supportive. If, however, something were done to increase access of underrepresented populations to these careers, this nation would begin to fill its growing need for a technically skilled workforce.

Recognizing the need to and importance of providing underrepresented populations with access to mathematics and science related careers, the Science Museum of Connecticut

established a coalition of public and governmental agencies and private industries whose purpose it was to begin to aggressively address the problem. Hartford, Connecticut is recognized as the insurance capital. Insurance, however, is not the only industry in the state. In addition to financial services, Connecticut has a strong investment in technology with companies like United Technologies Corporation (Pratt & Whitney, Hamilton Standards, Sidorsky, and Otis Elevators), Electric Boat, General Electric, Pfizer, Stanley Works, Combustion Engineering, SNET, Heublein, Inc., several utilities, software companies, and hundreds of large and small service corporations. These companies recognized the need for a "skilled workforce". With a shrinking supply to draw from, Connecticut companies were faced with national recruiting efforts in order to attract employees. This short term remedy has been difficult because of the high cost of housing, cost of living, and competition throughout the country. Many in the coalition believed that a long term approach would provide more lasting results. It was determined that the rapidly growing underrepresented populations should be brought into the growing workforce. Unfortunately this remedy was not as easy as it might seem.

Although Connecticut ranks number one in per capita income in the nation, it also has three of the country's ten poorest cities. In those cities (Bridgeport, Hartford, and New Haven) more than 85 percent of the students attending the public schools are minorities (people of color). These three school districts educate 65 percent of the state's minority population. The drop out rate between the elementary and secondary levels is as high as 50 percent. Only a very small percentage of those who graduate go on to college to major in science, mathematics, or engineering. Most have made their decision not to pursue careers in these fields because years earlier their interest in mathematics and science was muffled.

Aware of this dilemma, it was determined that in order to produce the numbers of qualified people needed to meet the needs of business and industry, efforts would have to be directed towards reaching minority children earlier and turning them on to science and mathematics. From this premise, the Connecticut Pre-Engineering Program, Inc. (CPEP) was established. CPEP began as a outreach program of the Science Museum of Connecticut. The program began at one middle school in Hartford with 46 students and has grown to include eleven schools (8 middle schools and 3 high schools) with more than 300 students. The mission of CPEP is as follows:

> CPEP is designed to identify minority students who have the potential for college level work in mathematics and sciences. CPEP prepares them at the upper elementary through the middle/junior high and high school levels to enter and graduate from quality institutions of higher education. Providing the support system necessary to motivate students to perform well in a pre-college program, CPEP furnishes students with a strong foundation in mathematics, sciences and English to pursue mathematics, science or engineering based fields at the four-year university/college level.
>
> CPEP has seven main objectives. These objectives are:

- To identify upper level elementary, middle/junior high and senior high school students who display the potential to do well in college prep mathematics and science.

- To provide minority students with information on careers in mathematics, science, and engineering and to assist them in making decisions about their future.

- To increase significantly the number of minority students enrolled in college preparatory mathematics and science courses.

- To supplement the content of upper level elementary, middle/junior high and high school mathematics, science, and English courses with judicious use of community and educational resources.

- To motivate students to maintain at least a B average in mathematics, science, and English.

- To provide teachers, counselors, and parents with additional resources so that students have every opportunity to succeed.

- To assist students who graduate from the program in locating and obtaining financial support to pursue college work at quality institutions.

## CPEP PROGRAMS

CPEP is a year round enrichment program. It has eight main components. These components are:

### After-School Program

Students meet after school two to three times a week. During this time students engage in hands-on activities in science, mathematics, and writing skills. Modules are developed by teachers or obtained from resource materials acquired through various sources. Modules usually last 45-60 minutes. Depending upon the topic, 15 to 30 students may participate in each session. Sometimes guest speakers and mentors meet with classes.

### Field Trips

Schools are encouraged to expose students to enrichment opportunities and to work settings where science, mathematics and/or engineering are practiced. Students visit museums, manufacturing facilities, genetic laboratories, zoos, power plants, research centers, bogs, Long Island Sound, hospitals, and other locations where students can witness science in action.

### Saturday Programs

During the school year, classes are held for CPEP students on college campuses or at the Science Museum of Connecticut. Usually classes are structured to be project oriented and generally run between 4-6 weeks in duration. Projects have included robotics, electronics, fiber optics, material design, and artificial intelligence. On other occasions, classes have been held for only one session and have usually been a laboratory experiment or a special hands-on mathematics activity.

### Parental Programs

It is the philosophy of the program to include the parents/guardians of students in the educational process as much as possible. Parents are encouraged to support their children's involvement in the program by becoming involved themselves. CPEP creates opportunities for parents to actively participate in field trips, conferences, CPEP Day, workshops, and awards programs. CPEP equips parents with information and resources which help them become more informed and supportive of their child's needs.

## Summer Enrichment Programs

For five weeks during the summer, CPEP sponsors enrichment programs throughout the state. During the summer of 1989, four programs were held at four higher education campuses. Three of the programs served 104 commuting students in the 6th to 8th grades (bus transportation was provided for most of the students). The fourth program was a residential program for 54 students in the 9th and 10th grades. The curriculum for each program emphasized science, mathematics, language arts, and career guidance. Each program provided follow up sessions in the fall and spring.

## Teacher Equipment

CPEP depends upon the active participation of teachers. Technology has advanced so fast that teachers have not always been able to remain current. CPEP provides workshops and professional development programs for teachers designed to improve teacher effectiveness and to introduce new curriculum ideas.

## Tutorial Services

In order to remain in good standing in CPEP, students must maintain a B average in their academic courses. Should a student have difficulty, CPEP will provide a tutor at no cost to the student. Tutors are recruited from local colleges, volunteers, and high school seniors.

## Career Guidance and Counseling

With the support of school guidance counselors, role models, and college student personnel administrators, CPEP provides students with academic and career support. Sessions are scheduled to help students explore career options and to learn how to apply human developmental skills.

# "THE NEW ABC'S" VIDEO BY S.M.A.R.T. IN CONJUNCTION WITH THE NATIONAL URBAN COALITION

**Valerie L. Thomas**

**Assistant Chief**
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As I was listening to some of the comments that preceded me, I got a lot of good ideas that I wanted to talk to you about. Then I decided that I was really invited to talk about the video[1] that I brought to show you. I would like to start with the video and then go on to other things, rather than start talking and run out of time and be unable to show the video.

I am the Vice-Chair of an organization called S.M.A.R.T. and that stands for Science, Mathematics, Aeronautics, Research and Technology. It is an interface group to the National Black Leadership Roundtable. It is made up of African-American professionals who are scientists, educators, and other professionals who are interested in the very topic that we are discussing today. The perspective that we are taking is: we look at the fact that there is an underrepresentation of African-Americans in science and technology. There has been concern about this over the years and even though there has been concern and there have been some actions taken, not much has been accomplished in terms of the numbers. We still represent less than three percent of the scientists and technologists. So we are very concerned about this problem. As we approach the year 2000, we know the demographics that have been projected, and we also know that the country, the nation, and the world are becoming more and more high-tech oriented. So we see it not so much as an altruistic gesture on our part, but something that is becoming very critical, especially since African-Americans have been steered away from the science and mathematics which provide the basis for one's ability to do well in the high-tech environment. What we are looking at is what can we do to prepare ourselves for the year 2000. When we think about the year 2000, it sounds like a long way off, but we are talking about 10 years away.

You look at the Affirmative Action Program that has been around since the '60s, and that has been quite awhile, but still we represent less than three percent. What we look at is that in order to make that major leap between now and about 10 years we have to do something different. We have to do something over and above what has been done. There are a lot of good things being done now, and a lot of the people who are selected to participate in existing programs are good students. I am not going to say "good" students, especially, as much as students who have an affinity to do well anyway and who probably would have gone in that area anyway with a little nudging. What needs to be done is to recruit other students, who never even considered pursuing a technical field, students who have the basic ability to do it but need more than a little nudging. So that is what we have been looking at - how can we make that major leap.

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[1] Editor's Note: For information on how to obtain a copy of "THE NEW ABC's: Preparing Black Children for the 21st Century" S.M.A.R.T at P.O. Box 70871, Washington, D.C. 20024-0871

If we are to do that, there are some basic things needed to get us over the hump. The first thing is that the community needs to know how critical this problem is. When we think about the community, not only the students need to know it, the teachers need to know it, their parents need to know it, and in general, even professionals. We who are working close to the problem are very much aware of it, but when you get away from the technical types, even the social scientists as well as the people who are far removed from science and technology, don't appreciate the problem. One of the things that I would hate to see is to wait until we get to the year 2000 and all of a sudden we would be in a reactive position again, trying to decide what to do. We would think, "Here we are, we can't get jobs, our community is really underrepresented in terms of job opportunities. What can we do?" So we in S.M.A.R.T. think that there are some things that we need to do now. The first thing is that people need to know how critical the problem is.

The other thing is the fact that in our community we steer away from science and technology as a group. There is a feeling that African-Americans can not do science and technology. There was a lot of talk about role models. The role models are not there in numbers; however, we can handle science and technology. We are doing it. We have done it. We have done science and technology for years, I mean thousands of years. But, the role models are not there so the connection is not made between the community of science and technology and African Americans.

One of the first things that we did in the S.M.A.R.T. group was to put together a Mission Statement. That is part of what the interface groups to the National Black Leadership Roundtable have to do. We put together the Mission Statement of what needs to be done to be included in a book called, The Black Family Plan.. But, even as we put it together we were thinking, "Now if we give this to the other people who are a part of the National Black Leadership Roundtable, we know what the reaction will be, and we are talking about professional people." The reaction will be, "So what." They will look at it and do the same thing that the kids will do. They will probably be afraid of math and science or not appreciate how important it is or not see it as something in which they can be involved.

We decided that we in S.M.A.R.T. have a bigger problem than most of the interface groups. That bigger problem is that we have to get the people who are involved with the National Black Leadership Roundtable to the point where they can appreciate how important this is. We were trying to think of ways to do this and we said, "Well, maybe we have to make a very dramatic statement." We thought about that and we put together a very dramatic statement. Then we decided to talk to Reverend Fathroy who is the Chairperson of The National Black Leadership Roundtable and he said, "Why don't you do this?" He told us about an experience he had. He had gone to a conference and he saw a video which was approximately ten minutes long. Once you saw the video it hit you and grabbed you. That is what we needed to do to get our point across. We decided that was a good idea.

We decided to embark on trying to make a video to get across the point that needed to be made to the community. One of the things we wanted this video to do was, first of all, let the community know that science and technology are not alien to us. Science and technology started in our community thousands of years ago, not yesterday, not a hundred years ago, not a couple of hundred years ago, but thousands of years ago. So the first part of this video makes that connection. It goes back the thousands of years and it shows the various kinds of contributions that have been made in those areas. Then it follows through and shows role models coming forward - our role models up through slavery, past slavery, contemporary role models, etc. Then it goes into the kinds of things that can be done, and that need to be done now to prepare our community for jobs in those areas. We did not want to conclude the video without saying what a person can do to help, because this video is really aimed toward lay people, to get them to the point where they appreciate the problem. We wanted to say to them that everybody has a part to play to accomplish the goal that needs to be accomplished in the short time that we have to accomplish it. It will take everybody's efforts - everybody working

together. We wanted to be able to say to the average person, "These are the things that you can do." So without any more of an introduction I would like for you to take a look at this video. Then I can come back with some more comments on our vision of how to approach this problem.

**Video Presentation:** ***The New ABC's: Preparing Black Children for the 21st Century***

Question from the floor:

Who is Carl Holman? What is his role?

Carl Holman is now deceased, he was the Head of the National Urban Coalition.

Question from the floor:

What did it cost you to make that?

Let me tell you what happened on this. S.M.A.R.T. decided to follow-up on the recommendation to make the video and with no money we undertook that. However, to make it realistic, it cost $30,000.00 and the National Urban Coalition absorbed that. That is why you see very prominently National Urban Coalition on the beginning and the end, too. It cost $30,000.00. But the real cost was more than that because we had some volunteers, for example, some of the people who did major parts of the technical work volunteered their time.

Question from the floor:

What is your major cost, the time or the technicians?

The major cost would be the camera crew, the studio cost - getting into the studio and using their equipment, (that is really expensive, you know) the editing, and the whole thing.

Question from the floor:

I would like to ask a very pointed question. This is a very interesting subject to me, something in which I have a lot of personal interest. I read a book a couple of years ago called, Blacks in Science, with which you may be familiar. Excellent. It touches on some of the things like the smelting done in Africa, things like the Dog Star, Sirus, being discovered as a double star, long before it was discovered in Western civilization. But, my question is how can my corporation buy a copy of this video tape to share with our Gulf Coast Alliance for Minorities in Engineering (GCAME) students and other students who could use this to help defray some of these cost that were mentioned earlier?

Let me tell you what I will do for you. Usually what I do is I'll bring a copy and show it and people want copies of it. If somebody wants one right then, I will sell them mine. Then I don't have a copy - which is my personal copy. So what I did this time, I got two extra copies and brought them with me in case two people want one. If three people want one, then I will sell my copy.

Question from the floor:

How much is it?

Thirty dollars.

Question from Dr. Nina Kay:

It is not copyrighted, right? Okay, if somebody has a copy we can make a copy.

You could do that. We try to recoup the cost that we ended up causing somebody else to pay.

Comment from the floor:

It might be easier if you left an address and we could just write them.

I have that and I brought a flyer too.

Question from the floor:

We may be able to buy it for our various organizations.

Right.

One of the major things that S.M.A.R.T. wants to do is get the information out to the community and that was one of our first accomplishments - making that video. The other thing we did was to have a conference. We wanted to bring together representatives from technical organizations and people representing other areas that are concerned with the same problem and are working toward it. We wanted to take a more systematic approach to solving this problem. A lot of people are doing things. There are pockets of activities going on around the country and we just think that these need to be pulled together more systematically. There are things that are working well, like the presentation that was given earlier. That information needs to be made available across the country.

There was a lot of talk about role models. There is something that is easy for us to do and that is to get out and be visible. You know, go into the schools, go to the PTA meetings. I have been doing a lot of PTA meetings recently and that works out very well. I have been showing my video at the PTA meetings. There is a show that is coming on PBS on November the eighth and it is called, Crisis - Who Will Do Science?. This is a very good program. We need to let people know that it is coming on and to make sure that they are watching it. Not only do we need to make sure they are watching it, we need to make sure that organizations, professionals, etc. make those contacts and make those connections. They need to be out in force after the program to be role models so students can see real live minorities, especially African-Americans, who are doing these kinds of things that are talked about on the television. I think if we could do that it would be excellent.

As I said, we had a conference in February and the objective of that conference was to bring together these people to work on a ten-year plan. How can we systematically try to solve this problem? What things can we do and how can we do it in a way that maximizes the efforts that are being done now? So out of that has come the basic information for a ten-year plan. We are going to do it in two forms, one is going to be an abbreviated form for mass

dissemination and one is going to be a more complete form for organizations that want to implement programs. That will be the next thing coming out from S.M.A.R.T..

When we had our conference we had a speaker, Dr. Edwin Nicholas, who gave a very interesting presentation. He talked about cultural differences. Even the reading materials that you gave on studies that are being done on intervention programs demonstrate that nothing much has been done on cultural differences. Dr. Edwin Nicholas made a very good presentation. He said there are cultural differences in learning styles and that was of specific interest to us. This was eye opening for me. In terms of how people learned, he had it broken down into the European, the African, and the African-American oriented. It turned out, much to my surprise, that Native Americans and Hispanics have another learning style. The other learning style was the Asians. It appears that the natural style for the European oriented people is cognitive, counting and measuring, so you break things down to their component parts and count them or measure them. In the African and the Native American communities, it is conceptualizing the whole so it is more holistic and is rhythmic. Then the Asian is transcendental. He didn't go into that very much but he was showing the difference between these two.

The thing that was very interesting about this was that we learn in a way that is different from the style that is the basis of our educational system. Our educational system is oriented toward the European style. What happens is that children make the transition from their natural style - when I say children I mean African-American children - to the European style at different rates. It appears that girls can make it earlier than the boys. As I listened to him talk it was very, very insightful for me. I have heard about the problems that boys experience in our educational system and this seems to shed some light on why this is happening. It seems that the girls make the transition around kindergarten or first grade but the boys make it about a year or two later. So if you have the boys in an environment where they are being measured by counting and measuring and they are still in that holistic/rhythmic learning style, they are not going to do well in that environment. I think we can see the results of that right now.

The first thing that we need to do is to get to the kids at a very early age and let them know that they can do science and mathematics. We need to make it simple and easy for them, similar to things that Lawrence Livermore National Laboratory is doing. In addition to that, we must do it in a style that is comfortable for them before trying to change styles. If we are going to have them do the rest of their learning in another style, we should not switch them before they are really ready. We found that to be very interesting.

Question from the floor:

> Operationally what does that mean? In the case of the male, what would you do?

> What would you do? I have to use the example of the young lady that gave the talk before Nora Butler. One of the things that Nora talked about was doing basic science. You take some water and you pour something in it and you do some things and people see it. That is science. It is not doing calculations and trying to understand it in terms of breaking things up and measuring and things like that. It is conceptually teaching some basic concepts at an early age and getting the kids turned on about science and feeling good about it.

There is something else that came from Dr. Nicholas, and I have heard this from a subsequent speaker. That is if the student feels good about himself or herself, it makes it much easier for them to do well in science and mathematics. One of the ways to make a student feel good about himself or herself is to help them realize that they have contributed - they have contributed to society and they are still contributing to society. When kids look around they

see a lot of role models that are negative. There is a lot of media attention to things that are very negative about the community. In terms of history, there is not much about us that is positive in the history books. Now, if we could just change that. We must start focusing on some positive things about the people so that the young people can feel good about themselves. Then that frees them up to be able to do well in math, like everybody else.

These are some of the basic things that I wanted to share with the audience. Thank you.

# PREFRESHMAN ENGINEERING PROGRAMS

**Wayne Perry, Ph.D.**

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*At the time of the symposium, Dr. Perry was Dean of the College of Engineering and Architecture, AT&T Professor of Engineering, Distinguished Professor of Industrial Engineering, and Director of the Texas Engineering Experiment Station at Prairie View A&M University. Dr. Perry earned his B.S.M.E. at Tuskegee Institute, his M.S.M.E. at the University of New Mexico, and his Ph.D. at Carnegie-Mellon University. He is a Registered Professional Engineer and has held academic, research, and corporate positions at the National Entrepreneurial Development Center at Florida A&M University, The Rand Corporation and the Rand Graduate Institute, Carnegie-Mellon University, Sandia National Laboratories, and Ford Motor Company. He has published extensively and directed research or consulting projects with the President's Commission on Industrial Competitiveness, Mathematics Policy Research, Inc., General Electric, 3M Company, and the U.S. Departments of Defense, Energy, Commerce, Education, HUD, Labor, Transportation, NASA, NSF, and others.*

*He is affiliated with the National Society of Professional Engineers and the American Society for Engineering Education, and has served as a director, board member or officer for organizations including the Young Astronauts Program of America, Texas Alliance for Minorities in Engineering (TAME), and the National Action Council for Minorities in Engineering (NACME).*

I am very glad to be here and be a part of this program. It has been interesting talking with many of the friends here, particularly a young lady who we recognized over twenty years ago with the INROADS program.

I might mention that it is clear that the precollege/pre-engineering effort is important. I want to bring a little historical perspective here, too. This has made me reflect on my days at Tuskegee University and some precollege programs. I am originally from Texas. I was in a precollege program sponsored by the National Science Foundation (NSF) at Prairie View A&M University, which was my first introduction to thinking about engineering as a career. There happened to be a fellow by the name of Dean Clark Wilson who founded the College of Engineering and who has been significantly involved in precollege programs for many years. Prairie View A&M University is the second oldest public institution in the state of Texas. We are older than the University of Texas (UT) at Austin and many others. The only older state institution is Texas A&M University at College Station, and there is only about a year's difference. We have been in engineering for about forty years, since 1948. Actually we were in it in the '20s and '30s because it evolved out of what was called the Industrial Arts and Mechanical Arts Program. This was basically the beginning of an engineering program in the 30's. So we have been in engineering for approximately a half-century.

My first engineering project was with the 1964 Mustang with Ford Motor Company. On April 17, 1964 we brought it out. Little did I know at that time that it would have the same popularity that it has today. I have one in my garage and it is still running quite well, by the way.

When we look at the industrial sector and the competitiveness of American industry, I think we can say that there are still some products around that have made a difference, even in terms of the international market. Actually, as a matter of fact, I have noted that the '64 Mustang, the design of it, has been ranked as among the 50 most significant products in this century, right behind color television and the transistor. I thought that was interesting.

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***"In Texas we produce more Black American engineers than all of the other twenty engineering programs combined. COMBINED! The trend in Texas right now is, of the top minority students (both Black and Hispanic) who are entering the University of Texas (UT) system, the Texas A&M University system, etc., one out of ten to two out of ten are graduating in engineering."***

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Comment from the floor:

I priced one recently and I think it was about eighteen thousand.

That is the convertible, I don't have it. When I was in Detroit I didn't really need a convertible at the time.

I am sure we have gone over these statistics, but I will just briefly do it from a trending point of view. We have seen in engineering production relative to both minorities and women, etc., that there has been a significant increase since the '70s and moving into the '80s. What is occurring is that it is leveling off. That is, we are not seeing a significant increase in the number of persons entering the profession. Even in terms of women as percentages of freshman classes, we are seeing that it is leveling off in the '80s. So what it says is that, mathematically speaking, we are reaching an asymptote. We have got to expand the pool so that we can increase these numbers to be a greater percentage of the overall. The production of engineers now among minorities is at about five percent - that includes Blacks and Hispanics. We are up in the total population of new graduates in the eighties. With 78,000 being produced, approximately 3,800 are minorities. This is approximately five percent, which is one of the largest number of minorities, that is Black and Hispanic, in recent years.

We are going through a major structural shift in the demographics in this nation. Texas and a few other states, particularly California and Florida (I have worked and lived in both), are certainly leading in that trend. But, it is happening in Hartford, Connecticut; it is happening in Illinois; it is happening in Cambridge, Massachusetts. We were lecturing at MIT this summer and one of the interesting things I noted was that when you looked around Cambridge you found that it is significantly minority now, as well as the city of Boston. So it is a national trend, it is not localized to Texas or the "Sun Belt" or Florida or California alone.

Interestingly enough, in terms of institutions, there is another change that is occurring. We were discussing what is happening to four-year colleges and higher education. For the first time in history at the University of California at Berkeley, the freshman class became majority minority this last year. The University of California at Los Angeles (UCLA) is approaching it now - that is if you include Blacks, Hispanics, and Asians in the California system. So fundamentally what we are going to see is a significant increase in the number of majority/minority institutions in the nation. In our state of Texas, we now have five or six

already. So it is a trend of the year 2000 and beyond. It reflects the demographics of the eighteen to twenty-six year-old age group, which is the prime college group.

If we look back at 1985, we find that Prairie View A&M University, interestingly enough, was the number one producer of Black American engineers. Actually, we were almost the number one producer of minority engineers, including both Blacks and Hispanics at that point.

In Texas we produce more Black American engineers than all of the other twenty engineering programs combined. COMBINED! The trend in Texas right now is, of the top minority students (both Black and Hispanic) who are entering the University of Texas (UT) system, the Texas A&M University system, etc., one out of ten to two out of ten are graduating in engineering. But, one out of ten to twenty percent in engineering. Also, interestingly enough, when we look at the statistics we see that an institution, say Texas A&I University or University of Texas at El Paso, may be classified as a minority institution, but its engineering program is not majority/minority. I think that is a fundamental point to understand.

If you look at more current statistics, as far as overall engineering production in the nation, we are still either three or four this year, depending on the statistics of Howard University. But, I think this year North Carolina Agricultural and Technical State University may be right there with us. Most important I think, from the standpoint of our recruiting and precollege efforts, is that we still have the largest enrollment of Black engineers in the nation. As of now we are somewhere in excess of a thousand students, approximately 80 plus percent. Another reason for these statistics is that the College of Engineering at Prairie View A&M University, as of last year, had its name changed to the College of Engineering and Architecture. What that means is that we predominately had an architectural engineering program which accounted for some of those statistics. That has now moved to a full five-year accredited professional architectural program. That program is now a stand-alone professional architectural program. But when you look at some of our precollege efforts, you will find that is a very advantageous situation for an engineering program. Also, many of those professors have MIT physics and engineering backgrounds, as well as Prairie View A&M University grads in the program with an engineering background - and engineering and architectural registration. But, that also reflects in some of the change in the number of graduates purely in engineering.

Now in terms of precollege programs, I think that we have discussed often in the last sessions precollege or programs for 10th, 11th, and 12th graders. We have one of the national programs called Minority Introduction To Engineering (MITE), which is a two-week program for those students. We had approximately 156 students last year in the three sessions. But, we look at this and it has been discussed more today as a continuum and not just a precollege program, not just a prefreshman or a K-5th grade program, it is all of those. As soon as a student graduates from a precollege program, say the MITE program, he/she should be recruited immediately for a prefreshman program. As a matter of fact that is our philosophy; the day the student graduates from high school, the night he/she marches - the next morning that student is in the precollege programs during the summer - the prefreshman program as we call it. Actually, it is called the Engineering Concepts Institute (ECI).

The students in the MITE program are recruited for ECI and then we move with what is called "The Texas Alliance for Minorities in Engineering" (TAME) which is networking in this state. I echo someone else's comment, "I wish something structural like that with significant support had existed in the late '50s, early '60s." We work with them very closely. They have programs in the junior high or middle schools. I remember the comment by INROADS that GCAME, which is the local chapter in Houston, has moved to the middle schools almost totally now. During my research days, we were looking at technical manpower for the Defense Department and other industrial bases in the U.S. We recognized in the mid-'70s that there was a clear trend which we see now. With the children who were born then, that trend is already upon us. The only difference now is that the babies are here and it is no longer a projection; it is no longer a statistic; it is a reality. But, the concern that we had then, and the studies showed this (there was a young lady by the name of Sue Berryman and another young lady from Texas who participated in this study), was that unless we moved below the high

school level, that leveling off trend is going to increase. We have got to move below the high school level in terms of expanding the pool.

*"The other thing which I thought was even more interesting about the study, and I might not have predicted, is that it demonstrated that if a parent of a minority, Black or Hispanic, had any college experience, then the probability of the children entering into science or technical fields equaled that of majority population."*

The other thing which I thought was even more interesting about the study, and I might not have predicted, is that it demonstrated that if a parent of a minority, Black or Hispanic, had any college experience, then the probability of the children entering into science or technical fields equaled that of the majority population. Let me make that clear. If either parent had any higher education, whether it was community college, or one year in a four-year institution, or a B.S. graduate, then the probability of their children seeking a science and technology degree was equal to that of the majority population. This tells us two things: that we are talking about familty and the family situation. It makes a significant difference if the parents have had college experience. You ask how the change is going to occur. Well very clearly as we increase the numbers - and let me highlight it again - if either parent had any college experience, that is community college or four-year college, then the probability of their children entering a science or technical career was equal to that of the overall population. (This study was directed primarily to Black Americans because there were more data available on them.)

Now, I will discuss the program on our campus. As you may note, the program began about 19 years ago. We are almost into our twentieth year now. During that period the total number of participants in the ECI program has been over 2,000. Ninety-five to ninety-seven percent of those participants were Black Americans. I think an equally important statistic is that there has been a change in enrollment in the overall college from around 300 twenty years ago to well over 1,000. That is three times as many. That is why I wanted to bring in an historical perspective as we were talking about the "gloom" aspect that things will not change.

When I graduated back in the early '60s from Tuskegee Institute, I think there were about five in our class in mechanical engineering. The same thing was true at Prairie View. Right now we are producing, as you saw, well over 100. That is a ten-fold increase in twenty years. That also gives you the influence of the Historically Black Colleges and Universities (HBCUs) on the potential to address this issue, engineering being one example.

But, it was a two-fold effort. It was not only the educational opportunities that existed, but there was also the economic aspect and that relates to why anyone goes to college. If you are dealing with undergraduates, don't ever forget that the main reason an undergraduate is at the university is to get a job. You forget it when you work with graduate students. Sometimes I missed it when I began to deal more with undergraduates. That is the basic reason for entering a university and we should never forget that. So economic opportunities have changed significantly in that 20-year period for Black Americans in engineering, and therefore you also see a significant increase in the enrollment. But, also there have been more concerted, structured efforts. The National Action Council on Minorities in Engineering (NACME) is one example, as is the Texas Alliance for Minorities in Engineering (TAME).

The other most interesting statistic that I like to quote, probably even more important than the absolute numbers, is that 96 percent of these students are entering engineering after the prefreshman programs. The freshman year is very significant in engineering - freshman/sophomore. Eighty-five to ninety percent of these students make it through their freshman year. After the sophomore year the probability of graduating increases significantly.

Therefore, having precollege and again on the continuum, not just prefreshman, not just precollege, but also the middle schools programs is important.

> *"... 96 percent of these students are entering engineering after the prefreshman programs. The freshman year is very significant in engineering - freshman/sophomore. Eighty-five to ninety percent of these students make it through their freshman year."*

The composition of the student body is something else that I think you will also notice is changing. In terms of using some of the standard measures of SAT and grade point averages, etc., there is a steady increase in the grade point average as well as the SAT scores. The population of minority students that score above 1,000 on SAT is one percent of the national population. **One percent!** That is the student body that we are trying to attract. We do recruit out-of-state and although the student body is predominately from Texas, it is national as well.

Texas, as a state, ranks 46th in terms of SAT scores in the nation. This is interesting enough as a statistic. I was glad to see the principal of Booker T. Washington High School, and one of our graduates. Franklyn's school is one of the ten schools in the nation that is consistently ranked high in this category in production of high school students. It has consistently produced Merit Scholars and students having those kinds of averages - both GPA's and SAT's. Other highest scoring schools are Brooklyn Polytechnical and one in the Maryland suburbs. Those are three of the highest in the nation of which I am aware. I think that there are some on the West Coast.

The other thing is, of course, the population. The Prairie View A&M engineering department is 99 percent, and I underline this, <u>Black American</u>. There are approximately one percent Hispanics, now. That number is going to increase, both in terms of the population changes as well as opportunities for those students.

From the female/male statistic we are still majority males. Approximately 37 percent of the students in the pre-freshmen efforts are now women. In the entire college about 25 percent of the students are now women. Interestingly enough in my undergraduate days, in the late '50s and early '60s, the only woman in the building was probably the Dean's secretary.

Another interesting statistic, back to the continuum again, is that we are talking about what has happened in the precollege before many of the programs we have discussed. About 17 percent of the students have participated in our program, another 5 percent participated in others, but note that 78 percent have not. That is the idea of increasing these kinds of intervention programs. Seventy-eight percent, that is about 80 percent or four-fifths of the students have had no precollege experience. I think that we are doing reasonably well getting 17 percent - the national average is a total of 22 percent. About a fifth of the students have had some precollege effort and it definitely makes a difference.

The other aspect of it and the reason that the discussion has centered on why one goes to higher SAT's or higher GPA's or etc. at times - is to help the student be successful. I believe this as deeply as I believe anything. It is not the idea of bringing a student to a university; it is the idea of graduating a student. When we were discussing this with some of our corporate people (we have an engineering professional curriculum committee) we agreed the bottom line is to graduate students. Therefore, with scarce resources the bottom line also is to produce technological leaders through academic excellence. That means that while Prairie View A&M is an open admissions university, those students will not enter the prefreshman programs. They may enter the precollege on average. They can enter in the fall and there is a program to have them enter as freshman and sophomore students, but not as scholarship

students. The reason for that is our limited resources and we do get a large pool of applicants. One of the reasons that we are producing about a hundred graduates, on average, is that we have seven to eight hundred recruiters coming to the campus to employ those graduates.

It is a scarce resource, but it is also a costly resource. The summer program to which I am referring costs between three to four hundred thousand dollars per summer, which are primarily private funds, not state funds. If we are going to increase, I think that is another important number. You may have seen the statistics slightly decrease with the increased SAT scores and the increased recruitment of out-of-state students. We have approximately one-third to twenty-five percent out-of-state students, mostly from the West Coast, Detroit, Chicago, the Boston area, and the Washington D.C. area. We call these our target cities. Kansas City happens to be another important city because of the significant alumni participation there. But, as we have increased the out-of-state students and as we have increased the entry requirements, the scholarships and the costs actually increased for this reason: for out-of-state students the tuition is greater by definition and, also, it is a more competitive model. Everyone wants these students. We live in a highly competitive world, in terms of attracting scholarship, or out-of-state waivers, or whatever. Where you saw the statistics on graduation, graduations and numbers are the results of the dedication of faculty, the commitment of the institution, etc., but it is also a function of what kind of precollege enrichment programs are there. I mean, again, it is a continuum. What we are seeing clearly is better preparation of the entering students.

The curriculum for the program is primarily in the mathematics, computer skills, computer literacy, and quantitative skills but also there is a communicative component. Communication engineering, as all here probably know, is not just a course, it is both graphical as well as communicative - that is verbal and written. It is graphical and that is why I am trying to emphasize the importance of having architecture and graphically oriented engineering professors. So one must be able to communicate both graphically, as well as in the English language.

The program which introduces that concept in the freshman year is Engineering Graphics, which is both computer and hands-on graphics. One interesting thing about the computer applications course, which we noticed this summer, is that there is a significant increase in the preparation of high school students in computers. However, it is bi-modal. We are getting one student who is ready for Advanced Pascal or C-language and another student who hasn't seen a computer - even with a 1000 SAT score. Let me bring up another point about that. Even having a high SAT or ACT without the appropriate mathematical and science background, we would not let the student into Calculus I. We test the students, even those with a 1000 or 1200 on the SAT. Interestingly enough, many of those students will decide that they need some more algebra or trigonometry, or maybe a combination of pre-calculus. The idea is to acquire basic mathematical literacy. As I mention to students, "It is not enough to do homework problems, you are internalizing this process. You are beginning to think quantitatively. You are beginning to analyze in a quantitative manner, not just perform as an exercise in academics."

The next area, of course, is the Engineering Professional Concepts. It is interesting to note that we just left a meeting of the Texas Board of Professional Registration, as we serve on the Advisory Committee for Profession Development. They are looking at possibly implementing this course throughout the state. The State Legislature just provided funding to look at every undergraduate engineering curriculum to add this component. The course is professional ethics, as well as professional practices. But, there is another portion of it, called Professional Registration, which means the license to be a professional engineer. Over the last five consecutive semesters we have a 100 percent passing rate on that examination. That ranks us number one in Texas, by the way, based on percentage passing, which is the statistic that is used. But, the important thing is that it is introduced to freshman, not to a senior level student, not a graduate, but to an entering seventeen-year old. What they are doing is internalizing a professional attitude and a professional approach to problem solving. That is what we were talking about this morning.

Included in this course is Professional Communications. That includes the ability to speak well, to write well, and to get on your feet and do both. It also brings in practicing engineers, as well as nationally distinguished lecturers and a significant number of our alumni to give the students an understanding of what a practicing engineer does, and encourages students to realize that they, too, can do it. But more importantly, that helps students decide which one of the engineering disciplines they think suits them. They can learn about the research environment, the manufacturing environment, and those kinds of things. They need to begin asking these questions and answering these questions as freshmen, and not as seniors.

*"Last year in our nation, of the 300 plus engineering programs, less than 15 Black American Ph.D.'s in engineering were produced. That is a tragic statistic and with the changing demographics, it is an unacceptable statistic."*

The other aspects are the tutorial sessions. I really don't like to use the word "tutorial," particularly with these students. I like to use the term "problem solving" or "advanced problem solving." It is the ability in these courses to go beyond the regular homework assignments. We have regular senior level students participating in these efforts in our program. That is, our seniors, juniors, and some sophomores who had completed the program last year are involved, as well as faculty in the evening problem solving sessions. Therefore, equally important is the fact that there is a significant student involvement.

Another significant aspect is that it is totally faculty from the university. One, they are credit courses. But, I should also add that these faculty are the ones who teach the precollege program, the MITE program. They are full time, not part time faculty, not graduate students. All are degreed, whether in architecture, engineering, or mathematics.

In the Professional Concepts Course all are Registered Professional Engineers. They are usually from each of the various departments: mechanical, electrical, civil, and architectural. The idea here is to introduce the students to the laboratories, as well as to our graduate research projects early on, so we have every department represented. Usually the person involved in the course is a registered engineer.

As an Historically Black Institution (and somewhat as a nation) we have made significant strides, at the undergraduate level, in the last 20 years in terms of minority engineering. We are not nearly where we need to be at the undergraduate level, but we have made significant strides.

Where we have failed totally is at the graduate level. I have to mention that many of the Historically Black Colleges are just beginning graduate programs. Ours is in its sixth year. We produced our first masters candidates in '84. But, we have failed in selling students on graduate education and education as a profession. I put the blame on both of us - not only on the corporate side although many persons will blame the corporate side. It is a blame in a positive way, in that there are great job opportunities. A student can come out making thirty or forty thousand dollars a year, so why sacrifice by going on to graduate school? I remember a man by the name of Howard Adams, many of you may know him, who is head of the National Consortium for Graduate Degrees for Minorities (GEM) program located at Notre Dame University. We were at a meeting in Washington, D.C. about two years ago. He stood up in the middle of the Accreditation Board for the Engineering and Technology meeting (there were a few deans, mostly from around the country, as well as professors) and said, "I am glad that none of your students are here, because not one of them would think about entering this profession." In other words, we weren't selling our own profession.

You begin to see all of the strains and pressures on a new Assistant Professor. Everybody recognizes the papers, the teaching load, the ability to seek grants, etc., but that is all for a purpose. It is just like going through the degree process itself, because of what the academic community provides which no other community provides, and that is why we haven't sold it well. It was mentioned here some today that the door swings both ways. You can either enter the corporate world, or government, or the university. So, number one you have the range of flexibility. Secondly, there is nothing like the experience of seeing a seventeen or sixteen-year old move from being a teenager to a polished professional. That is a unique experience. It does not happen anywhere else except in the university. That is the only place that I know of that it happens. There is a third reason, the intellectual freedom of a university and the teaching profession. There is freedom to help direct your career much more so than normally is done in an industrial or government setting. In other words, you pursue your research interest, and your personal and your professional development. But, there is another reason and it is also economic. There is no question that the salaries of a university will not normally compete with that of a Vice-President or Senior Manager in a firm, but they will certainly compete with the average salary in a firm as you progress through the academic levels. Sometimes it will exceed, as a matter of fact. I guess what I am suggesting is that a student or a young professor may see the strains of an Assistant Professorship as opposed to the benefits. And, just as we said it should be fun at the undergraduate level and at the high school level, it also should be fun in an academic environment. But, you have got to have a dimension to it other than just the hoops through which one has got to go in order to move up the academic ladder.

Then there is another one - as I said, the door swings both ways. We can easily bring professors in from industry as visiting professors. We will share a professor with Bell Labs, or Sandia National Laboratory, or any of the national labs. We have a number of visiting professors. In other words, you can go both ways. We have a young man coming in right now, an undergraduate from Howard University, graduate study at Carnegie-Mellon University, one of the top VSLI design people around. He can go back and forth, exemplifying what I am saying about the door swinging both ways.

Let me get to the graduate statistics. Last year in our nation, of the 300 plus engineering programs, less than 15 Black American Ph.D.'s in engineering were produced. That is a tragic statistic and with the changing demographics, it is an unacceptable statistic. But, maybe more fundamental than that, and it probably has been mentioned here today, in the last eight years we have seen a halving of production of minority Ph.D.'s in terms of Black males and other males. Females have been level. But, we have seen in the last ten years (the last eight more specifically) a significant negative trend in terms of our graduate production. Let me add that this applies to the majority population as well. I should not only highlight Black males because the statistics include White males entering graduate education as well. If you walk into the average Ph.D. engineering program in this nation, 60 to 70 percent of the students are non-U.S. born, primarily of the Asian realm. Therefore, there is a significant opportunity for Americans. We are saying that we should limit the opportunities for these other countries, and we should expand our opportunities. However, if we did not have those persons we would not have instructors now, and let me be very clear on that. Forty percent of all Assistant Professors in this state are non-U.S. citizens. That is in the State of Texas, not only on our campus. Forty to forty-five percent are non-U.S. citizens entering as Assistant Professors. The average age of an American engineering professor is now 59. I think it is 60 as of this fall, it was 59 last year. The average age of an American-born engineering professor is 60 years of age. Obviously, we are going to see some significant shifts and it may be the one most serious problem.

As I mentioned, we talked about the financial drain or the financial deficit. I think the country is facing in the next century, if we are not absolutely careful, clearly an intellectual deficit as a nation. Believe me, and I think we all know that there is a significant correlation between intellectual deficit and financial deficit. It is almost a correlation of one, I think,

because without expanding technology and expanding new commercial products we are not going to see this nation continue to have the standard of living it has experienced. Particularly, about half of the population is not moving into the technical or managerial mainstream.

The other question is the defense one, and it has been brought up more than once. With the current military technology and industrial base, if we are not able to maintain this kind of population trend and turn it around, we are not only not going to be an economically viable nation, we are going to be a very insecure nation in terms of our ability to maintain both our political and economical systems.

Recently, to highlight this, one of our students, who was one of the first selected of the top 30 students in the nation in terms of the White House Initiative on Black Colleges and Universities, was honored by the Reagan Administration in science and technology. He happened to be a mechanical engineering major. Last year a female chemical engineering major received the same honor, and we were very pleased to see that. During the last Presidential Initiative, Prairie View A&M College of Engineering received one of three university awards for developing model alliances with both the corporate sector and the private sector, as well as with national government laboratories. The important thing about that is it is good to have the relationships, it is good to have the partnerships, but we have to continue to expand and develop them. We don't live on what happened three years ago, we have to look at what is going to happen in the next ten years. We also have to look at what happens in terms of the current administration.

Thank you very much.

# THE EMERGING SCHOLARS PROGRAM AT THE UNIVERSITY OF TEXAS - AUSTIN

**Jacqueline McCaffrey**

**Director of Special Projects**
**University of Texas**
**Austin, Texas 78712**

*Jacqueline McCaffrey is the Director of the Office of Special Projects and Coordinator of Minority Programs for the College of Natural Sciences at the University of Texas at Austin. In 1988 she developed, with faculty members in the Department of Mathematics, the Emerging Scholars Program.*

For all of us from the University of Texas - Austin, we are really pleased to be here talking about the successful science intervention program. We are really excited about the model program that we heard about at Berkeley a couple of years ago. We are real proud of our Emerging Scholars. I have to say this is a very young program. Our first pilot was last year - we started with 21 students. Our pilot continues and now we have two classes of Emerging Scholars in 1989. So when we are talking about this program we are talking about something very new. There has not been a formal evaluation - we are in the middle of it, we are looking at things. So we will just do our best to describe the program, tell you why we are enthusiastic about it.

Basically, the aims of this program, Emerging Scholars, are intended to increase the numbers of minorities and women who excel in calculus at the University of Texas. Also, its purpose is to increase the numbers of minorities and women who are successfully completing degrees in math based disciplines at the University of Texas. This includes: mathematics, of course, the courses in the College of Financial Sciences, and the courses in the College of Engineering. It is a joint project of the College of Natural Sciences and the Department of Mathematics, but the Department of Mathematics serves many constituencies at the university. Actually, we have students from several colleges, in addition to the College of Natural Science.

The Emerging Scholars Program is an adaptation of a model. It is a model about which I think most of you have heard. It is based on the work of Uri Treisman at the University of California, Berkeley. Uri was invited to our campus in 1987 to talk about the program that he had begun at Berkeley. It was based on his completed research investigating students who do extremely well and students who don't do so well in freshman calculus at Berkeley. He had focused on Black students as a group of students who, on paper, ought to have been doing exceedingly well. These were very strong students - they were at U.C., Berkeley. Yet, they were not doing well. In fact, they were not passing freshman calculus. He looked at Asian

*"He noticed that the Asian students, who were also very motivated, tended to group together. They studied together, so much so that their social lives and their academic lives were as one. They intermingled. . . . the Black students had very clear differences between their social lives and their academic lives. They didn't connect in any way."*

students who were strong students also and they, in fact, were not only passing, but excelling in freshman calculus. A mathematician likes to look at the problem. He studied this problem and conducted research, essentially by following groups of Asian students and groups of Black students around for a semester - observing their study habits, going to parties, and that sort of thing. Out of his research, a kind of a ethnographic research, came an idea for a course that would lend itself to the strength of Black students and other minorities, rather than concentrating on their weakness.

He made certain observations about Black students, in particular. He felt that the strongest students came to the university prepared to be self-sufficient, to continue to study on their own and to work very hard. They were extremely motivated, and when things went wrong, when things were not going right, they studied harder and worked harder. They are very motivated and very self-reliant. He noticed that the Asian students, who were also very motivated, tended to group together. They studied together, so much so that their social lives and their academic lives were as one. They intermingled. When he looked again at the Black students, the Black students had very clear differences between their social lives and their academic lives. They didn't connect in any way. I am not going to go on and on. You can get this information about his study, or I can get it for you.

At any rate, he created a program, "The Math Workshop," at Berkeley that was really phenomenally successful in terms of getting Black students in position to do extremely well in calculus. Black students began out-performing Asians and students of all ethnicity - who were not in these math workshops. In fact, it became evident that the workshops were increasing persistence in graduation rates. The program that we have started is an adaptation of Uri Treisman's program at Berkeley. It is a program that differs from other programs for minorities in several important ways, and perhaps the most important of these is that it is a faculty initiated program. It really is a product of faculty interest, of faculty sponsorship - the faculty really care about this program, and they own it. There is ownership of this program in the department and this is pretty significant. At the University of Texas - Austin, as at most similar institutions, programs for minorities generally are in the Student Services Building. The Deans of Students do a good job and they have many activities, many programs that are intended to help the minority students on those campuses. This program is not so much about helping, actually. This program assumes that the students who have made it to the University of Texas - Austin, are strong students, motivated students - they are planning to be successful. This program says that the faculty in your math department, whatever your major, if mathematics, engineering, biology or medicine, whatever - thinks that you can excel in calculus, and that it is important that you excel in calculus. That is what this program does. It "ropes" these students in, insists that they are wonderful - what their mothers and fathers, aunts, and grandparents have been telling them - and asks them to work harder than the other students. It assumes that if asked to work harder, the minorities on our campus will work harder and that they will excel. In fact, that seems to be what is happening.

So the major difference between this program and other minority programs on majority White campuses, such as the University of Texas, is it is sponsored by the faculty, by the people

*"It "ropes" these students in, insists that they are wonderful - what their mothers and fathers, aunts, and grandparents have been telling them - and asks them to work harder than the other students."*

who are teaching the students. It is close to the academic work of the students. It, brings the students into a situation, (and this is true of many programs that are working with minorities), where they can meet other students, and in the Emerging Scholars Program they really are meeting other students. They are being brought together with other students, who are like them, who really want to achieve, and who are willing to work harder than the others. What happens is a tremendous group cohesiveness. These students come together to work hard and to work hard on mathematics. Regardless of their major, they are willing to work hard on mathematics.

Regarding the selection of the students: I, basically, handle the selection of the students. I am an administrator in the office of the Dean of the Natural Sciences, and this is a joint project. I don't know anything about math as they would tell you. The Mathematics Department takes care of the content, of course. I look at the students who are coming in and decide who will be a good person to invite to be in this program. Well, it is really tough because if you look at the students who are coming in, particularly at the minority students, you find that these are really strong students. These are students who graduated at the top of their classes, they are ready to achieve, they have really wonderful academic records. Some of them, not surprisingly if they are from Texas, had inconsistent math experiences in their schools. All may not have had the same amount of algebra, the same amount of calculus, and some might not have had calculus. Some of them went to schools that did not offer calculus. It is not a totally homogenous population. But, the students that I look for (the profiles of the students) are the students who are high achievers, as indicated by their high school graduation rank - that is significant. Also, I look at the SAT quantitative score.

In the early stages of our selection the reason we look for a math SAT of 600 or above, is because there is a very strong prediction rate between the SAT quantitative score and the score on the Math Level I Exam. The Math Level I Exam is the exam we give students when they come into the University to see whether they should be in calculus or whether they should be in pre-calculus. With students who have a 600 quantitative or above, it is almost a sure thing, not absolutely sure, but almost a sure thing that they will be in calculus in the fall. Sometimes all I have to go on are those quantitative scores until they actually come on campus and take this Math Level I Exam. That is the first thing that I do. I look at class rank and then go from there. This program is not entirely for minority students. We serve Black students, Hispanic students, and we have about 1/3 of our places reserved for others, which generally are Anglos.

They found at Berkeley that those Anglo students who really like the math workshop and really blossom with them are rural White students. So what I am looking at is Black students, Hispanic students, and Anglo students. The Anglo students are generally going to come from a small rural area where they may or may not have a family with a college background. They have many things in common with the Black and Hispanic students who are in the class. They are high achievers, they are motivated, but they may have had an inconsistent math background. They may need a little extra nurturing, attention, and challenge to make it on a big campus like the University of Texas - Austin campus, which has 50,000 students. So we do look at these quantitative scores. Later on when the students have gone through the orientation, the general orientation of the University, or have come to register for school and they take Math Level I Exam, they are going to be students who fit this profile who are high achieving students. They ranked high in their graduation class, but didn't have a 600 quantitative. However, they turn out to be ready for calculus and we will bring them in.

Usually students come by word of mouth. They hear about the program and they come to me and say, "Hey, I think I should be in this program. I want to work hard, I like math, I want to do this." And, we say, "Okay," and we bring them in. So it is not a real strict, rigid kind of a system.

The recruitment involves sending out a letter of invitation saying that, "You have been nominated for an honor level program," and this is an honor level program. Efraim will be telling you about that component. We invite the students to an orientation. The orientation is really a fun affair. The last two years we have had Uri Treisman come and talk about the program, how he got it started, and about the other students in this network that is forming on campuses that have this kind of program. At the last orientation kids sat around and did a little math while we were talking to them, so it was a lot of fun. There are a lot of students that we approach who do not get into the program for a variety of reasons. There are some students, very few, who really don't want to work hard. They are scared when we say, "You are going to have to work harder and do more." Most of the students respond to that and really want to do it. There are a few students who do not choose this program. For example, engineering students. Engineering has a lot of programs and the students are confused. There are so many programs in which they can get involved, or they are really interested in programs that are central to the College of Engineering. So a lot of students will decide to not be in this program and be in engineering programs.

At any rate, we get a lot of wonderful students, outstanding students and I will talk about the results a little later. I think that is essentially it: the selection and recruitment. Efraim will talk about the content of courses - what actually happens inside an Emerging Scholars class.

# THE EMERGING SCHOLARS PROGRAM AT THE UNIVERSITY OF TEXAS - AUSTIN

**Efraim Armendariz, Ph.D.**

**Associate Dean**
**Department of Mathematics**
**University of Texas**
**Austin, Texas, 78712**

Let me begin by telling you why the Department of Mathematics is interested in doing this. It is clearly self-preservation. We are well aware that the production of Ph.D's in the United States is certainly declining, especially in mathematics. There is a large untapped source of people out there, namely minority students, who have not been included in mathematics - especially at the Ph.D. level. When you have a university such as The University of Texas, where beginning calculus students have 1200 SAT's and are from the top 10 percent in their high schools, it is criminal not to retain those people. Anything that we could do that would initially get them through a calculus program (because that seems to be the filtering part) is important. If we can get them through that program, then we have a better opportunity to get them into a Ph.D. program. I think (I'll be honest about it) that our goal is to convince people to become Ph.D.'s in mathematics. If it means draining them off from engineering, so be it, unfortunately.

We recognize that will not always happen, but our experience with most Ph.D. mathematicians has been that very few of them started out in mathematics. Their initial interest in mathematics was prompted because they were good in mathematics. They end up being in a Ph.D. program after going through one or two years in an engineering program. I am one of those persons. I certainly had no intention of getting a Ph.D. in mathematics. I ended up in it and my situation is not uncommon; in fact it is a most common situation.

What we are looking for is that student who has had a lot of success, or indications of success, in mathematics. We hope that by associating with other people with the same sort of experience they are going to eventually wind up staffing our universities.

Why do students go into mathematics? We don't know. This reminds me of when Solomon was asked by God if he wanted instant gratification he could have one of three things - wisdom, wealth, or longevity. He thought for awhile and he said, "Wisdom!" He should have taken the money! I feel that way sometimes by doing mathematics, and so I feel a bit reluctant about telling people to go into that.

What is the format of our calculus program? First of all this is a year-long program. Our calculus program is taught in two semesters. It is a large lecture class - there is Calculus I, Calculus II. It is a large lecture class that meets three-hours per week in classes of 120 students per lecture. There are three discussions sections that are attached to each of these lectures that meet twice a week, so each student has to attend discussion twice a week, and those are in classes of 40 students. They meet for one hour each. What the Emerging Scholars Program (ESP) does is replace that discussion section by an additional program. We call it "The

Workshop," which meets three times a week for two hours. So the students attend the lectures and rather than go to the discussion sections, they meet for six-hours per week in two-hour blocks. The intent of this is to give them sufficient time so that they will do concentrated work and continuous work. We not only substitute the workshop for the discussion section, we also give them credit. The students will be receiving four hours credit for the calculus - that is on a grade basis. In addition, they are receiving two hours credit of mathematics - just two hours of credit, there are no grades involved. The advantage of doing that, by the way, is it removes the tension of a grade between the people who handle the workshops, who are graduate students, and the students. I think that it develops a real sense of community among the students, as well as with the person who is in charge of the workshop.

*"The whole idea is to encourage them to work together, to work in groups."*

The heart of the workshop is really the worksheets. I have passed one out, and we are going to have an exam at the end of this. You can look ahead. As you can see, I have selected some samples taken from worksheets that are handed out throughout the semester. The students meet three times per week - that is roughly 45 class meetings, * **five workshops** that they will have. In each one of these they will have a worksheet that will have some problems of this nature, but the problems will be related to the lecture of that type. There may be 12 to 15 problems and they will go into different degrees of difficulty. Roughly, for example, the first problem on that sheet is a rather standard problem, that is not a very difficult set up. It is what one does in calculus that everyone can do. The second one is a requires a little more thought, but still examines the aspect of mathematics, so it gets students to thinking about it. Then the problems start getting a little more difficult as you go along, and they are more challenging.

In the two-hour program it is unlikely that the students will work all the problems, but they will have some success. The whole idea is to encourage them to work together, to work in groups. So the workshops are typically structured - they will meet, they will go through the worksheets, they will start working on the worksheets, they will discuss what was supposed to be covered (they are required to read ahead), and then they will break up into small groups to work and try to formulate solutions to the problems. They then exchange solutions. It is important that people work together. That is a very strong point of this program. We encourage lots of interchange of ideas. It is good to see them for a two-hour period sitting there working together on something; we hope it is mathematics.

The other thing that I mentioned earlier, we feel that it is important for graduate students to work with the students in the workshops. There is less of an age gap between the students and the instructors. The Teaching Assistants (TAs) can facilitate instruction a little better, I believe, than perhaps an instructor of a regular lecture class. It is very good training. The graduate students are required to make up the worksheets, so they spend quite a bit of time looking at old exams, and looking at three or four different calculus texts - advanced calculus texts. They modify problems, taking good things out of the texts, drawing from their own personal experience in graduate school the kind of things that they encounter. The give a broad idea of how calculus fits in at that level in their mathematics experience. I think that one of the strong point of this program is that we are able to work with graduate students together with workshop students and "hit it all" at different levels of instruction.

James is a graduate of our first year. I think he is going to give you some feelings of how students feel about it (I hope).

# THE EMERGING SCHOLARS PROGRAM AT THE UNIVERSITY OF TEXAS - AUSTIN

**James Scott**

**Student**
**Emerging Scholars Program**
**University of Texas**
**Austin, Texas, 78712**

I was in a program last year, and this year I help with the program because I really enjoyed it and I thought that it really helped. As Efraim said, most people who decide to be math majors don't know why they want to be a math major. I have always done well at math so I decided that was going to be my major. At first when I got college brochures and they asked me what major I wanted to choose, I wrote "engineering" because that is what I was told that I looked like. I was good at math and somewhat good in science. But, as I got to calculus in high school I felt that I was more geared toward math, so I decided that was the official major that I was going to declare.

In the summer I got the invitation to be in this program, and although I didn't know what it was about (because I really didn't read the worksheet that much), I went to the orientation. I liked what they had to say because it pertained to working together. In high school I didn't really need to study to make good grades so I worked alone, and I got good grades. I didn't find anything wrong with that. But, what I found from being in the workshop was that working together helped me a lot. I had someone to turn to if I couldn't do a problem, and a friend was less intimating than a professor, which would have been the only alternative I had.

Another advantage of the group and making friends is that we bonded together in class, but we also bonded together socially. This meant that we could always turn to each at anytime to work together. Also, we were introduced to their friends and we introduced each other to our friends, who probably were majoring in a subject that pertained to another class we had. So that helped us excel all around. I took an economics class my first semester and one of my friends in the class had a roommate or somebody they knew that was a business major and who was real strong in economics. I could always go to that person and ask for help if I needed help, and I could help that person with math. I really think that was the great point about working in a group.

I am not going to say that the whole thing is fun because it really wasn't. It did demand a lot of time and a lot of people who come to college want to get through the undergraduate work really fast and go from there. But, working in a group helps maintain math, and since I am working in math, I would like to keep fresh in my calculus and on up. I find that when

you help someone else with math it helps you understand it even more as you go along. That was one of the major reasons I decided to help this year because when people ask me a question, I try to remember it, and I would work with them. If I didn't remember it I could find out what it was and work with them. I think that is the major point in the program - when you work together not everybody will get it right. Maybe one person will get one part and another person will get another part of a problem. Then they would all put it together and go and explain it to someone else. That is what we try to emphasis this year. When someone needs help, instead of me explaining to them I get someone else who got the problem right and have them explain it to that person. This will help them increase their understanding of it while helping some else to understand it.

Basically, I don't want to stand here and babble, so if you have questions, I will try to answer them. I would really like for you to ask questions.

## SUMMARY AND QUESTION AND ANSWERS

### Jacqueline McCaffrey

Can you hold the questions? We will do a kind of finish up and then have questions if there is time.

Something that Efraim said after something I said caused me to realize that there was an inconsistency, and I wanted to talk about different agendas.

I come from the administration. I come from the College of Natural Sciences Dean's Office. We are very concerned with the fact that after four years only eight percent of our Black students are graduating. After six years only about 14 percent of our Black students are graduating with degrees from the College of Natural Sciences. The overall figures for the University of Texas are far, far better. I might add that for engineering they are better than that. But, we have the highest out-migration of any college on campus. We were worried and when we saw this program, at least from the point of view of the dean, the dean saw a way of touching students and really making a difference in terms of persistence in graduation rates. The math department was thinking more in terms of math majors, creating majors, creating minority scholars, and creating future Ph.D.'s for a multitude of reasons that we have discussed here. So there are different agendas, but what has happened is the administrative arm of the college has come together with the faculty of a department in a true collaboration. It doesn't matter where we are coming from - we want these kids, these students, these adults to excel, to do well, and to make tremendous progress which they really seem to be doing. But, that different agenda thing I think is real interesting in terms of from where we are coming.

It is a true collaboration, not just between the college, department, and faculty, but with the students. The students are so much a part of this. If you could visit the classroom, and you are invited to visit, it is just a tremendously exciting thing. The students really have fun. They are having some fun. They really are talking mathematics, and they really are working together. The graduate students and the undergraduate assistants who are in the classroom are working together with the students toward a common goal, and it is tremendous.

Another thing about this classroom that I would like to point out is that it is a truly integrated classroom, if I can use that old-fashioned term. These are Black, Hispanic, mostly Chicano, and Anglo students who are genuinely working together. This friendship part that James was talking about is real. These are kids who are friends, and they are working together. When you walk into that classroom that is what you see. You don't see people thinking about it. You see a respect for differences, but you don't see people doing a lot of thinking about the differences. You see a lot of people thinking about what they have in common in terms of what their goals are and what they want to achieve, which is really exciting for me.

Another thing I wanted to say is that the worksheets don't really look like this carefully typed thing that Efraim just handed out. In fact, they are dittos because the math department has a ditto machine - one of those old-fashion purple things. They are handwritten. So they are not quite that professional, smooth, and slick. But, this isn't a slick operation, it really isn't. It is a very warm and caring operation.

I am going to talk a little bit about results. One obvious result is that James is here and cares about this program enough to travel here and cut a German class to do it. I can't give you too much, because again we are just evaluating. We are also talking about a very small sample, 21 students in our first Emerging Scholars class. The second semester (the second semester of calculus, which not everybody has to take) had only fourteen students in that class. We have two classes now of nearly 20 each - about 18 and 17 I think. At the end of this year I think we will have more to go on.

At any rate, let me tell you how these Emerging Scholars compare to the other students in the rest of the class. We had a lecture section that had a total of 112 students; of those 21 were Emerging Scholars and 91 were the nonworkshop students. Of the Emerging Scholars 86 percent made A's or B's in first semester calculus at the University of Texas. Of the nonworkshop students only 39 percent made A's or B's. Now I am not go into SAT's and the whole bit, but if you do go into SAT's it is surprising that it still works. I can divide that up a little. Of our first class that first semester 48 percent made A's, 38 percent made B's. This is pretty evenly distributed among all of the genders and ethnicities. Incidentally, this is a gender-balanced classroom. In fact, in that first class there were more women than men working on math. It was terrific. It was very exciting to watch. Of the nonworkshop students (this is an unfortunate set of figures) of the 91 there were 16 percent A's, 23 percent B's, 16 percent F's. There were no F's in the Emerging Scholars. I have to say that we did have a couple of D's, about which we were unhappy. But, if you go into it there were family things and things like that, from the outside, which we weren't able to control within the class, and that got out of hand.

In the second semester, of that little group of 14 students who were taking second semester calculus, 78 percent made A's or B's. Of the nonworkshop people, there were 88 others in that class of second semester calculus, 42 percent made A's or B's. So whether it is simply time in the classroom, whether it is having challenging mathematics - many of the problems come from the honor's calculus book - whether it is knowing the calculus in a deeper way, whether it is interacting with one another and testing on one another in terms of intellectual achievement, something seems to be happening in this class.

There is another result that I observed. At the orientation this fall when Uri Treisman came to talk to the students, he was asking everybody in what they were majoring. He asked the new students, the new entering freshman, and everybody knew exactly in what they were majoring. Then he talked to Emerging Scholars from the year before who had come to visit - they were interested, they wanted to be there, and a good chunk of them were there, and asked about their majors. James started out as a math major and he is still a math major. But, what we found is that the students from the year before were saying that they weren't so definite about their majors. Some of them were undetermined. Some were saying, "Maybe biology, maybe math, maybe engineering, or maybe bio-chemistry." Everyone was in a state of confusion. I think that is a good result in a way. Most of the engineering students had stuck with engineering, consistently. I think that it is good that students start looking around and

exploring, and that they look at their time at the university as an opportunity to expand their horizons. I think in some ways seeing this indecisiveness is almost an optimistic note. I think that in terms of results that is about it.

The other thing is that a lot of the students have expressed an interest in going to graduate school, including those students who are in engineering. Many of them see teaching, whether it is at the secondary level or post-secondary, as something they want to have in their future. I think that this is borne out to some extent in that there were more volunteers than we could possible use to become teaching assistants or undergraduate assistants in the new Emerging Scholars classes this year. There are three others who are assisting and we didn't have room for the rest. There was a clamoring. That was one of the results, they really want to teach others, so I think that we have done well.

**Efraim Armendariz, Ph.D.**

We have expanded it this year. We are working with a pre-calculus experimental section this semester. Hopefully, we will continue into a calculus section next semester. We have expanded it to two sections this year so we have increased the number of students with whom we are trying to work. Hopefully, if all goes well we will be able to double again next year - we don't know. It is a very expensive proposition because of the number of students we are using. We are using graduate students - roughly two graduate students per each one of these courses together with two undergraduate assistants (those who have completed our previous program).

I think that a more important factor is if you look at this as a retention program, then it has been highly successful. One of the most important things that I felt about this, why I felt that mathematics should get involved in something like this, was that the Berkeley workshop model was the first program we had seen which was not remedial in nature. It was actually a program that took the opposite tack. It assumed that students had achieved something and that you were going to challenge them. I think that if one looks at our results - we have retained them. I believe out of the 21 students that started last year, 20 enrolled again in the fall this semester. That is much higher than a group of students that you select at random; 21 students, you wouldn't get that high of a retention factor. So I think that if you look at retention and you extract what it is that is working here, one of the things that I think probably could be examined is that we have identified something that the students have in common - mainly in this case the ability to do mathematics. We have grouped them together and put them in touch with other people who have a common interest. Then we have taken that and challenged them by giving them a good strong environment in which to work. I think that the same thing could be duplicated in other areas. It doesn't have to be mathematics. I think that this is conceivably something that could be tried in other disciplines. It would be interesting to see how that works.

**QUESTION AND ANSWER SESSION**

Question from Milford Greene

I want to know about the grades in the other courses in what would be your Control Group, those people who were not in the intervention program part of the program? Were they consistent with the grades of the students who went through the program?

In other words, what I am saying is that if indeed the variable is what you did in mathematics then I would expect that their English grades were failing.

*James Scott*

Are you talking about the people in my classroom?

*Milford Greene*

Is there data on the students who didn't go through the program? Were their grades in English comparable to yours or in social science?

*James Scott*

I would think that it would be what they are strong at because there could be someone taking calculus who is stronger in English than I was, but I am stronger in calculus than he is.

*Efraim Armendariz*

I think that I can answer that. The GPA's for our students range from 2.74 up to 4.0 - 2.74 is the lowest for the overall GPA's over a year. So when you look at the overall GPA for, let's say the College of Natural Science, I think that it is way below that.

*Jacqueline McCaffrey*

Ideally, also they are learning skills not so much the math skills, but skills about working together and networking. I think that we are going to see after awhile, hopefully, an improvement.

*Milford Greene*

It is not exactly a direct relationship, but I would be interested to see how they do overall.

*Jacqueline McCaffrey*

Yes, it would be interesting. Incidently, this networking stuff is continuing. We were talking about it on the plane coming down that the Emerging Scholars from last year who are taking math and science this year find one another when they are having trouble. They continue to work with one another.

Question from the floor:

I missed the information you saying in reference to the hours you meet. If you meet three days a week that is three hours.

*Efraim Armendariz*

Yes, that is the lecture.

Question from floor:

Then you said that in the calculus course there was a discussion group that meets.

*Efraim Armendariz*

For the standard calculus class the discussion meets two hours a week. So the typical student would go five hours a week, three hours lecture, two hours discussion.

Question from the floor:

Are these students all involved in that special group?

*Efraim Armendariz*

No, we take away the discussion section and substitute two three hour sessions for a total of six hours in addition to the three hour lecture.

Question from the floor:

What time are these workshops held?

*Efraim Armendariz*

For example, the lecture meets this year Monday, Wednesday, and Friday ten o'clock to eleven and the discussions meet Tuesday, Thursday, and Friday from one o'clock to three.

Question from the floor:

Okay, I have a question for James. How were you advised to take this for twelve hours?

*James Scott*:

It was Jacqueline McCaffrey that I was talking to and she was talking about excelling. Some people would take a lot of hours and try to do that many hours and try to do everything and ended up only doing mediocre in each class. She was saying take fewer hours and try to excel in each one of those.

Question from the floor:

Were all of these students advised this way?

*Jacqueline McCaffrey*

Yes, last year it was just friendly advice and partly based on what had been learned at Berkeley. That it was more important to really put all of your effort into a smaller number of courses and do exceeding well and get stable, and also have time to explore your freshman year - to live rather than study all of the time. It was partly because of that, but it was also partly because the research showed that Black student particularly who were honor students coming out of high school were used to taking a lot of courses

and would tend to think that they could still do that at the University and do just as well as they had been doing. Then they were overwhelmed and thought it was them, when actually they were just overwhelmed with too many courses. So it was friendly advice last year. We kind of asked that they not overload their first semester or two. Especially if they were participating in our program. This year, because second semester there was one person who overloaded and I watched what happened, I was absolutely firm and I said, "Don't get in this program if you are planning to overload." I asked that they stay around the minimum and not overload and made it mandatory.

Question from the floor:

What else do you do?

*Efraim Armendariz*

We have visitors of different types. Mathematicians come in to give lectures, presentations. We expose them to as many mathematicians of different gender and ethnicity as possible.

*Jacqueline McCaffrey*

Also, to give them familiarity with the academic life in general.

Question from the floor:

I have a question for each person. I was just wondering, you mentioned studying on your own in high school and having been successful at it. How did you come to the determination that this kind of team or group approach was what you needed when you got to UT? I am asking because in my experience many of the students in engineering have it rough that first year and experience problems working on their own and then come to the conclusion from the bitter experiences they had the first year.

*Jacqueline McCaffrey*

We scared them.

*James Scott*

It was a very stiff talk. We all had conceptions of what we could do and what would happen. He just told us that it basically was not true, that it usually didn't work out that way. I had always wanted to work with people. The reason that I worked alone was because I really never had the chance to work with other people. Actually, I started noticing this when I took calculus my senior year because calculus was almost like hitting a brick wall. I finally came in touch with all of the honor students in my school because math was the only class that I took honors in so I didn't know the rest of the honors students in my school until I got to calculus. That is when I sought their help and worked together as a group there. I discovered that was the best policy to go with.

*Question from the floor continued*

I wanted to ask Efraim, I was wondering in the terms of putting students together and asking them to work together on a problem if that in itself has a positive effect? But,

I am wondering if there has been any work done on actually structuring the approach problems in a more formal way. That the work on it has to be done by a team, rather than just letting it happen? Can the problems themselves be structured in such a way that you need to work together with somebody, as opposed to just a regular old problem that two people work on?

*Efraim Armendariz*

We haven't looked at that, but I think that possible that would be a good thing to incorporate into a semester type project - a long period type program.

*Question from the floor continued*

I know that they have that with younger children in elementary school.

*Efraim Armendariz*

They work on cognitive problem solving skills.

*James Scott*

Matt, the Teacher Assistant (TA), gets them to work together where they make a review for the chapters for the test - he gets them to work in a group and they each take a section of the chapter and go through it in detail and get together and piece together a review sheet for the whole class to use. Also, he has them choosing a problem and presenting them to the class. A individualized problem which they have to work out and present to the class later.

*Question from the floor continued*

I wanted to ask Jacqueline, I still wasn't clear on your selection process. Ultimately do you decide who are the students who need this service the most or who are the students who are the best students to begin with and then this would be icing on the cake? I don't understand.

*Jacqueline McCaffrey*

First of all if you look at the best students (we are starting to look at this at UT and they look at it at Berkeley). Let's say that students with the highest SAT's sometimes are the students who do the worse in calculus, right? So it is a little shaky there who the best student is or who is the student is who needs this the most. What we look at is students who have high achievement motivation who are going to respond to a challenge. That really does take in a lot of students at the University of Texas. So some of what is going on in the selection process is real arbitrary because we are not big enough to take in the hundred who might fit that profile.

*Efraim Armendariz*

An example of this is one student that we selected for the fall semester who had been in an honors calculus program. When he came to the orientation program he brought along two of his friends that had been in the honors calculus program that wanted to be in the program but hadn't been selected because it had been a random process after we had profiled the people.

*Jacqueline McCaffrey*

Yeah, it was funny because he comes in and says, "You know, my friend was the valedictorian and he didn't get a letter," and then he says, "And, my other friend was salutatorian and he didn't get a letter." And I went, "Oh." Then he goes on about all of his friends who took honors calculus with his in this tiny little town in Texas. I said, "Do you think they would like to be in this program?" He said, "Yes, I think that they would." I said, "Then where are they right now?" He said, "Downstairs!"

Actually, these kids for the most part would not have been chosen just on pure numbers. But, wow, they are wonderful! They are wonderful! So the selection process, if it seems a little fuzzy, it is fuzzy. It really is.

Question from the floor:

I have about three questions. Number one, you said that you had four TA's or student leaders per group? That is pretty expensive. Now as far as getting the students together so that they can take advantage of this course, that means that you get them in initially and you make up thier schedules, right? Because, they are in the same class, I assume?

*James Scott*

Yes.

*Question from the floor continued*

So you catch them at the very beginning before they get there, you make out their schedule, they don't go to engineering to get their advisor?

*Jacqueline McCaffrey*

No, they go through advising. I don't know about engineering advising and there is no single person who really can advise for all of the departments, or ought to advise for all of the departments in a school. So we have a cooperative thing going with engineering. This is kind of interesting. We give them credit; Efraim mentioned that the students get credit for Math 210. In the College of Natural Sciences I went to the Dean and I said, "Can they use this credit toward their degree?" He said, "Yes, they can use this credit toward their degree." Well, you go to the College of Engineering and their students are required to take just huge numbers of hours in order to get certification. I know that it can be designed differently, but the way it is designed at UT there is not an inch there. There is hardly any leeway at all. But, the Dean in engineering was interested enough in this program and the results that he had heard about at Berkeley that he compromised. He said, "Well, we can't give them credit towards their degree for this Math 210, but what we will do is the two semesters they are in the program we will act as though Math 210 can be used toward an engineering degree. We will say that this is part of the 12 hours towards an engineering degree that they have to have each semester. So we have a cooperative thing going, then when the student goes over - the student, he or she has been told by me to go to a particular advisor or straight to the Associate Dean and say that I am in Emerging Scholars. Then the advisor knows what to do next. They know what can fit in and what can't fit in. They have already been told by us that this is the Emerging Scholars calculus

section, these are when the ESP intense workshop sessions meet, and these are the ones that we would like this student to be in.

*Question from the floor continued*

It works more effectively that way?

*Jacqueline McCaffrey*

Yes, and plus I think you are in a real dangerous area if you start advising somebody else's students. Especially if you make really bad mistakes. So they advise their own students. I act a general resource for the students, a point of contact. I have been around the University a long time, I have been in Student Development a long time. I know our degree program in the College of Natural Sciences real well, and so generally they will kind of stop in with me and ask general types of questions that you might not want to take to a faculty advisor. I can do that for both engineering and natural sciences - general things.

*Question from the floor continued*

One last question. We have a similar type program at the University of Houston based on the information from the University of Berkeley, but I just wanted to ask the student from his point of view since he has gone all the way through it. Do you think it was the extra problems that the TA brought to you or that you guys networked together that helped you the most. Which was more important to you?

*James Scott*

Probably the fact that we networked together.

*Question from the floor continued*

That was more important than content. If they just let you use your own homework would it have been just as effective do you think?

*James Scott*

I don't think so. I don't know if this is true for all students but you have a tendency to do what you are asked to do and nothing else. Unless you have a personal motivation to do more, but if you don't you just do what you have to do. Like, they have the homework - they were telling us not to do just the homework, because we came to class and did the worksheet, but we didn't have to do the worksheet outside of class. So at home we didn't have to do the worksheet. But they were asking us to do extra work besides just doing the homework.

*Question from the floor continued*

Okay, so you worked on the worksheet in the class and you did your homework on your own or together, but it was away from the two hour period?

*James Scott*

It was away from the two hour period. If it was just done with the homework, and I guess they are right, that the book does not challenge you enough so the homework problems would challenge us enough because the problems were designed to make us think and think about why something is and how it should be when it dealt with calculus. I guess in that respect the worksheets did help because they showed us how much harder problems can be than just from the book because the books problems just weren't that hard.

*Efraim Armendariz*

If you look at the worksheet, for example, the first problem you might find in the calculus book, the others you won't.

*Question from the floor*

One last question. Do you think that it is necessary to have four TAs? In our program I have one and he is a student, he isn't even a graduate student, he is just a student like yourself who did well in math and is beyond the course in which the students are taking. Do you think that you need four and that two of them are graduate students?

*Efraim Armendariz*

Let's see, two graduate students - well, we are training one for the coming year, that is why, and one is actually conducting it. We hope to expand. The two undergraduate students who are there - we are being selfish about it. We want them to get involved with mathematics, and we want them to have the experience of exchanging mathematics information and actually teaching. If it just so happens that they wind up being mathematics teachers, great. So we are going to "buy" them if we can.

*Question from the floor continued*

That is a good idea; I didn't think of that one. You tend to notice that those students who participate as instructors or workshop supervisors tend to strengthen their own skills in the subject because they seem to learn more when they try to explain it.

*Efraim Armendariz*

Yes, they are apprentice teachers right now.

*Jacqueline McCaffrey*

Also, I think that the worksheets are subtle. It is not just doing more. The TAs who are doing this spend an awful lot of time, love, and commitment putting these worksheets together to really give the students a very deep knowledge of the calculus. They are subtle; there are nuances there that I don't think you are going to get from the homework or just going over some problems. They are really very carefully constructed to kind of ferret out any deficiency that might be there and take care of them as they work the problem. So it is a very subtle thing. I don't think that the students are going to feel what is happening mathematically that much but I think that it is happening in an understated way. Does that make sense to you?

Question from the floor:

What I was wondering, one of the things that you seemed to have enjoyed as an outcome of the program is perhaps an awakening to other opportunities and career options in science and mathematics. You mentioned that you make it a point to bring professionals of varying ethnicities and gender into the classroom. Do you also bring professionals of varying disciplines that are related? Or do you focus simply on mathematics?

*Jacqueline McCaffrey*

This is something that I have been thinking a lot about lately. We did have Vern Hunt, do you know who Vern Hunt is? Efraim arranged for her to come and that was a real interesting thing. Vern Hunt is into dynamical systems. She has been working in dynamical system in biology. So she talked about how her math and her biology come together. The excitement from some of our students was really evident. Like one student who is in bio-chemistry, but loves math - it was really neat to have her get turned on.

*Efraim Armendariz*

We do recognize that the boundaries of mathematics are spreading out so we have incorporated people who cut across different disciplines. We are not that narrow-minded, but we still want them to consider entering mathematics.

Question from Nina Kay:

I wanted to ask James a question, please. In terms of taking the twelve hours, let me say that I approve, but did this make a financial difference to you or any of the other students that you knew? In other words, part of it is that you have already been saying, "Gee, I thought I might get out in four years, now they are telling me that it is going to be five and that is okay, but..." Does it matter financially that it takes longer?

*James Scott*

From what I have gotten from what my friends have said, most expected to be there five years. Nobody had the idea that they would get out of there in four years. Friends from high school that I know that will get out in three or four years have by passed calculus or they only needed calculus. So what they took in high school and what they got on the AP Test sufficed for their sciences and they started off like in their junior year. But, the friends that I have that started in their freshman year knew that it was going to take 4½ to 5 years.

*Nina Kay*

So you had already programmed that in. Okay. But, sometimes this does matter. In other words, that the one reason they may be trying to load up and go faster is because of a financial constraint. Obviously, the department is helping you with that. Speaking of that, now this is funded by the mathematics and natural sciences department, right?

*Jacqueline McCaffrey*

And, the Office of the President and the Office of Graduate Studies. The Office of Graduate Studies at UT is very aware of what is going on in undergraduate instruction. So, yes, it is very much an institutional effort, although I think that if we are going to keep expanding we need to have more money coming in because it is an expensive program.

Question from Nina Kay:

Let me ask you this, Dr. Armendariz, what does the discussion group do? In other words, the others who are not in the workshop. What does that discussion group consist of- what does it do for the two hours?

*Efraim Armendariz*

Typically it would depend on the TA who handles it. It is handled by the teaching assistant. Generally, we will go over homework assignments and work on problems. Since they only meet two hours a week they don't really have time to do a lot of concentrated work.

*Nina Kay*

They get no credit for that?

*Efraim Armendariz*

They are getting roughly one hour of credit for the discussion group.

*Nina Kay*

But, is it voluntary or do they have to attend?

*Efram Armendariz*

In most lecture sections it is voluntary. The general way of handling the discussion sections is that they make them optional for attendance. It is a place for going over homework, for handling problems that were not covered during the regular lectures sections.

*Nina Kay*

Whose decision was it to give credit for the workshop? I think that it probably one of the things that makes it most successful, because this is not usually the case. You consider this as a variation of a support type group. It is not always the case that they get credit, and therefore the getting of the credit makes it far more acceptable for the students to spend that time, right?

*James Scott*

Of the 21 of us who took it last year, I don't think you could have found one who would have done it for no credit.

*Nina Kay*

Okay, that is what I am saying.

*James Scott*

We already felt cheated... only getting two hours.

*Nina Kay*

Right, right. But, you wouldn't have done it at all if you hadn't gotten credit. I understand, but I am just saying that when the students put in the time and they don't get credit - this may be one reason that some programs don't have the attendance over the whole semester. I think that this is really great.

*Jacqueline McCaffrey*

Yet, at the same time it is interesting that the engineering students participate. And, we are real honest with them that this is credit but it is imaginary credit, and they do it anyway. They really want to do it.

Question from the floor:

What kind of scholarship program to you have?

*James Scott*

I am on two University scholarships. One is a National Achievement Scholarship associated with National Merit Society.

*Question from the floor continued*

So it is not uniform?

*James Scott*

Basically I have two scholarships. Then I have another one for Hispanics and Black students and it is a five year renewable scholarship that is approximately four thousand dollars a year. They cover my cost.

Question from the floor:

Are you still the lowest in nation in the terms of tuition?

*James Scott*

It is low. It is very low.

*Efraim Armendariz*

It still is 250 dollars. But, we have other fees. There are a lot of other fees and they are going up. They want to keep increasing them, too.

*Jacqueline McCaffrey*

We are still a good bargain.

*James Scott*

There are a lot of other fees and they are going up. They want to keep increasing them, too.

*Efraim Armendariz*

But, for residents the typical fees would run about 500 dollars. It is still "need" based your financial aid package for the most part.

*Jacqueline McCaffrey*

Well, the Texas Achievement test (TAHA) is actually not "need" based. It is merit-based. It is part of the recruitment activities of the University of Texas. One of the problems with this program is that we can't really have students in this program who are working to support themselves. We have a student who is doing Work Study and I talked to the people over at the Work Study Program that I think that if the student is doing 10 to 12 hours work study during the week this is not a disaster. But, if a student is really trying to support herself like to the tune of 30 to 35 hours of week of work then I wouldn't advice them to get in it because it would be frustrating and miserable for them in all sorts of ways.

*James Scott*

It is not the cost of the school that kills you, it is the living there that hurts.

Question from the floor:

Are you all residential, by the way?

*James Scott*

Not everybody.

Question from the floor:

What are your post-graduate plans?

*James Scott*

I am really not definite on my plans. I want to go to graduate school, but since I am not far enough along in mathematics yet, and I don't know how well I am going to do later on, I really don't know, yet.

*Comment from the floor*

He looks like he is pretty confident.

*Jacqueline McCaffrey*

He is.

*Efraim Armendariz*

We start talking Ph.D. from the beginning.

*James Scott*

It helps to have someone who is really confident about me because then at least I have a goal. I have something to look forward to.

Question from the floor:

Would you think that it relates to high expectations? I mean they could have done that same program and called it "remedial" - do you think that you would have worked as hard? The fact that they put the nice adjectives on it, "Emerging Scholars Program," honors, etc.; anything with honors and scholars on it made you feel that you were set apart from others so it maybe feels special?

*James Scott*

When we were out socially we never really announced that we were in the program. If someone asked we would say that we were in the program. We were glad to be in and it helped, but it was not something that we really bragged about.

*Question from the floor continued*

I mean, you guys didn't say, "Hey, I am in the Emerging Scholars Program." What if they had called it the Remedial Honors Program?

*James Scott*

I think it would have been a lot lower, yeah. I mean in our regular lecture class last year we couldn't really say it out loud because people hated us because our professor really got into the fact that we were part of the regular lecture and he really pushed the class. He always made it a point to mention us, and then the rest of the class didn't really like that.

# THE PRECOLLEGE PROGRAMS APPROACH FROM FOURTH GRADE TO COLLEGE

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## I. THE NATIONAL CRISIS

Introduction

Today, more than at any other time in the history of the United States, it is evident that if the country is to maintain its scientific and technological competitiveness in the world, it must restructure and increase the scientific and mathematical preparation of children attending its public schools. The future of the nation depends upon the educational preparation of its children. And the future of this nation is being significantly threatened by the diminishing pool of students taking science, engineering, and technology subjects in college. Furthermore, the population group from which most scientists and engineers have been traditionally drawn, namely White males, is a declining element of the total U.S. population and of the workforce that is derived from it. By the year 2000 it is predicted that at least two thirds of the workforce will be composed of minorities.

It is predicted that by the year 2000, 42 percent of all the public school students in the nation will be members of minority groups.

To maintain the current U.S. position in science, engineering, and technology, it is necessary to involve more minorities, particularly Blacks and women, in these occupations. It is no longer a matter of justice, or morality that the nation employ Blacks and women, it is a matter of doing the right thing.

## II. THE PROBLEM

The problem, however, is that while the number of minorities in the public school systems is increasing, the numbers of Blacks and women being prepared for scientific, engineering and technology fields is alarmingly miniscule.

Black Americans who constitute about 12 percent of the population were only about two percent of the employed scientists and engineers.

Forty percent of Black scientists and engineers have fewer than 10 years experience, compared to 31 percent of White scientists and engineers.

Also reported by the NSF, the numbers of new Black scientists and engineers in the pipeline are not that encouraging.

Though Black high school seniors may claim science or engineering as their probable college majors, they are less likely to take as much science and mathematics as White students.

Ten percent of Black college students are earning less than six percent of the college degrees in science, and engineering.

At the graduate level Blacks compose only five percent of the total graduate population and only four percent obtain the M.S. degree and only two percent the Ph.D. in science and engineering.

There is a national need to encourage and increase more minority participation in science and engineering. Unless the pool of minorities becomes more seriously interested in science and engineering, these job opportunities will be taken by other new entrants in the labor force (such as White women).

Recently, I attended a national conference where the theme indicated that tomorrow's engineers are already in the fourth grade. We believe that! Currently we are one of two fourth grade through freshmen in college programs (at least to our knowledge). The other program is at Tennessee State University.

## III. PRECOLLEGE PROGRAM

Any comprehensive strategy for increasing and strengthening the pool of minority high school graduates prepared for college and professional careers in science, engineering and technology must begin early in the student's educational career.

### PROBLEMS THE PRECOLLEGE PROGRAMS HAVE TO ADDRESS

ATTRITION OF STUDENTS - This can be attributed to many factors:

- Poor high school preparation
- Poor study habits
- Few role models/mentors
- A rise in racial conflicts (primarily on white campuses)
- Lack of support structure; e.g. tutorials, advising, etc.
- Lack of confidence
- Lack of knowledge of engineering, science, and technology careers
- Lack of financial support

ELEMENTS OF A SOLUTION - The precollege programs at Florida A&M University have attempted to address these problems by using the so called "Educational Ladder" approach:

THE NINE RUNGS OF THE "EDUCATIONAL LADDER"

1. Early intervention in the public schools to strengthen and improve the students' educational preparation and planning.
2. Summer "bridge" programs
3. Orientation programs
4. Tailored financial aid programs
5. Strong academic assessment programs
6. Tutoring/mentoring services
7. Intensive academic advising services
8. Career and graduate studies guidance services
9. Parent/Teacher/Student career awareness services.

Clearly, if minority students are to succeed in higher education, then every rung of the ladder must be in place.

INADEQUATE HIGH SCHOOL EDUCATION - Our schools, which play a critical role in laying the foundation for future studies in technical areas, are not doing their job. Consider the facts:

- Nearly 30 percent of the nation's high schools offer no courses in physics, 17 percent offer none in chemistry, and 70 percent offer none in earth or space science.
- Even students who have benefitted from coursework in the sciences and mathematics are poorly prepared. In a recent international science achievement survey covering 13 nations, American high school science students placed among the bottom few in all fields surveyed.
- In the U.S., one of four individuals does not finish high school--the dropout rate for Blacks and Hispanics is almost double that for Whites.

The dropouts, the unprepared, and the underprepared seriously limit the pool of individuals available for further study and careers in the sciences and engineering. They also limit their own options and opportunities.

CURRENT HIGH SCHOOL COMPARISON DATA:

- 36 percent fewer Blacks enroll in high school academic/college prep programs
- 19 percent fewer students take algebra I

- 28 percent fewer Blacks take algebra II
- 58 percent fewer take geometry
- 80 percent fewer take trigonometry
- 60 percent fewer take calculus
- 39 percent fewer take chemistry
- 28 percent fewer Black students take three or more years of mathematics
- 3 percent fewer Black students take 3 or more years of science
- 10 percent Black students receive "a's" in core science courses vs. 20 percent White
- 33-40 percent more Black students receive "d" or "f" in core science courses vs. 14-22 percent White students

The International Association for the Evaluation of Educational Achievement recently published "Science Achievement in Seventeen Countries: A Preliminary Report" (Pergamon Press, 1988) which included the following chart:

| Rank Order of Countries for Achievement at Each Level | | | | | |
|---|---|---|---|---|---|
| | 10 yr olds Grade 4/5 | 14 yr olds Grade 8/9 | Grade 12/13 Science Students | | |
| | | | Biology | Chemistry | Physics |
| Australia | 9 | 10 | 9 | 6 | 8 |
| Canada (Eng) | 6 | 4 | 11 | 12 | 11 |
| England | 12 | 11 | 2 | 2 | 2 |
| Finland | 3 | 5 | 7 | 13 | 12 |
| Hong Kong | 13 | 16 | 5 | 1 | 1 |
| Hungary | 5 | 1 | 3 | 5 | 3 |
| Italy | 7 | 11 | 12 | 10 | 13 |
| Japan | 1 | 2 | 10 | 4 | 4 |
| Korea | 1 | 7 | - | - | - |
| Netherlands | - | 3 | - | - | - |
| Norway | 10 | 9 | 6 | 8 | 6 |
| Philippines | 15 | 17 | - | - | - |
| Poland | 11 | 7 | 4 | 7 | 7 |
| Singapore | 13 | 14 | 1 | 3 | 5 |
| Sweden | 4 | 6 | 8 | 9 | 10 |
| Thailand | - | 14 | - | - | - |
| U.S.A. | 8 | 14 | 13 | 11 | 9 |
| Total no. of countries | 15 | 17 | 13 | 13 | 13 |

## FACTORS WHICH SUPPORT THE NEED FOR PRECOLLEGE PROGRAMS TO ATTRACT BLACK STUDENTS TO COLLEGE AND TO ENGINEERING:*

- Interest in science and mathematics begins as early as the fourth grade.

* Life-long learning, public awareness, and precollege preparation will be the area of top concern for engineering education in the 21st Century. Source: PEE Review

- Career decisions are made by youth as early as the seventh grade.
- School systems channel students into tracks as early as the seventh grade.
- A high percentage of Black students are channeled into non-college bound tracks.
- Black high-school students, who are considered "high achievers," are discouraged from attending historically Black colleges and universities.
- Black engineering college students perform better when they enter the university having completed required engineering preparatory courses while in high school as opposed to taking engineering preparatory courses at the college level.
- A major factor in the performance of Black engineering students is strong parental support for education in general and for scientific, mathematical and technical pursuits in particular.

**ESA PROGRAM OBJECTIVES**

| Student Target | Program Duration | Program Objectives |
|---|---|---|
| Elementary School (4th, 5th, 6th) | 25 Saturdays 25 Weekends | 1. To interest students in science, mathematics, and computers<br>2. To alert students and their parents to tracking methods in the Middle Schools.<br>3. To make students aware of the educational background necessary to becoming an engineer.<br>4. To introduce students to the various science and engineering fields.<br>5. To establish a parent network aiding parents to help their children develop a positive attitude toward mathematics. |

# ACADEMIC ENROLLMENT AND ACHIEVEMENT OF ETHNIC MINORITIES IN GEOSCIENCE

**MARILYN J. SUITER**

**Special Programs/Proposals**
**American Geological Institute**
**4220 King Street**
**Alexandria, Virginia 22382-9990**

*At the time of this symposium, Marilyn J. Suiter was directing special programs addressing the underrepresentation of women and minorities in the geosciences with the American Geological Institute. She attended Cheyney University and Franklin and Marshall College, earning her bachelor's degree in geology from the latter. She earned her master's degree in earth science from Wesleyan University while working on projects for the U.S. Geological Survey (USGS). Her experience includes science teaching in the Philadelphia Public Schools, superficial mapping and research in trace element geochemistry for the USGS, and petroleum exploration in the mid-continent of the U.S. Marilyn Suiter is currently national president of the Association for Women Geoscientists, and is a member of the Washington Geological Society, Association for Women in Science, National Earth Science Teachers Association, and other professional societies.*

I believe that geosciences are indeed the parent science in that no other science would exist without the earth sciences. They are all based in the earth. Chemistry deals with earth materials. Physics deals with the energy forces as they effect the earth, at least as we have studied it, and so on. So certainly life sciences are based in the earth and evolved from earth material. So in a sense you can look at geoscience as the beginning and the end. It is where it all starts and where it all comes together. I think we tend to overlook geosciences because we have compartmentalized science into chemistry, biology, physics, and so on. But we could have included everything we do - one of the first things that grade school students are taught is the unit on the weather. I think that most of us had an early experience with putting a lima bean that we soaked in water into soil that was in a little milk cartoon. Certainly that interaction with the soil and the nurturing of that seed is part of earth science. So we really do a lot of earth science, and we have overlooked it a lot. In addition to giving you some statistics about the achievement of ethnic minorities in geoscience, I am going to show you some photographs of minorities doing geoscience, because I think those are two unfamiliar areas to most people - both geosciences and ethnic minorities in science. I am going to show you that there is really something there so you will have some actual images to convince you that this is a reality.

The focus of my talk, however, is on the participation of ethnic minorities in the geosciences. This is part of what I address in terms of special programs at the American Geological Institute (AGI). The American Geological Institute is a federation of 23 organizations representing geologists, geophysicists, and other earth scientists. Basically, most of the major professional organizations in the geosciences are member organizations of AGI. I believe when many people think about geoscientists, they think about people out hammering rocks. These [referring to slides] are two different versions of some of the field instruments which indeed a lot of geoscientists do use in terms of breaking away small sections of rock materials for analysis and examination.

***"It is good to look at enrollment data so that we can see who is coming into the system, but probably what is of most interest in terms of science, engineering, and technology (SET) is how many people are coming out of the system with degrees."***

Some of the American Geological Institute's activities include surveying the geoscience population. We have a massive survey that we did a few years ago, The North American Survey of Geoscientists, which assesses the entire geoscience population. All of us who work with demographic statistics in the geosciences know that it is very rare to find data on that population in that particular science broken down by discipline, by gender, by ethnicity, and that kind of detail. We decided in 1985 that was something that needed to be done for the geosciences. So that is one of the databases.

We have for some years been doing a survey of geoscience student enrollment. That involves writing to each of the geoscience departments in the United States and Canada, of which we know, and asking how many students they have in each of several geoscience disciplines, at what level, and by gender. That started in about 1956. In 1974, under a contract with the U. S. Geological Survey, we started assessing the ethnic minority population as well. The contract and funding for that study ran out in '82 or '83. We have just recently resumed the study and now have new data on the participation of ethnic minority students, broadly, in the geosciences. For a more tailored data pool we have our own particular program, The AGI Minority Participation Program (AGI MPP), which works to increase the participation of minorities in geoscience largely by way of a scholarship program. We have supported over 400 scholars since the program started in 1974. In 1986 we did a survey of that population which is the meat of what I will show you today. We also have some data that I hope is indicative of what is happening across the pool.

First, we consider our student enrollment survey to give you a sense of what student enrollment has been like in the geosciences. We have in the last ten years certainly experienced a fairly steady climb, particularly in the late '70s and early '80s. I think this reflects what we have already heard during this meeting, which is some of the students' selection of career avenues has to do with what they perceive is their employment opportunity.

Geosciences have one dominant industry that is the employing industry - the extractive resource industry which is composed of petroleum extraction and mineral extraction. Of those the predominant one is petroleum extraction. So with the petroleum boom, in terms of the domestic industry in the late 70's and early 80's, we did have responsively an increase in enrollment. When things started dropping out significantly in the middle '80s there was responsively a drop in enrollment. It was a very sharp drop in enrollment. Total enrollment in 1983 was about 47,000. It has dropped down to the mid-20's, and that is a very significant

drop in enrollment. We feel that we have optimism now because in the last two years there has been a plateau at about 24,000. The enrollment in 1988 was only a few percentage points less than in the previous year, so we think we've bottomed out and we are seeing an increase. In fact, when we look particularly at the freshman/sophomore enrollments we do see a significant increase in enrollment. That's questionable because only recently has there been such a strong trend toward declaring your major in the freshman year; usually one declares a major in the sophomore year. So we are not sure that the numbers are accurate. But, it is what we perceive as a trend that we hope will hold.

***"At all levels, but particularly at the Ph.D. level, there is a larger percentage of ethnic minorities receiving degrees in 1988"***

To show you that even more clearly we have the 1987 and 1988 enrollment - at the freshman and sophomore combined level, junior, senior, master's candidate, and Ph.D level. There is indeed a significant increase in the enrollment at the freshman/sophomore level. However, at all other levels and at the Ph.D level there is that decline that is still trailing from previous years.

Question from the floor:

> I understand it dropping off some, but there is an increase there. Is that coming out of junior college?

> We haven't really decided exactly what happened there. Certainly when they are juniors in geoscience, that seems to be a committed group that does go on and complete the program. But, I am not sure what happens between that freshman/sophomore group and the junior year. In this year's data we did particularly try to assess two-year programs. Some of that inflated freshman/sophomore figure may reflect people who are in two-year programs. Secondly, I think kids change majors. In almost every discipline there is an early-on course that seems to separate the weak from the strong. In chemistry it is probably organic; in geology it is probably mineralogy, and that is often a second semester course for students - so that may be another factor for students. The answer is, "I don't know."

I was supposed to say at the outset that this is an initial analysis. We were talking about the fact that it is so difficult to have any real level of surety in these kinds of analyses. This survey that we do is simply a form that we send to departments, and we are not always sure how the geoscience department chairman responds to it. Are they filling out the forms themselves? We get notes back that say things like, "We can't break our data down by gender. We don't know which are the girls and which are the boys." I have trouble with that. "We don't know how many ethnic minorities we have." I have some trouble with that. Some schools are not allowed to release that kind of information. We have a lot of mixtures in the data. This is not something that is finite; I rather think that you would consider this information as trends.

Question from the floor:

How many schools offer geoscience majors?

I am not sure, exactly. We survey 877 departments. Some of those are institutions that have multiple departments. Some of the California universities have geology and geophysics and so they have separate entries. But, that gives you a ballpark sense.

Question from the floor:

That is pretty significant.

I feel very comfortable that this is at least giving us a trend. I am not sure that the absolute numbers are things that you would definitely want to use, but the trends are certainly clear. Looking at ethnic minority enrollment - the last year that we had that kind of data was 1983 and we have the '88 survey - so that is the gap. But in that five-year period, there has been a good increase in the absolute numbers of ethnic minority individuals who are enrolling in the geosciences.

***"Whatever it is that gets ethnic minorities to consider geoscience career options seems to have remained stable over time; therefore, perhaps it has something more to do with attraction to the field as opposed to response to employment."***

In our survey we determined that ethnic minority groups being assessed are Black or Afro-American, Hispanic, Native American (which for us includes America Indian, Samoan, Pacific Islander, and so on), as well as Asians. Whether or not Asians or Asian-Americans are a minority population in geoscience we are not sure. In the general science pool they are overrepresented, so in our scholarship program Asians are not included as one of the underrepresented groups to whom we give scholarships. So I will make that point clear to you when we switch into the information from the minority program. This, again, is the general student body.

It is good to look at enrollment data so that we can see who is coming into the system, but probably what is of most interest in terms of science, engineering, and technology (SET) is how many people are coming out of the system with degrees. When we look at the degrees by level (and, this is for all students for the ten year period of '78 to '88) we again see some interesting patterns in terms of increased degrees awarded until the mid-80's, and then we see a drop. I suspect that the drop is again in response to some things in the oil industry or mineral extraction industries. What is interesting is looking at this peak after that. I think a lot of geoscientists went back to school. That may be what is happening there. I really don't know how to explain this kind of bi-modal distribution through time for geoscience enrollment. This is difficult for me to describe.

Another thing that it may also reflect is the increase in employment in the environmental based geoscience industry, such as hazardous waste and that kind of thing. But, again it is important to establish a trend for the overall student body in degrees awarded so that you can have that to contrast with the distribution of ethnic minorities who have received degrees in geoscience. It is very interesting to note that between 1982 and 1988 there has been a fair drop

in the number of individuals. This is not as dynamic as it appears because we are talking about a fairly small number of individuals. There were approximately 200 degrees awarded to ethnic minorities in 1982 and approximately 175 in 1988. So the drop is not as large as it seems. This is at the baccalaureate level. At the master's level it is nice to see that there is an increase in both master's degrees, and at the Ph.D. level, of doctoral degrees. I think that certainly the decline in the petroleum industry and the scarcity of jobs has encouraged a lot of people to either go back to school or to stay in school for graduate degrees. And, as I will show you in later data for the geosciences the master's degree is pretty much the professional degree. That is different, perhaps, from engineering, where it is the baccalaureate degree, and in chemistry, biology, and physics where it is pretty much the Ph.D.

What is really nice for me to see is the percentage representation of the pool. This is what percentage of ethnic minorities are receiving degrees out of the total pool of students which is predominately majority. At all levels, but particularly at the Ph.D. level, there is a larger percentage of ethnic minorities receiving degrees in 1988. I think that is something that is an interesting indicator. People often say, "Why are there not more ethnic minorities in geoscience?" I think a lot of it has to do with the fact that ethnic minorities really don't experience geoscience very much in their precollege education so they are not exposed to it as a career opportunity. Somehow it seems that over time, although the majority population has dropped significantly, the ethnic minority population enrolling and getting degrees has remained fairly stable. I think that is an interesting point. Whatever it is that gets ethnic minorities to consider geoscience career options seems to have remained stable over time; therefore, perhaps it has something more to do with attraction to the field as opposed to response to employment. I am not sure.

***"There is a large percentage of the kids whom we are not reaching at all."***

In terms of looking at this more closely, we all have been examining these issues of ethnic minorities and degrees in science and technology. An article in U.S. News and World Report in June of '87 focuses on why fewer Blacks are graduating. I think they identify factors that most studies have identified. One is environmental factors. They particularly focus on isolation as reflected in the increasing feeling of alienation that a lot of ethnic minorities have experienced in majority institutions in recent years. Other factors are poor training (something that we have talked about somewhat in this conference) and the lack of money.

In 1971 various scientists in the geoscience industry also realized that there was a scarcity of ethnic minorities in geosciences. They started the Minority Participation Program (MPP), which is largely a scholarship program addressing the issue of not having enough money to go to school. The MPP provides scholarships to undergraduate and graduate students who are Black or Afro-American, Hispanic, and/or Native American (I have already described those groups). Historically the awards have been between $500 and $2,000. The average amount in recent years has been about $1000. They are not renewable in the sense that they are not automatically renewed. However, students simply reapply and the advisory committee usually does give preference to providing continuity in the awards. In recent years there has been a significant concern that a thousand dollars is not very significant for most students. For public universities tuition tends to average around $8,000, so $1,000 is very helpful - $2,000 is wonderful. But, in private schools, such as some of the geoscience power schools, tuition runs $14,000 to $17,000 a year; $500 to a $1,000 covers books and some expenses, but it is not

enough money. So we certainly hope to increase the amounts of awards. I will tell you later how we have managed to do that.

Again, a quick history of the program. The Minority Participation Program began in 1971. They actually got their act together and got something going in '73 and in '74 the first scholarship was awarded with one award to one individual of $1,000.00. That individual has since returned to be a member of the advisory committee and has been a constant support to the program.

Concerning the survey that was done, we looked at basically a demographic assessment of who these people are that we are serving and what happens to them. The total pool is 51 percent Hispanic, 40 percent Black, and 9 percent Native American. When we break the pool by gender it is about 67 percent male, 33 percent female. I find that very interesting that while the male pool reflects the whole pool's racial/ethnic distribution, the female pool does not. Of the male group (which is 67 percent of the entire pool), Hispanics comprise 58 percent, Blacks 35 percent, and Native American 7 percent. Of the female group (33 percent of the entire pool), Blacks predominate at 50 percent, Hispanics comprise 36 percent, and Native Americans follow with 13 percent.

When we look at what sub-disciplines of the geosciences our scholars are in, it is predominately geology and earth science, at about 86 percent. This group again reflects the major demographic trend of the pool, which is 51 percent Hispanic, 40 percent Black, 9 percent Native American. In geophysics, however, it is an interesting shift. It is about 6 percent of the population and it is 50 percent Black, 42 percent Hispanic, 8 percent Native American. Others would include some of the disciplines, such as paleontology, geochemistry, those kinds of things. This group is like the basic geology and earth science group; 54 percent Hispanic, 38 percent Black, 8 percent Native American.

***"I think it really comes out and hits very strongly that in the geosciences the master's degree is what you have to have if you are going to have a job."***

What is probably most exciting and satisfying for me, even though I can take minimal credit for it, is our success story. In our survey we had about a 47 percent return rate (I understand that 25 percent is what you usually expect for that kind of survey). We had that kind of enthusiastic response rate. Out of that response rate over 45 percent of our students have graduate degrees, 51 percent get bachelor's degrees, 42 percent master's, and 4 percent get doctoral degrees. This comprises a 97 percent success rate. I think that is phenomenal for almost any program, particularly for a program that does not necessarily have continuity. The students may enter our scholarship program at any point. They may be graduate students, so we can't take credit necessarily for all of their success, but the fact that we have such success, even with the discontinuous program, I think is noteworthy. The three percent in that other category that is not included in these degrees reflect those individuals who have changed their discipline as well as those, who at the time of the survey, had discontinued their academic career.

Looking at the ethnic distribution at each of those levels we see that the populations pretty much follow that dominant trend of largely Hispanic. What is interesting to me is to note that none of our Native American scholars have gone on to receive doctoral degrees, as far as we know. This would pretty much block them out of academia as a career, as you will see in our other statistics. I am not sure why that happens but I think it is an interesting trend to note, particularly for those who are looking at Native Americans in science. One of the things that

is often problematic, I think, is the fact that for Native Americans western science incorporates a variety of concepts that are very different from Native American spiritual concepts. They tend not to look at some of the things that we measure in terms of energy and solid earth in the same way, but rather to identify them spiritually. So that has caused a conflict, particularly in science education.

Looking at where these people go in terms of their employment we see that the large portion of the scholars go into private industry (which would include the petroleum industry) at about 39 percent. This group, as you might expect from our larger pool, is dominantly Hispanic, 33 percent Black, 7 percent Native American. There is a very large section of our population of Native American scholars who go into government. I suspect that this has a lot to do with, perhaps, a strong trend for American Indians and Native Americans of other groups to take their science and their professions back to their community. A lot of our scholars work for various aspects of the Bureau of Indians Affairs, for instance. And, again you see that there are no Native American scholars, as far as we know, who are in academia. I think it is very interesting to note though that a large portion of our Black scholars opt for teaching in academia. I hope that we can increase that percentage. Michael Howell and I have had an ongoing tug of war. I certainly respect his decisions and I worked in the petroleum industry myself, so I know how much fun it is to work there and have those kinds of resources. But, I think that he would be an excellent academician. But, you can decide when you hear him talk later.

What is the significance here? These are great numbers and I am very pleased with the success of our program. But, we still have a big problem out there and that is one that we have talked about in this conference. There is a large percentage of the kids whom we are not reaching at all. When we look at the participation of our young people in higher education, 18 to 24 years of age, we are looking at less than 30 percent, even for Caucasians. What is happening? The problem seems to be evident - things like the decrease in funding from the federal sector during the last 8 to 10 years. But, certainly there is a significant problem and it has not really improved significantly, either for the Hispanic population or for the Black population; at least there has been an increase in the trend for Caucasians. So, obviously there is a problem.

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*"In Korean schools, even at the elementary level, kids have a separate teacher for each of the different disciplines they study. Someone mentioned yesterday that might be a very good idea, I think, for math and science - similar to physical education and music."*

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This problem is not only limited to the science and technology professions, although, it is certainly crucial for those professions. In the Hudson Institute Report, Workforce 2000, that Dr. Kay mentioned yesterday, basically I think the information that she was citing in the statistics is that increasingly jobs in the future are going to require more education. As we see things right now there certainly is a fair percentage of jobs that are available to people simply with a high school education, but that is going to be decreasing. You are going to need some education, certainly two-year colleges are becoming more popular in preparing technology professionals, and there is an even better opportunity for people who get at least four years of college. This is across the board, not just in science and technology. Certainly, in science and technology more education is required than in most sectors.

In the geosciences, as I mentioned, we are finding that the master's degree is the professional degree. When we look at current employment levels and the kinds of degrees that people have in various areas in geosciences, looking at geologist, geophysicists, and so on, we see that in most areas the master's degrees is the degree of the largest number of participants in that field. When we look at the projected hiring (this was from our Geoscience Employment Survey which we do annually, comparing current employment levels to what geoscience employers expect to do for the next year) we see a stronger need for master's degrees. That is who the employers want. Those were absolute numbers but when we look at these percentages, I think it really comes out and hits very strongly that in the geosciences the master's degree is what you have to have if you are going to have a job. You don't get a master's degree by not completing high school. You don't get a master's degree by not getting into a four-year institution.

For employment in the geosciences, which are becoming ever more important as a sector in our science, engineering, and technology fields, you are going to have to have a master's degree. When I talk to kids in school and they say, "Okay, well you have us thinking about this as an avenue. How much school does it take?" I say, "Well, you are probably going to want to get a master's degree. Five years of school." Then they shudder. There are lots of alternatives. You can work while you do that. You can actually work in the professional sector and have your education supported by employers. But, that is a later stage problem. That is almost at the point where people have been successfully identified. If they are in high school and thinking about that, they have already had some math and science.

Interesting results were obtained from a recent survey by the National Science Foundation of students in Montgomery County, Maryland, a basically middle class community in the Washington, D.C. area. This survey reflects what others have also shown - that math performance in grades one through six can predict who will break through very early and who will be able to do science. The survey found that at grade one everyone starts out pretty much equal. We like to see what percentage of each of these different ethnic groups (Asians, Whites, Hispanics, and Blacks) are performing below level grade by grade.

*"Certainly there are resources that need to be improved. The American Association for the Advancement of Science has a project, Project 2061, which is looking at totally revamping the way we do education, particularly science education."*

When we look at grade one everyone starts out pretty much equal. We try to see what percentage of each of these different ethnic groups: Asians, Whites, Hispanics, and Blacks are performing below level grade by grade. Even by grade two we have a breakdown that has Asians and Whites at the upper end - that is performing close to level, and Blacks and Hispanics performing below level. And, pretty much that trend simply becomes more exaggerated to sixth grade, except that at third grade we have this interesting reversal. Where before third grade Asians were underperforming Whites, by the third grade that reverses. I am not sure why that it, there are a lot of hypotheses about it. However, there is hope and one of the ideas I use to encourage young people is that all the business magazines and all of the economic sectors are saying, "Yes, we are becoming a globally competitive economy. We have to get more people in. There is definitely a need for more jobs. We are willing support you. We are willing to pay the kinds of salaries that are necessary." So it seems it is more of a motivational kind of problem. Certainly there are resources that need to be improved. The American Association for the Advancement of Science has a project, Project 2061, which is

looking at totally revamping the way we do education, particularly science education. But, even with the quality of education that we have now, if we can get more kids in and more kids doing and enjoying science and mathematics, I think that would be a big start.

As I mentioned, I think that the image of ethnic minorities doing science, particularly geoscience, is one that we don't see often enough. I would like to show you some slides from field camps of some schools that do have ethnic minority students. We have heard lots of data that show that more ethnic minorities become involved in science more successfully at traditionally or historically minority institutions. Unfortunately, I know of only four such institutions that have geoscience degree programs, and we have already lost one and are about to lose another. One institution is Howard University which just lost its Geoscience Department. There is also Virginia State in Petersburg which has been a very strong institution. In fact, most of the alumni have formed a national organization called the National Association of Black Geologists and Geophysicists. There is also Hampton University which has a coastal studies program, and Elizabeth City State University.

So unless you have some questions about that data, and I can stop and take a couple of those now if you do, then I will show you some slides of people doing geoscience.

Question from the floor:

Which courses do you recommend for high school students?

I think it is pretty much the same for anyone in science. I am very much a supporter of liberal arts education. I believe in broad bases. I think that any student considering any kind of career in the sciences should certainly take biology, chemistry, and physics. And, earth science if possible. Certainly, take all of the math that is available, including trigonometry and calculus. So pretty much full sweep, and I don't know that there is really any difference for any. If you are going to be a physics major you certainly need to know chemistry and biology. So full spectrum. Also, of course, computer science should be taken because our society is becoming increasing more computerized and communication is important. I have personal affinities for music and the arts and so on, but in terms of this focus, I think those are balancing factors that are different from the crucial elements.

Question from the floor:

There is consideration being given for restructuring the way science is being taught? Where is that being targeted as far as schools are concerned? Is it on the elementary level?

Full spectrum. They have suggested some things that are quite radical, which is really sort of fun to hear. One of the things that they did was they tried to remove the boundaries between the sciences and simply to target what students need to know, and not to say, "You don't need these chemical kinds of theories." So that was one thing and there was a lot of resistance in the advanced science community but it was, I think, a good idea. Another thing that they are looking at is both bringing more parental involvement into school and having students be more involved in the maintenance of their school building, by doing some of the actual physical maintenance of the school facility. There are lots of interesting ideas about the time structure of classes and whether or not kids move around.

In Korean schools, even at the elementary level, kids have a separate teacher for each of the different disciplines they study. Someone mentioned yesterday that might be

a very good idea, I think, for math and science - similar to physical education and music. We don't expect one primary teacher to cover everything at good levels, but rather to have specialists to come into the classroom. So there are a variety of theories. It's initiated by "Educating Americans for the 21st Century," which was a project done a couple of years ago assessing science education. I would be happy to give you contact information so that you can find out more about it. They are at the stage now where they are doing some pilot projects to see what school systems want to do to adapt their education to this particular theory. One is in San Antonio, so they are very much working to try different economic and ethnic balances in the school systems as they test it. I think another is in California, somewhere in the northeast, and there is probably a southeastern one, but I am not sure where it is located.

Any other questions? I am going to show you a few slides of some of the Field Camp Programs. Field Camp is an upper-stage course for geoscience majors which shows them how to use these different pieces of equipment and techniques out in the field. Then I will introduce you to a professional geoscientist.

Elizabeth City State University is located in Elizabeth City, North Carolina, which is in the northeastern corner. It is an Historically Black College and University (HBCU), although it has been recently incorporated into the University of North Carolina system. Sometimes schools have Field Camps local to their actual institution. These kids all load up in a van and go across country to Colorado and Arizona. Obviously, just that traveling experience is wonderful for most of these kids. They get to see a lot of things culturally, they learn some things about getting along together, and they also see wonderful geology. This is the van in which they travel, and part of what they do is camping. A lot of our young people don't do camping any more so it is really nice for them to have this experience.

Part of what people do in Field Camp is getting an understanding of the rocks that we see in the field and how they relate to each other. This means both looking at a particular outcrop or terrain at a distance. It also means looking at it up close and trying to make some determination as to what kind of material you think it is. Is it sandstone? Is it some kind of an igneous rock, such as a volcanic rock, a tuff? There are all kinds of mineral determinations that they make.

Another aspect of Field Camp, I think, is seeing some spectacular scenery. These are the kinds of things that, when I was growing up in Philadelphia, I only saw on westerns like Cimmeron Strip and Gunsmoke - and not in color then. So it is really exciting to see kids from coastal North Carolina out in the middle of the country and in the Rockies, seeing some pretty dynamic kinds of geology and learning how we think, at least at this point, that these things came to be. The next program that I am going to show you is from Hampton University. They have a coastal studies program. They actually examine what happens along the coastline. I like to think that we don't have to have a hurricane like Hugo to understand that our coastlines are important. To understand why you don't build on a barrier island, and what part coastal areas play in our entire earth environment is important. Coming over in the van this morning I heard Mike Howell and Milford Greene talking about various kinds of coastal grasses, and how kids get to have some understanding of the kinds of habitats of different plants as related to their environment and what part they play.

They also get to do in-house studies, so the whole transition of collecting examples out in the field and bringing them into the lab and analyzing them is something that they understand. We tend to separate sectors. We see geologists as either working out in the field or working in the lab, whereas there is actually a kind of transition and more laboratory work.

The third program that I will tell about is from Howard University. A partnership developed between Howard University, the Department of Defense, and Lawrence Livermore

National Laboratory where there is a field program that takes place at the Nevada test site. Right now, especially for those of you here who are Howard University alumni, this is Just Hall on Howard University's campus. It is nice to see that, but this is certainly not in my opinion the prettiest part of Howard's campus. Howard has a beautiful campus with the kinds of old buildings with steeples and those kinds of things that you classically see. I certainly hope that whenever you come to Washington you will include Howard University as part of your looking around town.

Howard University's Geoscience Department has also hosted, in addition to having its own program, the meetings of geoscience societies. One aspect that we don't think about in geoscience is the aspect of engineering geology. We are also involved in the engineering sector in terms of looking at soil - soil stability, soil confidence in terms of buildings.

For those of you who may know him - there haven't been Blacks in geoscience for a real long time - this is Charles Baskerville on this slide. He is an engineering geologist from New York state who now works at the U.S. Geological Survey and is, as far as I know, one of the first of three Blacks known to get degrees in geoscience. He received his degree in the 1960's. Another is Mac Gibson, who is a professor at the University of South Carolina and is a friend, colleague, and associate of Mike's. The third is Dr. Bromerley. He has been Chancellor of the University of Massachusetts at Amherst and is currently President of what is probably the largest geoscience society. He has been a leading figure in our society in many ways - not always related to geoscience or ethnicity.

One of the things that is most exciting to geologists about working in the field is looking at deformation of rocks. Almost all rocks are laid down or deposited flat and when you see this kind of configuration, you see rocks that are essentially folded around. We are talking about rock - something that was deposited flat. You know how brittle rock is, and yet over time this rock was folded around into that kind of a tight horseshoe shape. That is pretty exciting and a way of looking at the dynamism of our earth. When we think of dynamism we think about earthquakes, and we think of simple, brittle failure of fault movement. But sometimes we also see something like this. We need to look at the domains that this kind of deformation takes place within.

Fred Wilson has been one of the major forces within that Lawrence Livermore/Howard University association and this is a photograph of him doing field work in Trinidad. The instrument that he is holding is a Brunton Compass and he is taking the attitude (strike, depth, and direction) of those particular rocks.

I will stop now and introduce you to someone of whom we, at the American Geological Institute, are certainly very proud. He can give you some insights on his activities in geoscience, as well as his activities as a minority scholar. It is fun for me to play mother hen with Mike, although I am certainly not old enough to do so. I am indeed very proud of him, not only because he is one of very few ethnic minorities to achieve a degree in the geosciences, but also because I have found him an extraordinarily well composed professional individual and friend. Mike can give you a little more detail about his background, but he grew up in New York and he will tell you more about that. He attended Cornell University for his undergraduate degree in geoscience, got his master's degree at University of Michigan at Ann Arbor. His Ph.D. is from The University of South Carolina.

# FROM STUDENT TO BLACK GEOSCIENCE PROFESSIONAL: Some Personal Views of a Former AGI Scholar

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*At the time of the symposium, Dr. Michael W. Howell was a Senior Staff Geologist at Mobil Research and Development Corporation's Dallas Research Laboratory. His primary area of research there was the use of stable isotopes of oxygen and carbon in determining the age of ocean sediments and tracking oceanic and climatic changes over geological time. He received his bachelor's degree from Cornell University, his master's degree in geological oceanography from the University of Michigan, and his Ph.D. from the University of South Carolina in 1988. Dr. Howell served as a volunteer in career programs for younger students, encouraging them to consider careers in science and engineering.*

As Marilyn Suiter of the American Geological Institute stated, I am Mike Howell, and I am a former recipient of the scholarships in the American Geological Institute's Minority Participation Program. I am currently employed as a geologist for Mobil Research and Development Corporation in Dallas, Texas. I thought it would be good to start off by giving you a little insight into my background, which, more than anything else, had the most profound impact on my choice of an eventual career path. If somebody were to classify me, I guess it would be appropriate to say that I am basically a second-generation middle class Black. My grandparents are all from the West Indies. They came to this country and reared my parents in the U.S. The people in my parents' generation were raised in kind of a mental state that is commonly associated with many immigrant groups: If you are in America there are a lot of opportunities available, so be sure you always prepare yourself to take advantage of them. As a result, many people in my parents' generation were not only the first of their families to go to college, but many of them also went to graduate and professional school afterwards. So, by the time I came along, it really was not a question of will you go to college or not; it was, simply, where will you go to college and what will you study. While my experience may not have been typical for most Blacks, it certainly was not unique.

The other important thing is that I grew up in a household where any kind of wholesome or good activity was encouraged, regardless of whether these were activities where you could visibly see Blacks making contributions or not. I will give you one good example, aside from what I am doing right now. I grew up, as Marilyn said, in New York City, and if you are a young Black male growing up in New York City and if you live in a Black neighborhood, as I did, if you do not play basketball you should at least have some interest in it, because that is

*the game*. Well, in my particular case I became a passionate ice hockey fan. I do not know why I became an ice hockey fan. Certainly, nobody in my family played ice hockey, let alone knew anything about the sport, and my parents thought it was a little weird. But they said, "Okay, if that is what you want to do, certainly - go right ahead, as long you are getting something out of it." So the point I was trying to make is that, as I said before, I grew up in a situation in which I was not necessarily limited, or suggestions were not made to me such as, "Well, this is something that Blacks really are not doing; maybe you might want to try to get into something that Blacks are doing."

I always had a natural interest in science and, in particular, I was always interested in earth science. My favorite place to go as a kid - for those of you who are from New York - was Coney Island, going to the beach. I could just spend the entire year there running around the sand, going down to the water looking at the rocks. In addition, I was interested in the atmosphere as well as the earth beneath. I always had an interest in earth science, and as a result my parents always made sure I got involved in activities that helped promote that interest, from taking courses at museums on Saturday mornings, to participating in science fairs. I mentioned the fact that there were not any Black role models. It did not really make a difference in my case. In my own experience, over the years, I have run into cases where I may encounter an individual, a young person who says, "Oh, yeah, I would really like to study or would liked to have studied marine science or geology or something like those, but my parents would not let me." Or, "My parents felt that there were not any opportunities for this and, as a result, I wound up studying other things."

***"Some program people have the point of view, 'We're going to give you money, so that means we are great. You are receiving our money, so that means you are great. Now, just have a good career and goodbye!' The AGI program was not like that."***

I have noticed in many cases Blacks who at a young age identify an interest in science, gravitating toward the health professions. I feel that they choose these professions because these are areas where there are visible Black role models who are making very significant positive contributions. In my particular case my father is a medical doctor, and I decided at a young age that I could only be a medical doctor if I could be guaranteed two things: that I would never have to work in a hospital, and I would never have to work with sick people. Since nobody was willing to guarantee me that, I stayed with earth science. As a result, all through my high school training, I went to the Bronx High School of Science in New York City. I just wanted to get as much science as possible. By the time I graduated from high school I knew I wanted to be an earth scientist. In particular, I knew I wanted to be an oceanographer. At that point I also made up my mind, as a result of the programs in which my parents got me involved as a young kid, that I wanted to do research. Already I was looking at my education as being four years of undergraduate work, then a certain amount of graduate work afterwards.

Now, I should clarify something for those of you who might be a little confused. I said that I primarily wanted to be an oceanographer, and I really pursued what would be considered more the traditional oceanography curriculum, at least by the time I reached graduate school. Yet, I am currently employed as a geologist with Mobil Research and Development. The two fields, oceanography and geology, are not mutually exclusive. There is a great deal of overlap between them. I eventually happened to work in the area of oceanography that relates to resolving geological problems. In particular, that area using ocean sediments - either sediments that are currently underwater or sediments which at one time were underwater but now are

exposed - to try to reconstruct past ocean environments and learn something about climate. That is really what my dissertation and master's work involved. So, I hope that I have eliminated any confusion.

The first time that I came into contact with the American Geological Institute's Minority Participation Program (AGIMPP) was when I reached graduate school. I was not aware of it and knew nothing about it. A faculty member happened to see a flier sitting up on a board, and since I was the first graduate student they had in the program they said, "Well, here, maybe you ought to check this out and apply for the money." I said, "Well, sure. I could always use a thousand dollars or so." So that was my first experience with the AGIMPP program. From then on I always managed to be sure to get my application in every year and, as Marilyn said, "Apply for the scholarship money."

I do not think I really need to go into much detail on the money itself and how helpful a thousand dollars or fifteen hundred dollars was every year, even though I had other fellowships and assistantships and all those kinds of things. There are incidentals always popping up out of the woodwork for which the money came in very handy. But, I think something else that was also very important, as far as the program was concerned, was that in addition to giving you money, American Geological Institute (AGI) did other things such as assigning you a mentor. That could be somebody whom you may have never met and did not necessarily have the same background or interest you had in geoscience. Your mentor could be the person you could call if you had a problem you felt you could not get resolved in your own particular department. A mentor could be someone to call on if you felt no one would understand a certain problem because they had never had your experience, or it could just be someone with whom you could talk. In other words, you were not left high and dry. Some program people have the point of view, "We're going to give you money, so that means we are great. You are receiving our money, so that means you are great. Now, just have a good career and goodbye!" The AGI program was not like that. There was this constant sense of that feeling I belonged to some larger group. That feeling relates to the other thing that I felt was very important, on which I will touch in a minute.

***"If an opportunity becomes available - job opportunity, educational opportunity - it can come into AGI and the information can get disseminated in a very efficient manner. It was through such an opportunity that I obtained my current position with Mobil."***

In my particular case I was also doubly blessed in that not only did I have an AGI mentor, but I had one of the people who was fundamental in helping get the MPP program off the ground, Dr. Mac Gibson (who Marilyn has also mentioned to you.) During my third year in the Ph.D. program at the University of South Carolina he became a faculty member there. He had founded the Geology Department at Virginia State, then went to work in industry for a number of years, and came back to academia at South Carolina. So not only did I have somebody I could call, I had somebody who I could just go down the hall to talk to. By the time he came I was getting to a critical point. Throughout most of my career, educationally speaking, I went from a situation where I might have been with a group of Blacks in a class to a situation in which there may be a handful of Blacks in a class, or department. By the time I got to graduate school I was "The Black" in the department. After a while that wears on you. By that time I was starting to say, "Gee, why am I doing this? All of my friends are out making money. I have already been in school for about nine years straight. There has to be something better." Then Mac came along. Although I did not work with him on a professional basis, just his presence there was enough to get me over that hump to finish school and complete my

dissertation. So, mentorship, I think, is very important and is one of the great things about the AGI program.

The other thing I think is important is the fact that having this kind of program helps us establish some kind of network. There are not too many of us in this business, either as students or professionals - we are very scattered. AGI serves in many ways as somewhat of a clearinghouse, a centralizing force. If people are doing something somewhere that may be of interest to me, they call AGI and tell them what they are doing. Somebody, like Marilyn, might say, "Gee, Mike might be interested in that, let me give him a call." I can find out about what other people are doing, and vice versa, they can find out about what I am doing. And, if an opportunity becomes available - job opportunity, educational opportunity - it can come into AGI and the information can get disseminated in a very efficient manner. It was through such an opportunity that I obtained my current position with Mobil. There are a lot of opportunities available, especially for minority geo-scientists, at this particular time. I was not planning on going into industry. I was training myself to be an academician. My objective until about a year before I finished my Ph.D. was to get a post-doc somewhere, and then get a faculty job and do teaching and research at the same time. Because I have always had good teaching evaluations, that was what the director of my program was interested in having me do.

One day I got a phone call saying, "Hello, this is Mobil Oil in New Orleans." And, I was, like, "Oh, my gosh, look, the reason why I haven't used the credit card is ..." Because, what else? I had never sent them a résumé. I had never filled out an application. I did not know a thing about petroleum geology; that was not my area. And they said, "No, no, no. You don't understand. We want you to come work for us this summer." I responded, "Are you sure that you have the right person?" They said, "Yes, we have the right person." They had called up the department and simply asked, "Do you have any minority graduate students?" Then they talked to a couple of other faculty members and they just said to me, "We want to give you a summer job." This was without having met me, or my having sent them a résumé, or anything like that. So I decided I would check it out, and I took the job. I enjoyed the work I did, and I got a job offer from that particular group. I worked as an exploration geologist. If I were to do that kind of work, I should have left school after I completed my master's degree because exploration and producing is the type of work where you need to get on the job and do it. Having a Ph.D. really does not give you all that much of an advantage. However, I said, "But, I could be interested in doing research within the industry." Research at Mobil is an entirely separate division. They have their own headquarters; they do their own hiring, but their attitude was: If you are not going to come work for us, we would like to keep you within Mobil. So they sent my credentials to the research lab. One day later I got a call from the research lab saying, "Come out and give a seminar." I am just using this as an example to show the kind of opportunities that exist when somebody does come along who is qualified and who is an ethnic minority. So I went out and gave a seminar. They offered me a position, and I accepted it. I had three job offers, all from industry. In the department no one else had more than one job offer, and on top of that, there were only three other people who got jobs out of a department of about eighty. I was very fortunate in my experiences. Since I have come to work at Mobil after completing my dissertation, I have really enjoyed my work.

My primary area of research is in what we call "stable isotope geochemistry". To put it in a nutshell, I try to use stable isotopes of oxygen and carbon found in marine sediments to get a better idea of providing information on time - on how old the particular formation or group of sediments may be, and on what kind of conditions existed at the time that these sediments were deposited. This is much the same kind of work that I was doing while I was in graduate school. So I have been able to use my previous experience. Instead of just pushing it all under the rug, I am just building on it. That is really exciting!

I also work in a few other areas, one of which is developing or playing with different types of mathematical analyses to learn about relationships between unrelated or independently generated data sets. This is one thing about geoscience that I have always enjoyed; it is very interdisciplinary. As Marilyn said, to be a good geoscientist you really must have some

knowledge of not only your particular subject area, but of related areas as well. I do just as much chemistry as I do math and as I do physics. I think that is always what attracted me - using all of these different scientific principles to understand natural processes that either are occurring or have occurred. From the professional aspect of things, my work has been very enjoyable.

To retouch on academia: I still pursued a career in academia even after my summer experience, but in my particular case, their interest was not there. I found this to be very unusual, because I was very heavily recruited by industry at a time when jobs were scarce. And, yet, with academia, all kinds of mysterious things would happen when I would apply for the very things people had told me to do, such as, "Oh, when you are ready, be sure to apply to our department because we need Black faculty members," and this kind of thing. As I said, I would send my curriculum vitae in, and all of a sudden it would be, "Oh, wow, gee, somebody was supposed to retire and didn't. We just couldn't find enough money to do this, that, and the other."

I am not going to go too much more into that. But, I think, at least in my personal experience, in certain areas the academic sector is not up to snuff yet. I think part of the reason is that there are not enough of us knocking on the door. They do not have to be up to snuff because the pool of qualified Black or minority applicants for these various positions is very, very small. I think that we have to be concerned about that, otherwise we are going to run into a situation where there are people doing instruction in the geoscience areas who may not be able to influence a young minority student who may just be taking something as a requirement. Such students may have the mindset of many of the kids with whom I work in Dallas. Unless they see somebody of their own skin color or their own racial type doing it, they do not really consider it. So, I think that we have a very big job ahead of us.

As I mentioned yesterday, for those of you who were at the luncheon session, one of the things in which I have been very disappointed is the involvement of professional minorities. (I am going to speak from my particular experience and not try to generalize because I really cannot do that.) Some of these persons do not take the time to get involved with the young people who are working in these kinds of professions, like geoscience, where we just do not have that many Blacks working. If they do nothing else they can keep a high profile and say, "Yes, I am a living example. You can do this kind of work if you are interested in it, and you can be quite successful." I have been involved in several programs in the Dallas area in the year and a half I have been there. I am primarily interested in the students who are particularly interested in doing science. I do not necessarily try to guide them into geoscience, but I try to do things such as bring them to the research lab and show them the types of things that we have been doing. It has been very hard for me to get my other Black professional peers, either in geoscience or in other areas, to come in and do similar kinds of things. So, I think that the programs that many of you represent are wonderful and they are great, but if we do not have the applicants or the people coming along who are going to be prepared to take advantage of them, it is really going to be all for naught.

As I mentioned earlier, right now there are a lot of good opportunities in geoscience. Many times over the course of a few months I will call Marilyn and say, "Look, I just spoke with somebody who has a full four-year fellowship or scholarship for three minority students. Can you get this information out in the network, and do you know somebody who could take advantage of them?" In many cases a lot of this money goes unused. You know how hard it is to get those kinds of funds. You know how hard it is to even retain those kinds of funds if you cannot justify their use. That is something I feel that those of us who have made it as professionals have as a primary obligation. We have to be involved in these kinds of programs, either by working directly obtaining funds, or by working directly in the programs themselves to try to get minorities interested in the various subject areas, including geoscience. Or, we can work to generate the interest among the people who theoretically will be taking advantage of these programs, so that the doors opened will not be closed.

I will just leave it at that and entertain any questions anybody might have.

Comments from Marilyn Suiter:

While you are thinking of questions I will mention a couple of things. One is that because the network is so important we are looking at formalizing our alumni network. We could have, perhaps, regional centers to which our alumni can tie, either to have events at local geoscience meetings, or somehow have a network where they can support each other for job search, go out to schools, and/or do various kinds of grassroots programs that will further this kind of thing.

The other thing I would like to mention is (as I had stated earlier) I was concerned that our scholarships were too small. Fortunately, we were just awarded a grant from the National Science Foundation that will help us to give larger awards to undergraduate ethnic minorities in geoscience. It is quite generous, it is $250,000 a year for three years, and I just hope that we can meet the challenge of finding enough kids to whom we can give these awards. We are looking at, hopefully, $10,000 awards. We have traditionally awarded about 30 scholarships a year, and now we will probably do about 30 undergraduate and 30 graduate awards. But, if you know any young people who may be interested, I think that is a significant award, and I will certainly be relying on all of the network to help us get that money out.

Question from the floor:

What is the size of that group to whom you have given scholarships over the years?

Ms. Suiter's reply:

We have awarded probably somewhere between 450 and 500 individual scholarships over the years - about 30 to 50 individuals per year.

Question from the floor:

And you have interaction with all of those people or follow-up on them?

Ms. Suiter's reply:

Not all of them, but a large sector. As I said, about 47 percent responded to the survey, so we certainly consider ourselves connected with them. With that other percentage they come in and out. You may happen to meet someone somewhere, but, I think we are in contact with at least 50 percent of them.

Question from the floor:

Does that represent your success rate with the people who have gone on and graduated - once they have received a degree?

Ms. Suiter's reply:

Of that 47 percent of the people surveyed, 97 percent had completed. So statistically I think it is safe to assume that 97 percent of our scholars have completed geoscience degrees.

Question from the floor:

Mike had mentioned earlier that he had developed his interest in oceanography through visiting the beach in Coney Island. I was wondering if there might be a structured way to develop those kinds of interest in our young people coming up?

Mr. Howell's reply:

Yes. There are some very structured ways of doing it. I think the main thing is just finding the individuals who would be willing to take it on. Let me give you an example. Right now I work on many aspects with kids at a particular high school in Dallas. One of the things I do is after-school tutoring, but I am also tapping into the network and resources of the people I know to do things. As an example, in a few weeks we are going to go on a field trip and dig for fossils in the Dallas area. While this is something I have initiated, it could be turned into some kind of a formal program if we could just get enough individuals who might be interested in just making the commitment. I think this is exactly the kind of thing that could turn on more people to the subject matter.

Ms. Suiter's reply:

When I was in grade school we went on field trips, and that is very hard to do now because of time and insurance.
Thank you.

# A LEGACY OF SUCCESS

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*Mr. Nelson is a registered Professional Engineer in the State of Texas, receiving a B.S. in 1978 from the Illinois Institute of Technology, majoring in Mechanical Engineering and minoring in Management. He joined the DuPont Corporation immediately upon graduation and has served in many capacities, including supervising an insecticide manufacturing facility, designing a C12 distribution/railcar unloading system, managing a manufacturing information computer system, and leading the site compliance effort for OSHA noise standards. His present assignment is Site Inventory Data Quality Resource/AG Products Mapping Resource.*

*He serves as the DuPont representative to the Gulf Coast Chapter (GCAME) of the National Action Council for Minorities in Engineering (NACME). As a third-degree black belt, he not only instructs at Rice University and the Houston Downtown Studio, but integrates the principles of martial arts training into his work and community service. In 1990 Mr. Nelson won the Cha Yon Ryu Heavyweight Sparring Championship.*

*Another interest is the Ebony Investment Enterprises Investment Club, of which he is the current president. Mr. Nelson is a member of Who's Who International Global Business Leaders. He has written on martial arts topics, including an article describing the use of martial art principles relative to safely handling hazardous materials which served as the basis of a "DuPont World" feature.*

Well, I hope I am doing this right - mechanical engineers are notorious for not being able to do things. I guess I would like to begin by thanking God for allowing me to be here to share my experiences with you, and allowing me to get my voice back. I have been nursing a cold all week; I hope I come across adequately. I would also like to thank CASET for giving me this opportunity, because I think that it has really helped me to crystalize some of my experiences. Just the task of going through my background, and even on the plane yesterday evening writing all of these things down, helped me to understand some of the things I went through and how they helped me to get where I am right now.

It was amazing, listening to Mike Howell's talk, how common our experiences have been and our backgrounds are. One of the things I had felt was that my experiences were not typical, but that at the same time they are typical. I was the product of a middle class environment also, but more from the blue collar side. My father was a milkman, and my mother was a high school graduate who worked as a housewife until the children left. Then she went out and worked for the Chicago Police Department. My mother was very interested in education. I really feel that she was ahead of her time, because she always felt that education was number one, and she made sure that my father provided the framework to allow

her to realize her vision. Out of six kids, four of us are college graduates, all of us have attended college, and all of us are doing pretty well.

I think, before I get any further, I would like to share a couple of stories which might help subsume some of the things that will follow later. I am saying that because when I read Dr. Kay's talk she made me pull out the dictionary to see what the word "subsume" meant. When I saw that it was a way of organizing around a general principle various collections of activities or thoughts, I thought that these two stories I want to share with you might help in understanding how my life and my background got me to where I am now.

The first story I want to share is from an article I read about a martial arts grand master named Jim Reeves. He teaches the martial arts in the Washington, D.C. area. He told a story about one of his instructors who was raised in a negative environment in Washington, D.C. After some trials and tribulations, he earned his Black Belt and became an instructor for the Jim Reeves School. Jim Reeves asked him to speak with some young kids about things they could do to improve their lives. He was horrified, and said, "I can't do that. I have made a lot of mistakes in my life." Jim Reeves said, "Well tell them about that." I thought that was very profound because I believe mistakes can always be looked upon as learning opportunities. I think that when you view mistakes as learning opportunities they will help you piggyback, as well as leapfrog, from those negative experiences to a more positive track. Of course, if you do not learn from those mistakes it could be viewed by some as something different. If we can always look at mistakes as opportunities to learn, and correct the problem, then I think we grow into better human beings. In fact, in our martial arts we have a phrase, "Dojang." Dojang is the created word for martial arts training law implying, "There are no mistakes in the Dojang." You use that mistake as an opportunity to improve yourself. Anything that is done should be viewed as an opportunity to improve yourself.

> ***"The things that set people apart are the things that are over and above that which you learned in school, for example, how you interface with people."***

The second experience that I wanted to share is one of a famous scientist of yesterday. I think all of us are familiar with Sir Isaac Newton, and as you know, he was the co-inventor of the calculus, something around which all of our scientific activities center, for the most part. Also, he was the inventor of classical physics. When he was being recognized for a lot of his achievements he said, "If I have been able to see further than any man, it is simply because I have stood on the shoulders of giants." I think what that means, and it goes back to what Mike said earlier, is that we have to depend on the people before us to achieve. I think that all of the success that anybody has is dramatically dependent upon people before them being able to help them out and let them see over the "madding crowd."

I also wanted to say that I think the challenge we have before us is education. I think that the next challenge is going to be what do we do as minorities after we get into either the academic environment or the corporate environment, or even the military environment, which is as much of an opportunity now as any other. I think that one of the things that we do not have is a strong background - we do not have our own role models in these organizations. We are beginning to have them. There are people like me and Mike and everybody who came to share this with me; for example, Mark Diego, who currently works here at NASA. Mark was working on the Space Shuttle Project, and he is a graduate of Texas A&M University with a master's degree in aeronautical engineering. Recently he was selected to work on the Lunar Colony Project, so I am very excited for him. I am also glad that he was able to make it today. I think that we need role models, and it is a responsibility for all of us to help serve as those.

When I look at the people against whom I compete in the corporate world, the people that I have seen who have really succeeded were, for the most part, people who had fathers or uncles or people like that who were in those same types of positions, from whom they got to learn the tricks of the trade. You know - the things that were really important, like being able to communicate verbally and in writing. I have found that after you have reached a certain level, your technical skills are assumed because everyone else at that level has those skills. The things that set people apart then are the things that are over and above that which you learned in school, for example, how you interface with people. Also, I think, more important is how comfortable the majority feels with you. Do you go to their parties? Do you go and bowl with them? Things like that. If you do not, you tend to get frozen out because I think that anyone who has any type of power is not going to be willing to share with anyone with whom they do not feel comfortable. It is just a fact of life. So I think that it is our responsibility, also, to make ourselves the kind of individuals with whom people would want to interface. It is not always their problem; it is our problem as well.

Dr. Kay shared with you some of my background, which I was glad to have her do, because I felt a little self-conscious about some of it. But I think that some of those things that I was able to accomplish were really a result of my background. I want to share with you more of my family background. On my father's side, some of my forebears took the opportunity to trace our family roots, and we discovered that we were also products of immigrants from Jamaica. We were from the bastard side of one of Lord Admiral Nelson's sons who took a mistress, and she took the Nelson name for her kids. Also on my father's side, on my grandmother's side, I was a descendant of a house slave who was the mistress of the master. She made it a point that her daughter would never learn how to cook because she did not want her daughter to work in the house. So she married a doctor who educated himself.

I missed the opportunity to express my thanks to Mr. Vernon Jarrett, who wrote a beautiful article about my great-aunt a couple of years ago when she passed away. I just wanted to share a couple of things that Mr. Jarrett said about my great-aunt. He said that the tragedy is that so few people had a chance to know her, not to mention adults of all races and creeds who could learn about living from her story. He also went on to say, to quote from her, that a key to her being able to enjoy a meaningful life was her ability to prepare herself to help others because there are so many worse than you. My aunt died at the age of 97 years old, and she still had her driver's license. She insisted up until her last breath in doing things that she felt that she could do. She founded a halfway house for girls in Chicago, back in the late 1940's, which continues to this day. She is considered to be one of the great Black Americans in Chicago. I am proud to be her great-nephew.

On my mother's side we were descended from people in Louisiana. On my grandmother's side we were descended from Jim Bowie's brother in the same kind of story. He took a mistress; they had a baby, who took the Bowie name. Later there was a marriage with the Dawson family. On my grandfather's side we were descended from a Scottish doctor who traveled around and probably had a woman in every port. He married a Creek Indian. It is interesting that in Louisiana, during those times, there were many occasions where women were taken from the tribes, but then later on those women were taken back into the community. So after my great-grandmother was born her mother disappeared one day and was never seen again. My grandfather was only one-quarter Black. His mother was half-White and half-Indian, and his father was half-White and half-Black.

When he moved to Chicago with my grandmother he was mistaken for a White man. In fact, when he worked as a union steward in the stockyards, I think one of the big reasons he was able to get that job was because no one thought he was Black, especially the immigrants who came to America and had never seen a light-skinned Black person before. Of course, there is a negative side to that, also. One of my great-uncles went to the Chicago suburbs and passed as a White man. In fact, he never really communicated with the rest of the family until close to his end when my mother made it a point for all of us to go out and meet him. But, you must consider the two sides to that. It is really an experience of Black America, I think,

where you have something called the light-skinned curse. My mother felt that in a lot of cases her family used that as an opportunity to improve themselves. It was really a plastic type of environment where they depended on what they were and not on what they did. That was one of the things that she admired about my father's family, because my father came from a family of accomplishers. There were people who went to Tuskegee University, which my grandfather attended. My grandmother was a school teacher - things like that. That is another reason my mother found education so important. I think that is one of the reasons she captured my dad.

I think that all of these people with whom I have interfaced, including my minister at the church I attended, and other people in my family, have really left a mark on me. I want to share some of the legacies that I think each of these individuals left to me. From my dad, I think that he left the legacy of family history. That was something that was always important to us - to know our roots, long before *Roots* came out, the book or the movie. My dad was always fascinated with history, and that is something that I still share to this day. I think that it has helped me to gain a world view of what is going on right now. If you think about many of the current affairs we are experiencing right now, and if you take a historical perspective, you can see that a lot of these things originated from tribalism, where people of different areas were looking out for their own self-interest. That has continued to this day, and I will elaborate on it, later.

Next, I think about the work ethic. My dad, as I mentioned, was a milkman. My dad made it a point, about work, from the time I was eight. My younger brother and I would help him on his milk route on Saturday and the holidays. We would have to get up at 4:00 in the morning, for he made his first stop at 6:00 in the morning. He was one of the first Black milkmen - they did that because all of his routes were in the Black neighborhoods. Forty-seventh Street, Sixty-third Street - if you are familiar with Chicago you know that those were the traditional Black areas of the South Side. So, from an early age, I learned how to sweat and be cold at the same time. I think, also, he left the legacy of being able to say what you think is right. My dad has a reputation for being blunt. Hopefully, I have needed some of that in my own experience, but he has always felt that you should not hold yourself back. If you think you are right, say it. Because of that he has been pegged to do and be various things that no one would ever think that he would be able to do. He served as the President of the Parents Association for Metro High School when Metro High School was first formed in Chicago. He also served as the Chairman of the Parents Association at my university for one year. That was unprecedented to have a Black person as the head of the Parents Association at Illinois Institute of Technology (IIT). He did that because he would be at the meetings and would bring up some point. Then eventually people would say, "Why don't you do it, Harry?" "Okay, no problem."

I think, also, he left the legacy of honesty and humility because my father was always known as an "honest man" on his milk route. He always came up with the right calculations, the right rebates, things like that. He was never, ever accused of stealing or trying to make calculations in his interest or stealing money, which was known to happen with some of the bread truck drivers and milkmen.

From my mother, as I mentioned, the legacy of education was one on which she was strong. She felt that, no matter what happened, she wanted her kids to be educated because that was an opportunity that she was not able to realize. She was one of eight children. Her mother was very sickly, so she had to help raise her younger brothers and sisters. It has its advantages, because all of her brothers and sisters adore my mother's kids. She also felt - and I think this is another instance where she was ahead of her time - that there was a need to reinforce the male image. She felt that in grammar school Black kids, in particular, Black male kids, were left out because they had no role models. My sisters complained, "Why do you spend so much time with the boys, Ma?" Let me say here that I have an older brother who my mother considers the experiment, because he was number one, and I have three sisters. Also, I have a brother who is a year and a half younger than I am. My mother spent a lot of time with us. She would take us to the Museum of Science and Industry, the Museum of Natural

History, The Planetarium - which I adore, I always wanted to be an astronomer when I was a kid - the Shedd Aquarium, Brookville Zoo, Lincoln Park Zoo. Every Sunday we always went somewhere. So, that legacy of being exposed to and of not feeling uncomfortable around people of other races is something for which I really thank my mother - she instilled that in us at an early age.

I think, also, she left us the legacy of what she called "kids are innocent". In other words, you have to look out for kids because anything that happens to them is not their fault. She reinforced in us the helping of our nieces and nephews because that is something that she had to do with her brothers and sisters. That is something that my brothers and sisters did because my mother, unfortunately, shared a lot of the same problems that her mother did and ended up dying at an early age. My mother died at the age of 58, four years ago. But, she left that legacy of helping the people behind us. This is something that I feel very strongly about now.

My background is one of my big motivations behind the Gulf Coast Alliance for Minorities in Engineering Program (GCAME) and my involvement in that. I am proud to say that next year DuPont will share in the GCAME organization, here in the Houston area, with me and one of my colleagues acting as the co-chairs. I am really looking forward to that experience. Some of the things that were mentioned earlier about alternative approaches to education I think are also the kinds of things that we can explore. I am looking forward to that challenge.

Mother also left the legacy of internal strength. My mother was not very strong physically. She was in and out of the hospital from my first memories, as well as even before I was born. But, one thing that she always had was an internal strength. She always felt that if she had to do something she would find the way to do it.

I mentioned early exposures. She always took us places so we had the chance to see all of the different things that were going on in the Chicago area. Chicago is a culturally rich area of the country because of all of our museums and zoos and things like that.

From my brothers and sisters I also gained a lot. My oldest brother, as I mentioned, was the experiment. Growing up where I did, in the Princeton Park area of Chicago, was an experience. That was a gang-infested part of the city, as was all of the Black community in Chicago in the 1970s. My brother never joined a gang; my brother never took drugs. He always told us, "You don't have to do that stuff." Because of that, and because of his reputation (he was considered somewhat wild), it helped me not have to go through some of the things that he went through. I was in awe of my brother, because he was nine years older than I. In fact, he even sa[illegible]d me from being robbed once. The day before I started college at IIT I was walking around with all of my Basic Education Opportunity Grant money. Rich, you know - five hundred dollars. I had never seen that much money in my life. I had it in my pockets because I wanted to experience what five hundred dollars felt like. So here I was with a couple of my friends - we are going to go out and celebrate my going to college with my money. We went to the liquor store in the old neighborhood. We had moved by then. My mother had finagled my father into buying us a house by the time I was a sophomore in high school. I was going back to the old neighborhood to share my experiences with my friends.

We went to the liquor store on 95th Street, and as we walked in we saw a group of guys outside. We did not think much of it, but as we were walking out with beer, wine, and stuff like that, I see this group of guys talking with each other. If you grew up in that environment you developed a sixth sense about things that were going on. I felt strange and I said, "Hmm, something is about to happen." As we walked back to my car, one guy came up to me - I recognized him as a guy that grew up on the other end of my block. He came up to me with a little .32 pistol. He held it so that other people could not see what he had. Of course, I could see it, because he was standing in front of me. He said, "Hey, brother, this is a stick-up." Those words are ingrained in my brain, right now. I said, "Oh, man. You don't want to rip me off." He looked at me very closely and he said, "Do I know you?" And, I said, "No, but you know my brother." He said, "Who is your brother?" And, I said, "Terry Nelson." He told his friends, "I can't mess with him," and walked away. And, there I was thinking that I am having to give up $500 - well, $483 by then. It was because of my brother's name that I was able to

get out of that. There is no telling what would have happened otherwise, because I do not think I wanted to give up all of that money. So, as I said, my brother really helped clear the way for us. We were able to enjoy things like telescopes, play chess, and things like that without worrying about being considered sissies.

My older sister took over for my mother. In fact, within my family we say that my older sister is most like my mother. She also had to raise her younger brothers and sisters while her mother was in the hospital. From her I learned how to read. She taught me how to read when I was four. I still have these memories of lying in the bed with her and her going over the words with me. So by the time I got to kindergarten I already knew how to read, I already knew how to count to a hundred, I knew what an infinity was, things like that. In fact, it would blow the teachers away when I would count to a hundred and say infinity. The teachers were saying, "Do you know what infinity means?" I said, "Yeah, it means numbers without end." I just blew them away.

My older sister helped me a lot, and because of that, I was able to skip the second grade. I also had the opportunity to skip the sixth grade, but my parents would not let me because I had a bad stuttering problem. I still consider myself a stutterer, but I think I fake it pretty good now. I was able to take speech therapy from the time I was in first grade through seventh grade. So I learned all about the "bouncing method", you know ba-ba-ba to get the word out, as well as all of the other tricks, like dramatic pauses. You know, when you cannot get the word out, and then it comes. What has helped me a lot, I think, is just being able to speak in front of a crowd like this. When I was a very young child I never thought I would be able to do this. I was one who was more comfortable getting behind a book or going out and playing sports and not having to talk.

From my middle sister I think I learned to accept a burden, as well as common sense. She is the one who, after my mother died, took over the burdens of the family. She took care of my Dad because my Dad was a spoiled brat when he was a kid. My mother spoiled him, too. My sister continued that with her family, and just being the "rock" of the family, I think. I think that I have learned a lot from her because my mother depended on me to be that same figure from the male side. When I graduated from college I had the distinction of earning the most in my family, which I still do, but not by very much. My younger brother is also a mechanical engineer who works for General Mills. I will get to him in a minute. But, because of that my mother was always pegging me, "You know your nephew sure needs a new coat," or, "I sure would like to go and visit your sister." "Okay, Ma. Here is $50 or $100. Whatever you need." But she made me appreciate that. It is almost funny, in a sense, because I could see why she was doing this. I did not mind, because it was the same things that my uncles and aunts did with me.

From my younger sister, I think I learned the legacy of being able to march to the beat of my own drummer. My sister, MaryAnn, never smoked, never drank, did not believe in having a boyfriend until she was a senior in high school. Then she said, "Okay, I guess it is all right now." She is very structured, even to this day. She got her degree in teaching form Chicago State University.

I should back up and say that my oldest sister, Darlene, is a social worker in Norwich, Connecticut, working for the county. She graduated from the University of Denver. MaryAnn is now in real estate and loves it. She has her license, she has sold three houses, and she is enjoying it.

My younger brother Pat and I are very close. To kind of give you some perspective - from the time I was six Pat has been bigger than I am. Pat is now about 6'2" and weighs about 230 pounds. You have to understand that in our neighborhood everything was based on the hierarchy - who your older brother was. How much protection you had was based on how much power your older brother had. I had to look out for my younger brother even though he was bigger than I am. So that developed a lot of competition between us. In fact, he was bigger than everyone else in his class - he was six feet tall by the time he was in fifth grade. If you look at all the pictures in grammar school you see these pictures of little kids, and Pat.

I was always known as the smart one, and Pat was always known as the athlete, and both of us resented those titles. So we always tried to expand our horizons in the other areas, and we have always had this friendly competition between us. That is why he is also a mechanical engineer. He almost makes as much as I do, and I am always looking over my shoulder.

I want to share something else. Dr. Kay had mentioned that I worked as an Area Engineer. My boss called me last night, and that was one of the reasons I was not able to make the dinner. I got a new assignment last night and I am going to work as the Production Supervisor. I will have a lot of responsibility, starting Monday. I am looking forward to that assignment. It was offered as an opportunity which I chose to take.

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*"I would like to say that we have a responsibility to do our best because there are others following us who are depending on us to be role models. How I live my life directly influences my nieces and nephews, the GCAME kids with whom I work, or anybody else who is aware of anything that I have done."*

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I think I will now get to the bone of what I wanted to say, especially since I only have about five minutes left. I wanted to talk about some of the factors behind my achievements, which I think is one of the reasons I was asked to come here today. I think the number one factor is a mentor I had a man by the name of Jay Thomas. He was the coordinator of all of the Minority Affairs at IIT. He helped develop the Blacks and other minorities there into a family, so that we helped each other. I think that, if nothing else, was the big thing that has resulted in the high minority graduation rate at IIT. Before I got there it was dismal. While I was there it was not that much better. In fact, I think the valedictorian of Harlen High School (one the high schools in Chicago) who went to IIT flunked out after his first year at IIT. The reason was that he had never had anything more than geometry in high school. I went to Lindblum High School, and I think that was one of the factors that helped me, because it was a college prep school. I took five years of mathematics, including calculus. I took four years of science, including astronomy at the Planetarium. I think that helped me when I got to IIT. Even though I did not have to take calculus again because I had placed out of it with AP Examination, I decided to take it again. Calculus was used as a "flunk-out class." It was a class in which I was able to excel. I was able to get an *A* in that class. A lot of the other Black kids were flunking or getting *D*'s.

I think the fact that I had to compete with some of the best and brightest students in the country really helped me, because I had to learn how to study. I breezed through grammar school; I breezed through high school, but I found out once I got to college I was not the big fish anymore, but a little fish. There were other people just as smart as I was and everything was based on the curve, so all of us had to do well. I could not depend on getting by as I had earlier when I did not have any competition.

I think the Co-op Program helped me also. I worked as a Co-op engineer and I also worked in summer programs with General Motors. I worked for Union 76 where I received a scholarship, which helped a lot. As Mike Howell mentioned, the money really helps, especially since my parents were not able to spend $4,000 a year to send me to college. The co-oping I did also helped because I was able to defray a lot of my own expenses. I did not have to depend on my parents for anything while I was in college. That was one thing of which I am very proud, that I never had to ask them for a single penny during my four years at IIT. As well as the work experience, I think that once I was in the corporate culture I was able to hit the ground running. I had had the opportunity to learn some of the tricks in project engineering, which has really helped my career.

I have learned the importance of fraternity by joining an interracial fraternity. I learned that White people are no different than Black people - we are all people. That is why I do not like to think of people as different races. I try to think of them more as tribes, because everyone has a cultural base. If you think about it, you cannot pick out any one distinguishing feature that sets one person or one race off from another. Orientals are as bright of skin as Caucasians. You can go to different parts of Africa where there are Pygmies, and you will find light-skinned pygmies with blue eyes. I could keep going on but my time is limited.

I think that by being able to make a good score on the ACT examinations and not having to take English, I was able to concentrate on philosophy. I almost had a minor. I took three classes and got straight *A*'s in each because I really enjoyed them. I think that developed my sense of ethics, which is something that is extremely important in this day and age. I use ethics a lot with my responsibilities as the Chlorine Safety Guardian for my entire department. I am responsible for the state of safety in chlorine handling for our entire department. This includes our plant, a plant we have in West Virginia, another plant in Alabama, as well as a plant in Puerto Rico. So all the things that are related to chlorine I am responsible for, in order to prevent another Bhopal, India, from happening in regards to chlorine. We also handle methoisocyanate, but we are able to do it very safely.

I guess, to sum it up, I think that what IIT taught me more than anything else was the ability to learn how to learn. If you looked at my resumé you would see that I have had a wide variety of assignments. As a mechanical engineer I think that I was in a position to realize those because it has the broadest base of the engineering disciplines, I feel. Right now, my new assignment is going to be one that is traditionally done by chemical engineers. I did not major in chemical engineering but I think that I have had the background to enable me to do the job. I feel good that others thought so, too, and have given me the opportunity.

I would like to summarize by saying what helped me is my family and religious values. I did not say much about my minister, but he is the one who encouraged me to read the Bible. In fact, this is a project that I did as a kid, and I am doing that again. When I was twelve I read the Bible from beginning to end, and now that I am doing it again, I can appreciate the history of the Bible - how the Jewish culture influenced our current culture. Of course, I could go on some more, but I will keep it short.

In conclusion, I would like to say that we have a responsibility to do our best because there are others following us who are depending on us to be role models. How I live my life directly influences my nieces and nephews, the GCAME kids with whom I work, or anybody else who is aware of anything that I have done. I would like to conclude by saying Thank you, and also I would like to thank a couple of my other friends who were able to share this moment with me. They are Elbert Gerron, who is sitting in the back, and John Hamilton, who also works with me and was kind enough to make this video for me so that I could share this experience with my family.

Thank you very much.

# NASA AND DUAL DEGREE PROGRAMS AT MOREHOUSE COLLEGE

**Milford Greene, Ph.D.**

**Morehouse College**
**NASA Sponsored Programs**
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*At the time of the symposium, Dr. Greene was Director of Engineering at Morehouse College. He received his B.S. in Biology from Morehouse College, his Ph.D. in Biology from Wesleyan University, and his M.P.H. in Immunology from Harvard University. He was also Project Director for the Dual Degree Program at Morehouse College which is funded through a grant from the National Aeronautics and Space Administration (NASA).*

Let me say a couple of things as a preface. I think Einstein said, "One of the most incomprehensible things about the world is that it is so comprehensible." It is such a delight to be able to be in the company of so many people who apparently know something about that understanding of the world, and who are willing to share their time and give of their energies to bring this understanding of the world to young people. Especially those of you all along the pipeline. Normally, this morning I would be doing something like running through some carbohydrate metabolism or running through some protein metabolism. As a matter of fact, I said to Ken the other morning, "Let me get some doughnuts here before I start to deaminate myself - start to take off those groups to run that carbohydrate through the acetate cycle and TCA cycle." Today, I get to talk to you about some of our programs. I also want to say that, yes, we want to make sure this young man [Dr. Michael Howell] teaches because I think that we must have him at that interface of education, that cutting edge where the learning process takes place. Also, we must encourage Marilyn Suiter, as well, to just stay in that classroom. I think it is very important that those of us who can teach science get into that classroom and teach those young people. As a matter of fact, I lost a job because, they said, I talk too much. I would not give up teaching although I was an administrator. Fortunately, the college allows me to do that today - I still teach in addition to being able to run my programs. I teach 12 hours of science per semester. It keeps me running, but it keeps me very sharp, and that is the other given. Teaching gives you back so much, because when you have to know it for them, you know it so much better.

At any rate, let me say I really appreciate the anecdotal information we have heard today about people. It is so good to know that there are real human stories behind all of these successes. As a matter of fact, if you look at all that we know about science and history, it is

the moving - the people who move you - behind the significant events that have occurred in science. Yes, we should all maintain that sense of history and cherish it.

I do not need to sing the praises of Morehouse College. I hope not - for it is certainly one of the Historically Black Colleges and Universities (HBCUs) which has had many successes over the years of its existence. Morehouse is one of four colleges in Georgia that have chapters of Phi Beta Kappa. It is one of, I think, three Historically Black Institutions that have Phi Beta Kappa chapters. One out of every nineteen Black Ph.D.'s in this country has earned his or her bachelor's degree at Morehouse College. About one out of ten Black M.D.'s in this country has attended Morehouse College. We have had a significant number of college presidents who have attended Morehouse College. So, Morehouse has certainly been in the mainstream of education in this country for a very long time. In the Atlanta University Center (AUC or AU Center), just by way of some background, there are about six entities in terms of colleges and universities. Morehouse is one of them, and is the all-men school. Spelman College is all-women. I should make that distinction - "all women" and "all men," not just "males" and "females," because that could be anything. These are men and women. Clark Atlanta University which combined two of the old institutions in the Center - Clark College and Atlanta University - consolidated their resources most recently and are still undergoing that consolidation. Atlanta University is a graduate entity, and only offers graduate degrees in the Arts and Sciences and in some special areas like Library Science, Social Work, and other areas like that. Morris Brown College is one of the coeducational colleges as well. And, more recently, since 1975, we have had the Morehouse School of Medicine with which, fortunately, I have had a long association, almost since its beginning. Those institutions form the Atlanta University Center.

*"About one out of ten Black M.D's in this country has attended Morehouse College. We have had a significant number of college presidents who have attended Morehouse College."*

About 1969 there was an effort to enable students in the liberal arts to study in the technical areas. I think that this is the whole point I want to make this morning: that in the Atlanta University Center we have a group of liberal arts colleges. We do not really have technical areas in the sense of engineering, but there was a need, of course, to be able to bring to that Center the students who wanted to study in those areas and provide them with such an opportunity. Now, dual degree programs, about which I am going to talk a little, are not really new. But the one in the Atlanta University Center is certainly one of the oldest, one of the largest, the most unique in the country. It brings together the four undergraduate colleges in the AU Center and four other technical schools throughout the country - Boston University, in Boston, of course; Rochester Institute of Technology, in Rochester, New York; Auburn University in Alabama; and, of course, the institution which was the original institution with Morehouse in this arrangement, Georgia Institute of Technology (Georgia Tech). Yesterday, when Dean Wayne Perry of Prairie View A & M University was giving you some statistics, you may have noticed that Georgia Tech was high among those colleges awarding degrees to minority students. Now, I will tell you right off the bat the reason for that is because of the dual degree program in the Atlanta University Center which is a three-two [three years at one institution, two years at another] program. We have provided Georgia Tech with some of their best students who continued and graduated. Roughly 50 students per year are being graduated from Georgia Tech. I think in the year before last there were about 68. Of those 68 or so people who graduated in that class, 30 were from the Atlanta University Center. So the AU Center represented almost half the students who were graduated that year. So, Georgia Tech,

while looking very good, really looks good at the expense of the Atlanta University Center institutions. I think that point should be made.

Morehouse, which is where I find myself now in the Center, is responsible for roughly 50 percent of those students who go on to earn those degrees. In fact, over half the students in the Atlanta University Center are Morehouse students, and we have roughly 600 students in the program now. There are 326 of those students who are at Morehouse College, about half as many at Spelman, and about an eighth of that number each at Clark Atlanta University and Morris Brown College. The program is advertized as a three-two program. Mind you, these people are earning two degrees, not just one degree. They are earning a bachelor's degree from one of the AUC colleges, in addition to a bachelor of science degree in one of the engineering disciplines from one of the four universities. Although it is advertised as a three-two program, I am sure you engineers know that for the most part those people are not about to get out in five years. More often than not it is more like six years. One might ask, "Why two degrees - bachelor's degrees?" Well, we would like to think we are educating a very different kind of engineer, and that is not to say there is anything wrong with the engineer being educated today in most of the technical institutions. We think we are educating an engineer who will have important sensitivities - more training in the social sciences, more training in the humanities, and in other areas where engineers normally do not get quite as much training. So, in addition to being able to know something about L.L. Cool, J. Miles Davis, and John Coltrain, they will also know something about Hayden, Mozart, Bach, and many of those other people. I am not saying that engineers do not get that training somewhere, but we make sure that they get it in these kinds of programs.

There are two options in this program for students. One is a very tough option; the other is not as tough. A student can earn a bachelor's degree at the college with no major, simply a general science degree. All he or she has to do is complete the general studies requirements - all of the social sciences, humanities, etc. - along with the pre-engineering requirements, then go on to the technical school to complete the engineering degree. Secondly, a student can also earn a bachelor's degree with a major. That is a tougher option to take. That major can be in anything from French to religion, physics, math, or computer science. In most cases those who opt to major in an area do it in one of the sciences, like physics or mathematics.

***"The interesting thing about the Center's three-two Program for all of the colleges is that it is, for the most part, totally supported by corporate contributions with in-kind support from the colleges."***

The other thing I think is important to say is that this is an open admissions policy, in a sense. It is not open admissions, but it is open admissions to engineering. Most of the students who come into this program do not come in at the level of the calculus course. This means they would probably never get into most engineering colleges. They do not really do a lot of remedial work in engineering colleges. But, here, students without the level of preparedness that would bring them in at calculus can enter, even take basic mathematics before pre-calculus, and earn enough credits get through this program. Mind you, it will be long and tough to do it that way, but one can do it, nonetheless. This means it is an opportunity program, whereas I do not think you can look at most technical institutions and say that they have an opportunity program. It is an opportunity, but not an opportunity program. We are beginning now, of course, to see students who are coming in with that level of preparedness. As a matter of fact, in the most recent issue of *Black Issues in Higher Education* - I do not know if many of you have seen this publication that comes out of Virginia - there is

an article by Jacqueline Conciatore, and she quotes me among some other people about dual degree programs. The point being made in this article is that many of these students who are well-trained and come with high SAT scores are now still selecting Historically Black Colleges. They are coming back to those kinds of schools. There was a time when they were all running from those schools and mostly enrolling in the majority institutions. But, many of them are coming back for a number of reasons - environment, in some cases, and others just want to have that training in Historically Black Colleges. Certainly, the three-two program that we are talking about provides that. It gives training in two different worlds, in a sense. Students are earning those credentials in the social world of Blacks, and they also get in the White world where they are more than likely going to work. So, they get that training in both areas.

The components of the program are simply: recruitment; scholarships; tutorial and counseling programs; instruction, of course (i.e. the curriculum itself); internship programs; job fairs held at the colleges; and a culminating major awards banquet. This is good. Each year we have a big banquet. Roughly, we have about 500 people at the banquet, and it creates the kind of environment Vernon Jarrett was talking about where one focuses attention on these students and looks at the achievements they have made. I think this is the kind of incentive we must continue to create - the giving of awards and the coupling of those awards with monetary rewards as well. This banquet is really one of the very big things that happens each year in connection with the three-two Program.

Students can study in virtually any area because of the range of institutions with which we are working. As a matter of fact, we are now negotiating with Dartmouth University for a program with them. There are several other institutions - University of Southern California, Pennsylvania State, and others contemplating having arrangements with us. For instance, I have just completed putting together a package for a dual degree program in architecture with the University of Michigan, and we will probably do the same with Georgia Tech in the not-too-distant future.

***"Giving those programs during the summer that encourage young people to study in these technical areas, such as engineering, is another way to increase the yield of people from the pipeline and also a way to increase the number who are interested."***

The interesting thing about the Center's three-two Program for all of the colleges is that it is, for the most part, totally supported by corporate contributions with in-kind support from the colleges. The list of corporate companies is really quite long, but I shall mention a few. One of our major contributors is American Telephone and Telegraph (AT&T). Others are Digital Corporation and Xerox. Several others make much smaller contributions. Most of the corporate support is in the form of scholarships, so that we are giving on the order of - in this program alone - some $500,000 a year in support provided by corporate America. There are also other kinds of support from corporate America - many of them we have mentioned here and I will not go over them again. The faculty Executive Loan Programs are very helpful. These people are generally a little further along in their careers. They join us at that interface of the teaching/learning process. Many of them, as someone pointed out, opt to stay on with us as regular faculty. We have a couple of people who will be coming from AT&T in the very near future. International Business Machines (IBM) has also had a very big Executive Loan Program with us over the years.

Let me say, briefly, something about our science faculty. Because of its long tradition in the sciences in general, Morehouse College has had a very good faculty in the sciences. Ninety percent of the biology members of the faculty hold Ph.D.'s.; all five psychologists have

Ph.D.'s; the six faculty chemists hold Ph.D.'s; of the four physicists, three have Ph.D.'s.; and 70 percent of the ten-member mathematics faculty hold Ph.D.'s. These are all full-time people. We have a number of part-time faculty as well. (I want to add parenthetically, most, if not all, of these individuals are Black Americans, several of whom earned their undergraduate degrees at Morehouse. In fact, each one of our departments - computer science, physics, biology, math, engineering - all have faculty who earned their bachelor's degrees at Morehouse College. There are two ways to look at that. A little bit too much in-breeding, maybe, but then, on the other hand we just have a strong pool of alumni from whom to draw.)

The enrollment is significant and should be mentioned. In biology, we have 264 students; 180 in psychology; 58 in chemistry; 54 in physics. We have only 44 in math, and I think that is because there is so much overlap with them in other departments. Engineering, interestingly enough, has 326. If we look at the recent trends in education we will see that in 1976 there were about 25,000 bachelor's degrees awarded to Black males; in 1984 we are talking about 23,000, a decline of about 10.2%. Michael Hershorn has done some studies recently that indicate that in the research world we only earned about 321 research doctorates in 1986 compared to 684 in 1977, so there is a tremendous decline. I have not even calculated that percentage. The decline is about 25 in the physical sciences; about 64 in the life sciences - a drop of 27% in the last decade. The point I am making here is that we now have a program, the NASA Program which has come into being. Dr. Joseph D. Atkinson, Jr., of the Johnson Space Center mentioned a 6.5 million dollar program over about eight years. This program is really a scholarship program which will enable us to bring in 20 students each year over the next five years, giving them full scholarship - tuition, room, board, books, you name it - everything is paid for them. In addition, the program features a summer component as a major element. Before the freshman year there is a pre-engineering program or a pre-freshman program. In the summers we take them to visit the various NASA facilities where they will be engaged in research with a research team. The bottom line is to give them a real introduction to research in the summers while they are in college, and hopefully we will be able to get a significant core of these people to continue on to earn Ph.D.'s. These are some very talented young people. If you look at their profiles they have better than 1200 on their SATs. As a group they have 3.5 or better GPAs. They come from all over the country. We have some who scored a perfect 800 on their math SAT, and several over 700. In fact, we have one student in the program mentioned yesterday who is from Houston. He will be coming here, hopefully, this summer, to work at Johnson Space Center (JSC).

Let me just wind up by saying: Since the beginning of this program in the Center we have educated roughly 250 scientists, engineers in particular. That does not look like a lot of people since 1969, but it is a model by which we can begin to educate students in nontechnical environments - giving them technical degrees in nontechnical environments. Giving those programs during the summer that encourage young people to study in these technical areas, such as engineering, is another way to increase the yield of people from the pipeline and also a way to increase the number who are interested.

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# THE LAWRENCE LIVERMORE NATIONAL LABORATORY LESSON SCIENCE PROGRAM

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What I am going to talk mainly about is the LESSON program (The Lawrence Livermore National Laboratory LESSON Science Program) which is sponsored by the Lawrence Livermore National Laboratory. Primarily the program evolved out of a perception on the part of some Lawrence Livermore scientists and engineers that children, especially minorities, were not receiving enough science education. Of course, the reason why a place like Lawrence Livermore would be concerned about that is because, as a scientific research institution, we have to be concerned about having a pool of scientists and engineers to replace those people who get older and retire. We must have people to come in and fill those positions. Let me say first of all the LESSON program is about 20 years old. It started in the late 60's. Initially the approach was that scientists and engineers visited schools, particularly in areas where there was a heavy minority enrollment such as Oakland, California, and did science activities and taught science lessons to the children. In 1974 it was decided that more children could be reached if, instead of teaching the students, the scientist could gather together the teachers and teach them how to teach science, and then they could take it back to their schools. So from 1974 to now that is the way that we do it. We have a summer LESSON program held in the Oakland area. We gather together about 35 to 40 teachers in each of these sessions and teach them how to teach science.

We cover primarily the four fundamental areas of science, which are physics, electricity and magnetism, chemistry, and biology. Scientists and engineers go to the workshops and teach these lessons. Then, in addition, we remain available during the school year to assist the teachers in whatever way they need. If they want a scientist role model to come into the classroom to do a lesson with the students or to talk about career issues or academic preparation, then we do that.

I guess I didn't say that the LESSON program is geared primarily toward grades K-6th, with some at the junior high school level. The feeling is that there is a need to spark an interest in the sciences at those earlier grade levels. Because, by the time the kids reach high school often it is already too late to get them interested, and they have already fallen behind in math and science. So if you can spark an interest in the early years, then you are much further along in the game.

The workshop that we do in Oakland is completely funded by the Lawrence Livermore Laboratory. In addition to the summer workshop that we do every year in Oakland, we have done workshops in other parts of the country. This summer I went to Benedict College where they included the LESSON program as a part of a larger teacher training program that was funded by the National Science Foundation.

Last summer I had the opportunity to go to the Virgin Islands to do a Lesson Workshop - we did a dual workshop on St. Thomas and St. Croix. In other years we have gone to places like New Mexico. There are LESSON Workshops that take place on the Indian Reservations in Arizona, and usually those require some funding in addition to what the lab is able to provide. Our mainstay is the one we do in Oakland, California. The others require that people have to provide some funding of their own, and then Lawrence Livermore will chip in with some of the funding.

What happens in the LESSON program is that each teacher is provided with a kit for each of the four disciplines and a LESSON manual. I have a copy of a LESSON manual back there on the desk. I brought it with me just in case someone wanted to look through it and get a closer look at what it was about. A lesson contains a tota. They can take it also for no credit and no charge.

The physics section contains units on specific areas and there are 17 units in the physics section. Electricity and magnetism contain six units. The section that I coordinate is the chemistry section and those are the units that we do in chemistry. Let me say that we don't actually do every single one of these in the workshop. In the beginning we did and it was a four week workshop. Many of the teachers complained that it was too. They can take it also for no credit and no charge.

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The LESSON manual provides the teacher with lesson plans and background information - all that they need in order to teach the concepts. This is an example of a lesson out of the chemistry section on acids and bases. In the beginning it gives the purpose of the lesson, what materials are needed to do all of the activities in the lesson, and safety precautions. We have a discussion of the chemicals involved. There are illustrations that give the teacher probably

more information than she needs to have for, say a kindergarten class, but enough that the teacher is comfortable going into the classroom to teach these activities. Then, again, more definitions and background information.

The reason that I chose this particular lesson is because I did bring a demonstration to do here today. I want to demonstrate the simplicity of the materials that we use. We try to do things that are hands-on, that are visual, that are eye-catching, and that will make science interesting to children.

The particular experiment that I have set up to do is an experiment for showing neutralization with acids and bases. Has everybody seen red cabbage? What we do is take red cabbage leaves and put them in hot, hot water and soak them until we get the dye out. We get out of that an indicator. Then we take a small amount of that indicator and put it in water. I didn't bring water from California. This is Texas water. Hopefully it will still work. Then for the acid we use lemon juice. It looks like the water here is very basic. When I did it with my tap water at home it turned blue. You notice that these are not the same color now. Then for the base I just use household ammonia. You notice that I don't have fancy flasks. I have just regular jars and stuff. I also did that so that I don't have to take it back, I can just throw these away.

Question from the floor:

Do you get into equal numbers of this and that, as well as equivalents of units?

There is one experiment that we do (we don't actually do it in class, well we have tried it in class) with things like Rolaids and anti-acids that goes along with this lesson. We use the indicator (the cabbage juice), or one of the other indicators that we provide in the kit and we have the students see how much acid it takes to neutralize the Alka Seltzer or Rolaids and which one consumes more acids. They had a commercial on television showing that Rolaids consumes twice as much acid or something like that. Well, we do that as an experiment in the class. The way we do it is very quick and dirty. Just have the students count the drops of acid that you add before the color of the indicator changes. So that way we are relating it to something practical and everyday.

Comment from the floor:

So you are challenging proof in advertising to an extent!

Question from the floor:

How do teachers get information on how to get involved in your program?

At the beginning of the calendar year we send out flyers to all of the school districts letting them know there will be a LESSON program, and include applications for them to apply for the program. In the last few years we have been getting more applicants than we can handle. We like to keep the classes to about 35 students. Usually we end up with about 60 or 70 applicants, thus we have to turn down almost half of them.

Question from the floor:

What kind of response are you getting from the teachers who have gone through your program? Do you get any feedback in terms of how it works once they get back to the classroom?

At the beginning of the class we usually go through the class and do a verbal survey of how people feel about teaching science and what they feel about physics and biology, etc. We usually get a lot of, "I am very nervous about it; I don't understand it." Then, usually, after the class the responses are more positive. They indicate that they like it and they feel more comfortable about teaching it. We have had several of the teachers during the school year who, after going through the LESSON program, ask one of the scientists or engineers to come out to the classroom and work with them, or to do a particular lesson. About three or four years ago Sandra McQuire from Alabama A&M University came out and worked with us on a LESSON program, and then took it back to the Huntsville area. Before the teachers took the workshop, she gave them an examination in each of these different areas to see how much they already understood. Then, after taking the LESSON class, she gave them the examination again to see how their scores compared, before and after. There was a significant increase in their ability to answer the questions. Now in the Oakland workshop we do give an exam in each discipline after the workshop is over, to see how well the teachers understood the concepts. I don't know about the others, but everybody in chemistry always gets an A.

Question from Marilyn Suiter:

I have two questions. One, you said that this is a 20-year old program; has it been updated?

Updated? It has pretty much been done the same way for the last 20 years, except the switch over from doing it with the students to doing a teacher workshop. We've revised the manual a few times. That is one of the first manuals. It has been slightly revised but we have not changed many things. It is basically the same.

Question from Marilyn Suiter:

The other question. You saw my presentation in geoscience and you know that I would obviously ask, is there a particular reason for the exclusion of geoscience?

It is not really excluded. It is in there.

Question from the Marilyn Suiter:

Is it included in the way that it usually is, which is as other things are included? What I was thinking is not so much that you might want to add a unit on geoscience which, of course, I would think ideal, but rather add elements to each of the units that would focus on it. Physics is broken down from physics to electricity and magnetism which is not always done.

Well, there are units in physics on geoscience. There is a unit in chemistry on weather and one that is not really geoscience, one on water purification. What we try to do is deal with the basic fundamental four areas of science and try to show how they relate to everyday life.

Question from the floor:

Has this LESSON science program had a major impact on the curriculum in the school districts?

In some school districts, I think. The LESSON workshop is held in a middle school in Oakland and we've gotten feedback from them that their academic achievement in those areas has gone up significantly. That particular middle school really does quite a bit in the area of teaching science to their students. They do a yearly science fair in which all of the students are required to participate.

Question from the floor:

I was just wondering how it interacted with the established curriculum?

I don't know if there have been any curriculum changes directly influenced by the LESSON workshop.

Question from the floor:

My McNair Scholar who scored a perfect score came out of the Oakland area. What I would like to know is how do you change these things over the period of time?

It really hasn't changed very much.

Question from the floor:

Who puts this together?

It was put together by the initial group of scientists and engineers that conceived the concept of LESSON. They all contributed various chapters.

Question from the floor:

Can one get a copy of this?

It is possible, yes.

Question from the floor:

I think that it is really worthwhile.

Are you interested in getting a copy? Okay.

Comment from the floor:

I would like to bring you back to something I believe that Marilyn Suiter may have been leading toward, and again Milford Greene. It seems to me that you have a really good model or a good program going. I would like to know if the individuals involved at Lawrence Livermore are considering, or perhaps you might think about, expanding this type of lesson plan into various stages. You could actually teach science and physics and the like, and I suppose at some point teachers involved in that program do. I know, at least on the East Coast, teachers are always concerned with taking courses for credit and promoting their education. This can go from one level all the way up to an advanced level, where ultimately you might think that some of the teachers could become specialists, as Dr. King indicated yesterday, if none other than in one particular area.

Comment from the floor:

That is another thing about the update. I mean there are some very basic things that people did in 1940 in science demonstrations that still work and are excellent. On the other hand, there are some new technologies and some new things that might be equally fun to incorporate.

When I go out to classrooms there are some other things that I do. Most of the other things I could do are things that require fancy chemicals and other materials that teachers have trouble getting. I do an experiment where the material is a chemiluminescence and when you pour together two chemicals, it lights up. The kids just love it but the teachers can't get the materials.

Question from the floor:

Two quick questions. Are you planning to expand this? I mean 60 teachers a summer is great. I am excited about your program and I think it should be duplicated in a lot of areas. When you can reaffirm learning to a kid and make it fun for him/her, this is something that keeps them from saying, "Oh, science. I don't want to even deal with it." The second question is: how much does it cost for a teacher to go to your program?

It doesn't cost the teacher anything. Yes, there has been a proposal put forth to expand LESSON to other parts of the country. A proposal has been put forth to do a grand LESSON program and expand it all over the country. Whether or not that gets done depends on whether or not the program gets funded. The funding request is being made to Lawrence Livermore Laboratory to fund a major LESSON program that we could take across the country.

Question from the floor:

Where does the funding come from?

Some of the funding for the LESSON program comes from our in-house Historically Black Colleges and Universities (HBCU) program. That is what funded part of our program when we went to the Virgin Islands, in addition to Virgin Island funding from their Department of Education.

Question from the floor:

What was the cost?

To do a workshop out of the Bay Area, including travel cost, the cost of kits and manuals, and everything is about $50,000.00. This includes travel for the instructors and everything.

Question from the floor:

That is for a summer workshop?

For a summer workshop away from site.

Question from the floor:

How long does it take them to go through this whole thing?

We do a two and one-half week workshop. To do the complete manual, every lesson in the manual, takes four weeks. That is initially what we did. We do an evaluation every summer after the end of the program and ask teachers what they liked about it and what they didn't like. When we were doing the four week program everybody complained that it was too long. So we cut back and cut out a few of the lessons. Chemistry has about ten lessons and I think we only do about seven of them.

Comment from the floor:

I just wanted to suggest that one other source you might consider is industry, because for each of the three areas that you mentioned there is a corporation or a group of corporations that have a strong interest in those areas. In the area of science, electricity and magnetism IBM would be a natural. Dow Chemical should be interested in chemistry. Consider the pharmaceutical companies for the life sciences, as well as the oil companies for earth sciences. What you might consider are some of the newer experiments, like superconductivity, which are very easily done now. Consider computers, which I think is a skill in which our up and coming generation needs to have a strong emphasis. So I just throw that out as a suggestion.

# PROCEEDINGS OF THE WOMEN IN SCIENCE, ENGINEERING, AND TECHNOLOGY SYMPOSIUM

October 14-17, 1990

# WOMEN IN SCIENCE, ENGINEERING, AND TECHNOLOGY

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## WELCOME FROM JOHNSON SPACE CENTER DIRECTOR, AARON COHEN

*Welcome to the First Women's Symposium on Science, Engineering, and Technology that is being cosponsored by the NASA Johnson Space Center (JSC) Federal Women's Program and the Center for the Advancement of Science, Engineering, and Technology (CASET). This symposium will address issues and answer questions relating to the underrepresented status of women in the quantitative fields of science, engineering, and technology. I am excited that we have been able to bring together such a cadre of "experts" from across the United States to address the needs of women in becoming a part of the future development of our nation through their participation in these career fields. Future workforce projections reveal that women will become an even more valuable resource in the years to come, and it is up to us to ensure that we have a pool of qualified applicants from which to recruit and hire.*

*The Johnson Space Center has taken great strides over the past years to increase our representation of women. Currently, women represent 32 percent of our total workforce and 17 percent of the total scientists and engineers at JSC. I am also proud of the fact that we now have 13 women astronauts, with 5 more currently in training as astronaut candidates.*

*I hope your discussions of new and innovative methods that have aided in the matriculation of women from all ethnic groups into the fields of science, engineering, and technology will provide JSC with useful information which will assist us in the further recruitment and retention of outstanding women professionals.*

## WELCOME FROM HUSTON-TILLOTSON COLLEGE CHANCELLOR AND PRESIDENT EMERITUS, CASET DIRECTOR AND CHAIR, DR. JOHN Q. TAYLOR KING

*I would like to welcome most cordially, all of you in attendance for the Women's Symposium on Science, Engineering, and Technology co-sponsored by the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tillotson College and the NASA/Johnson Space Center (JSC) EO Office.*

*The underrepresentation of women in the fields of science, engineering, and technology (SET) is a problem not only for the technical community, but it is a problem that must be addressed by the entire nation. If we are to remain as the scientific and technological leader of the world, then industry, education, and the political leadership of this country will have to make the inclusion of women and minorities into the pool of SET professionals an urgent priority.*

*This Symposium is part of a team effort by both CASET and the NASA/Johnson Space Center EO Office to address the current issues affecting the status of women and minorities in the U.S. pool of scientist, engineers, and technologists. both members of the team are committed to addressing this problem positively.*

*On behalf of CASET, I am pleased to take this opportunity to thank all of our guest for their participation, and to commend the NASA/JSC EO Office for its continued support of the efforts of CASET and its programs.*

*I wish for all of you a most productive and enjoyable experience here!*

## WELCOME FROM JOHNSON SPACE CENTER DIRECTOR OF EQUAL OPPORTUNITY PROGRAMS OFFICE, DR. JOSEPH D. ATKINSON, JR.

*As Director of Equal Opportunity Programs, I have served on the Astronaut Selection Board since 1978. During that time, women have become an integral part of the astronaut core. Although other women were selected in 1978, and thereafter, they all were mission specialists. On January 17, 1990, NASA proudly announced the selection of Air Force Major Eileen M. Collins, the first woman pilot Astronaut candidate. This came 30 years after the selection of the first seven Mercury Astronauts in 1959, all of whom were male military test pilots.*

*To be selected for the pilot category, NASA requires that candidates be experimental jet test pilots and have a degree in engineering or science. Until recently, no woman applicant met these basic qualifications. The most likely place to get jet test pilot experience is in the military. Until recently, women were totally excluded from training as military pilots, the first step toward jet test pilot status.*

*Today's astronaut is one of the world's most prestigious popular idols. Once launched into space, she holds in her hands something far more costly and precious than the millions of dollars' worth of equipment in her vehicle; she holds the prestige and the honor of her country. These have been entrusted to her because she is judged to possess high technical skills and even higher virtues of intelligence, endurance, resourcefulness, discipline, courage, and the capacity to make life and death decisions. But the astronaut is also something else; she is the symbol of her nation's way of life. Possibly, it is this latter aspect which is very important to the women who have sought to become a part of the American vanguard in space.*

## WELCOME FROM PRINCIPAL INVESTIGATOR OF CASET, DR. NINA W. KAY

**and**

## JOHNSON SPACE CENTER FEDERAL WOMEN'S PROGRAM MANAGER, MS. FREDA MARKS

*CASET and NASA/Johnson Space Center are happy to welcome you to this Symposium on WOMEN IN SCIENCE, ENGINEERING, AND TECHNOLOGY. As we move through the 1990s and into the 21st Century, women are becoming increasingly more important to the work force and thus to the productivity and technical competitiveness of America. It is essential that women themselves recognize their potential because as a nation, we cannot afford to have half our population unskilled and uninformed on scientific and technological fronts. Our future as individuals and citizens is related to the economic well-being and preparedness of the country.*

*Today, and in the following sessions, we hope to bring to your attention issues, questions, policy-matters, and successful programs which are all aimed at alerting women, employers, educators, and the media to the work which needs to be done in order to encourage women to enter - and persist in - science, engineering, and technology (SET) fields.*

*Our special thanks go to the Johnson Space Center and contractor organizations for their assistance with this Symposium.*

*Thank you for coming and we hope you enjoy the program.*

## ACKNOWLEDGEMENTS

The CASET research project, "A Study to Determine and Test Factors Impacting on the Supply of Minority and Women Scientists, Engineers, and Technologists for Defense Industries and Installations" was led by Dr. John Q. Taylor King, Huston-Tillotson College Chancellor and President Emeritus and CASET Director and Chair. His principles and ideals informed all phases and facets of the Study. His own career as Ph.D. mathematician, United States Army Major General (Retired), historically Black college President, author, businessman, lay leader of the United Methodist Church, and devoted husband, father, and grandfather make him a role model and an inspiration for all Americans and especially for the groups most closely connected with the Study - American Indians, Blacks, Hispanics, and women.

The NASA/Lyndon B. Johnson Space Center, under the leadership of Director Aaron Cohen, provided resources which added immeasurably to the success of the Symposium. Our thanks go to Dr. Cohen and all the JSC personnel whose individual contributions added so much to that success and enriched the experience of the participants.

Implementing the cooperative presentation of the symposium was the JSC Equal Opportunity Program Office, under Director Joseph D. Atkinson, Jr., Ph.D. and Federal Women's Program Manager Freda Marks Lockhart.

CASET is grateful to Dr. Harriett G. Jenkins, NASA Headquarters Assistant Administrator for Office of Equal Opportunity Programs from _____ to 1993, who has been consistently supportive of the CASET study and research goals. Dr. Jenkins was invited to be a Symposium keynote speaker. Although unexpectedly unable to be in Houston in person for the Symposium, Dr. Jenkins was here in spirit, spearheading this effort to bring women and minorities into mainstream SET careers with NASA and other organizations.

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# MAYOR'S PROCLAMATION

**presented by Donna Parr**

**Assistant Director**
**Mayor's Citizens Assistance Office**
**Houston, Texas**

## WOMEN'S SYMPOSIUM ON SCIENCE, ENGINEERING, AND TECHNOLOGY DAYS

***WHEREAS,*** *the Center for the Advancement of Science, Engineering, and Technology, CASET, is a multi-phase research project funded by the United States Department of Defense, with support from the National Aeronautics and Space Administration, NASA, and the United States Department of Labor, and*

***WHEREAS,*** *the goal of CASET is to increase the size of the Scientific, Engineering, and Technological pool of Americans through the recruitment and the retention of all underrepresented minority groups and women; and*

***WHEREAS,*** *Johnson Space Center and CASET are sponsoring a Women's Symposium on Science, Engineering, and Technology from October 15th through 17th; and*

***WHEREAS,*** *prominent speakers at the symposium include: Dr. Harriet Jenkins, Assistant Administrator for Equal Opportunity Programs, NASA Headquarters, Ms. Betty Vetter, Executive Director of the Commission on Professionals in Science and Technology, and NASA astronaut, Dr. Mae Jemison. Whereas, CASET is to be commended for sponsoring this important Symposium and its work in encouraging and supporting minorities and women in the pursuit of Scientific, Engineering and Technological careers.*

***NOW, THEREFORE,*** *I Katherine J. Whitmire, Mayor of the City of Houston, do hereby proclaim, October 15 through 17, 1991, as "Women's Symposium on Science, Engineering, and Technology Days" in Houston, Texas.*

# KEYNOTE ADDRESS

**Nitza M. Cintron, Ph.D.**

**Staff Biochemist**
**Medical Sciences Division**
**NASA/Johnson Space Center**
**Houston, Texas 77058**

*Dr. Nitza Cintron has been a staff biochemist in the Medical Sciences Division of the NASA Johnson Space Center (JSC) since 1978. She is currently Manager of the JSC Endocrinology and Physiological Control Research and Technology Operations Program, Research Advisor in the NASA Resident Research Associateship Program, and Chief of the Biomedical Operations and Research Branch. In addition to her responsibilities at JSC, Dr. Cintron is also an Adjunct Professor in the Department of Pharmacology and Toxicology at the University of Texas Medical Branch at Galveston. She is involved with a number of national organizations including Beta Beta Beta Honorary Biological Society, American Association for the Advancement of Science (AAAS), Aerospace Medicine Association (AsMA), and the American Institute of Aeronautics and Astronautics (AIAA). Dr. Cintron has received many honors and awards including the NASA JSC Sustained Superior Performance Award and the NASA Medal for Exceptional Scientific Achievement. Dr. Cintron earned a B.S. in Chemistry and Biology from the Universidad de Puerto Rico, Rio Piedras, Puerto Rico, and a Ph.D. in Biochemistry and Molecular Biology from The Johns Hopkins University School of Medicine in Baltimore.*

Thank you, very much. My concern about coming and talking with you all was not the questioning of the purpose, I think this is very important. It was whether I was going to be able to contribute something valuable and express it in such a way that would contribute to your meeting this morning. So what I will try to do this morning is describe a little bit of what we do within my organization and use that as a frame work to describe to you what I do in my role within the organization. Perhaps I can finish by making some personal comments about which elements in my development were important in reaching the point where I am now, and hopefully, about areas where I want to expand to take me to the future. As Ms. Marks said, I am with The Medical Sciences Division here at the Johnson Space Center (JSC), and the Division is tasked with the responsibility of crew health and safety. The astronauts reside at the Johnson Space Center. This is their home base and it's very logical, then, that the medical community that has the responsibility to take care of them resides here, as well. We're a relatively small group compared to the other organizations within NASA, not only the medical sciences, but the life sciences. But, we consider our roles and functions quite important for the success of the overall program.

Assuring crew health when we send these people into this very foreign and hostile environment is a very critical issue. Up until recently it was more of a support function in terms of making sure that when people went into space they came back healthy and were able to adequately perform their functions during a mission. But now, as you are probably aware, all the programs, almost without exception, that NASA is either planning for or is in the process of developing, deal with exposing human beings to very long term exposure to space flight. Now, that presents a whole other issue because, we have really not had the

experience of sending people out for that long. We are talking about a year or two years if we're talking about a mission to Mars, for example, or lunar bases for extended periods of time. We know that we can build a machine that will get us there. We have already sent a machine to Mars that took pictures of the Martian landscape. That is not all clean cut. We know that we can send a machine, but we can't assure that man can make that same trip. Medical and life sciences have thus become a critical component of the future success of the Manned Space Flight Programs.

We are now being called upon to answer very critical questions about human physiology when a person is taken into this environment. Can they come back and be healthy? We don't want to send people and then bring them back and have problems, either with muscles, with bones, or with the cardio-vascular system. There is a whole host of questions that are currently unanswered.

Not only do the functions of the Medical Science Division translate into the positions that provide health care (and they do that for the astronauts and their families throughout their career), but they translate to the support of a large number of medical research programs that will hopefully answer some of the questions that we need to have at hand in order to ensure man's health in all these future programs.

Within the Division we have three branches. One of the branches is where the flight surgeons are. They are the physicians who provide the health care delivery. There is another branch that is totally dedicated to physiological research. By physiological I mean they look at systems within the body: cardio-vascular system, physiology systems, and so forth. Our branch, The Bio-Medical Operations and Research Branch is a hybrid between the two. We do research as well as operational activities within the context of medical sciences. It is a very multi-disciplinary group for we have various disciplines, and I will rattle them all off in a minute. But, what is a common denominator for all of them is that the level of work and function activity on which we focus is at a very molecular and analytical level of function. We're often known as the analytical branch, or the laboratory branch, but it is at that very fundamental level. We have the areas of toxicology, micro-biology, clinical chemistry, bio-chemistry research (which includes endocrinology), and cell biology. We have the group of water analysis and quality, and the group of bio-technology. More recently we have added nutritional bio-chemistry, muscle physiology, and now even more recently, radiation biology.

That sounds like a large spread of groups but, we do have a common purpose and we have a function level which is very similar. Even though we are talking about radiation biology, the level of work they do is cell biology. There is a lot of intermingling with the various science and the various technical people. Most of the various groups, if not all, have the research and the operational component. As an example, toxicology is for all NASA not just for JSC. We have the NASA toxicologist who accesses the environment of a spacecraft to make sure that the air is healthy to breathe. You have to remember that we are in a closed environment and we can't just open the window, if for example, there is a little smoke that gets in the way or some chemical is released, or so forth. A complete analysis of the materials that go in it is very critical before we put payloads on board. There is a potential for contamination, a potential for hazards, while our folks are in space. Enormous toxicological evaluations and assessments are necessary to make sure that each mission that goes up (such as a Space Station) includes input to its development, with respect to the air quality and the environment. They input into the program directly, but these same people are in our laboratories performing research to look at the specific effects of some of the compounds put into a living system. We look at some of the components, like hydrazine, which is one of the fuels and propellants, as to what kind of effect and what kind of limits we can have within the spacecraft. Researchers in JSC labs do operations and research in bio-chemistry, which is my area.

When I first came to JSC that was where my home was - strictly in the bio-chemical research area. We're looking at how the body responds to space flight at that very basic level. We work with all the groups. We work with the cardio-vascular, and all of the regulation that occurs. If you are not familiar with the effects when you go into space, there is a fluid shift that occurs from your legs up toward the torso because you lose the gravity force. You may see an astronauts with a puffy face because of that shift. That shift also causes a stress to the heart so the body begins to signal through bio-chemicals and hormones that this is the situation - let's try to relieve that. The result is that astronauts have a net loss of fluids from their body to adapt to this new environment. The changes in the circulatory dynamics change the distribution of the circulation, and then there are a lot of secondary questions that come from that. We are involved in that research in the bio-chemical area.

In the clinical chemistry and clinical micro-biology area we support the flight surgeons in analyzing all the astronauts' blood and urine before and after flight to make sure, at least from a clinical standpoint, they are healthy before and after they return. This becomes more and more important as we extend our stay in space. So we are involved in that capacity in terms of the actual health care delivery. One area which is very innovative and perhaps the only one that isn't involved directly in manned space flight is the area of bio-technology. That area is the only one in the Division that comes outside the health care questions. But, because we are dealing with cell systems and cell biology and trying to study cell biology in space, it's within our branch. It is within the level of function that we study and it matches the functioning very well with all our other groups. What we are trying to do is not find out what weightlessness does to living systems, such as man, but we are looking to use weightlessness as a tool to manipulate ourselves. So that is another arena that space provides the scientific community. It is not just health care, it is a whole other world of investigations.

One of the very promising things is that we've developed equipment and facilities where we can grow cells and we are working with the M. D. Anderson Tumor Institute. We have been able to grow colon cancer cells in three dimensions. This is very difficult to do here on the ground and of course there is a limit size. We think that if we go into space, we can get a large tissue, or larger tumor, or larger colon mass, cancer mass. That is important because if you can keep the architectures of the tissues similar to what they are in the body (which you lose when you have only two-dimensions on a plate as they just kind of fall apart) you can study a bit more of the mechanisms that are involved in triggering a normal cell to become cancerous and also how you can intervene. So again, we are looking at this system, not to study cancer although it happens to be our model, but because it obviously has different applications for that arena as well. If we can translate that in space and actually contribute to that face of knowledge, I think we will have fulfilled one of NASA's purposes - to be able to contribute to the knowledge base.

There are many areas in environmental health. I mentioned to you that toxicology was responsible for the environmental health of the Space Station. We are developing all the requirements and all the facilities and equipment that are needed to assure a safe environment when we are in the Space Station. So it is multi-disciplinary and it has different operational and research tasks. This is a very large group of scientists, and I am very fortunate to have the staff that we have. It makes my job somewhat easier. We have approximately twenty-one civil servants, all of them scientists, and we have a support contractor staff of slightly over one hundred. These range from technical support to more scientists, also in support of a contractor group. In all cases, we rely on the whole group heavily and they are very confident, very technically astute people, very wonderful people in a personal sense. There is a good rapport between the groups; they're not fragmented; there is a lot of interfacing. One of my jobs as chief of the group is to try to make those interfaces better, because it makes all of the programs much stronger technically and from a personnel standpoint, too. Our budget is a little bit over thirteen million. We have always joked about it - we own half of Building 37 - and the other branches think that is too much space. But, in our defense we work with laboratory equipment that you can't fit into simple offices. We are very proud of the facilities that we have, our very state-of-the art equipment, and the people who know what to do with it. I mean, if you can get people who at every level have a sense of commitment to the program, have a sense of excellence, that is what it yields. It yields quality and excellence. I'm biased, but I will boast about our scientists and our technical people whenever I can because they are an excellent staff.

My role, in general, in our organization is first as a scientist, as I started twelve years ago, although it doesn't seem that long, and second as a staff bio-chemist to do research. In my development as a NASA scientist there have been some shifts in my focus, but it has always been toward identifying some of the key issues that will allow us to intervene in the physiology of humans to make their performance in space better. We are looking at the fluid and electrolyte changes, in that fluid shift that I spoke about previously, and what the mechanisms are. We are looking, also, at how drugs are processed by the body. When you take an aspirin on earth the doctors give a certain prescription or regimen to follow, depending on what they know about that drug and how it is handled by the body. But, in space there are so many changes that you can't say that I am going to give this drug and it is going to act exactly the same. With aspirin that is not a problem; you can have a lot of aspirin and nobody is going to be harmed.

There are a lot of drugs that are very, very toxic if you reach a certain high level. The reverse is also true, which we are seeing with anti-motion sickness drugs when not enough is getting into the body, so there

is no effect. They work fine here on the ground but they have very minimal effect in space. So again, when you are talking about long-term space flight you need to be able to at least give a good chronological intervention that is predictable and that is effective. We work on those problems, and on what things in the physiology are perturbing that. Such is an example in my areas of research. Five years ago when I took a management position, I continued to be involved in research. I think without that I would shrivel, so I continued those studies, and we still do research. We have a good staff. We meet and plan out the experiments and protocols.

I'm not at the bench as much as I used to be, but we still perform this research. I see my role still as a research scientist who contributes to the research activities. To my surprise, I thought my role in management was going to be more technical than not. It turned out to be a massive learning process including people inter-relationships, and I have learned a lot in the process. I had no training in management prior to my position. As the chief of the branch, what one has to do primarily is provide technical direction in all those areas and not always relying on your technical expertise in that area. It also involves, heavily, personnel issues, personnel development, working with the whole group of staff members and all personnel to ensure that the priorities that we set in terms of the Agency, and in terms of the Directorate, are met.

Frequently we have people who want to do one thing that is their favorite thing and it is very hard to tell them, "I know that is your favorite thing and we will still do it, but you can't dedicate fifty percent of your time to that, because some of the other higher priority issues are not getting done." It is helping the system and the group collectively to develop a good working priority so that they can do those other things that they want to do. We help set priorities. I have endless battles about space in the building, "I need this space, I really need this space," and there is no space to give. It is a continual battle, but, I lobbied with my Division Chief and our Director and literally begged for space, or for the resources that we needed. Also, we are involved in making sure that the communication between the groups within the branch gets done effectively. But very importantly I am an advocate for our program with our upper-management. I contribute, if you will, to developing the policies of the Division and the Directorate. In that way I try to develop a continuum between the staff, myself, and then the policies of the Directorate. Their input is valuable in terms of disciplines, as well. But, personnel development is probably the one that is key, and making sure that the people stay motivated when there is a lot of work. I think that is NASA-wide, there is more than we can do.

It feels, at least sometimes, as if we have three programs, actually four; the shuttle, the extended duration orbiter, the space station program, and in the very planning stages, there is still a program that is the future exploration - space exploration initiatives. The same people contribute to all of those and sometimes it is overwhelming to decide which one goes first. Again, it is my responsibility to sit with them and decide what goes first and take responsibility for my management. We have set those priorities and should they need to have those changed, then we will do it. But I'll take the heat, if you will, and say that we agreed on this priority and this is what they can do well. If they say, "We want you to change priorities," fine, we will change the priorities.

The biggest frustration that we have right now, in terms of personnel frustration, is they have to do so much that they can't do it to the maximum quality of which they think that they are capable. It hurts them to hand in something that is not fully developed or fully taken care of with the high quality that they can do. So in trying to ameliorate that, you prioritize, and then do the high priority ones as best as you can. If we have to drop some; then we have to drop some. If anyone is going to get the heat, it's me, and that's okay. It hurts to see the struggle they go through when they are in that mood. There are a lot of responsibilities, but I've learned a tremendous amount. I realize almost everyday there is still a lot I have to learn within NASA, but also in terms of interacting with people in general as to how to effectively motivate them and provide them with opportunities for career growth. This is sometimes not easy to do, at least in our organization.

My working environment is here at NASA in the Medical Science Division. I was asked to comment on what were the key issues, or key contributing factors, that helped me evolve in my development. I always thought that the key to success, to achievement, (and that doesn't necessarily mean that you get rich or that you have a high position, but that you strive to your full potential), is education. I know that is said so often, but I can't think of any door that is more viable to open all those opportunities. To foster and

nurture the whole concept of education gives you more choices. There are a hundred ways of doing that from the home, from the political arena, and so forth.

I was asked recently in a survey how would I distribute a hypothetical budget among a whole list of things, such as; environment, drugs, crime, education, a whole list of things. I put almost all of it on education. Someone asked me, "Why, don't you think drugs are important, don't you think the environment is important?" I said, "Oh yes, no doubt, those are all critical." But, if you develop a society that is educated, they will know that the environment is critical. They will be more mature to know, to hopefully address, the issue of drugs and dependency, the whole issue of the homeless. All of those get permeated, I think, effectively, and not overnight, but eventually, if you have a society that has a high level of education. I am about to clarify what I mean when I say "education." I don't mean a Ph.D. degree, necessarily. I don't mean advance training, but a sound basis of education, at whatever level, of quality, and I mean that it is a process that is continued throughout your life. I am not finished. I might think, as I listened to all the things that I have done, "She's at this summit here, and that's it." That is not how I view myself, and I don't think that we instill in our younger people the importance of the process of education, not just the end point.

We hear a lot of talk about getting the student into this field - be a doctor, be a this, be a that. The value of it all, is not just when you get there, but in the process. That process should never end. As I said, I am not through, I think that I will always be going. So when I said "education," I don't necessarily mean the degree although that is part of it. It's the process of always, always learning, of always becoming informed. Now you have heard all of this before and heard people say, "Yeah well, if you have a father that is a doctor, then that is easy." My parents were high school graduates and yet, they knew the importance of education. They taught my sisters and me how important it was, and it wasn't that I remember it as a lecture. They never lectured me; it was just instilled in the home atmosphere. I think my sisters and I really put a big effort into studying, not because of obtaining a degree, but because if I learned more I would be able to cope with more; I am able to deal with more; I do have choices I wouldn't have if I didn't learn. I wasn't thinking of myself as a degreed person or myself as Chief of the Bio-Medical Labs. That wasn't the end point for which I was looking. I think, that we as parents and educators and managers can instill, even at this level of adults, the idea that the learning process is still ongoing. That is fundamental. To me, my parents' influence was very critical, because I never questioned the fact that study or education was important. When I got through high school and went to college, I still knew that education was important, but I really didn't know where to funnel that, you know? I didn't know how to funnel education into what I wanted to do. My parents were still there encouraging me, but they didn't know which direction to tell me to go. There again is where the professors and teachers have such a critical role and the quality of education comes from those people.

To me, the second major influence was two professors. All of them influenced me, but two professors were extraordinary educators. I mean, I understood chemistry for the first time through one of them. I had started to say, "This isn't as interesting as I thought it was going to be, this is kind of boring, and I don't understand." Then this man just got up there and started to explain concepts, and he really loved it, he really understood it, and he really influenced my direction.

The other professor was a biologist, and she was an unusual person, in that she was different. The Puerto Rican culture is very conservative, and Dr. Condellas was, I won't call her radical, but she was different. She was extremely intelligent. For some reason, I was very insecure, very shy. I could look like a little turtle that would hide in her little shell, yet I guess she saw some potential in me. I was able to develop a very strong rapport with this very, very outspoken person. She took an active role in telling me, "You can do more. You don't have to stay here." I wanted a Ph.D. in bio-chemistry, but it was unavailable in Puerto Rico. I said, "The University of Puerto Rico is good, but the colleges in the States are very good and I'm just going to flunk out." She said, "No, you're not. You can do it."

She helped me. We ordered all of these catalogs from all sorts of schools, and she sat down with me and went through all of them. We chose the colleges to which I would apply, the graduate schools to which I would apply. She even commented, "No, if you go to California it is too liberal for you. You'll just come running back home and we don't want that. You need something." She knew how insecure I was at that point in my life and how easily I could get frightened. So she took an active role in my life and that was so critical. My parents couldn't have done that. They couldn't have counseled me; they couldn't have done

it. Even though they instilled the basic sense of achievement through education, achievement, again, doesn't mean being the chief of something, but meeting your potential. That is achievement. These professors in the University of Puerto Rico were very key. I believe that teachers, after parents, are the most important people that walk the face of the earth.

I have a son and I really care who his teachers are. When I have a teacher's conference, I am in awe, especially when they are excellent teachers, at the skills they must have in order to teach young people these basic concepts. They should be the best paid people in this whole country and not the least, from kindergarten on to the professor that you have in chemistry. Building the attitude is really critical because education is a process and each step is just one step, just one little part of it. The teachers instill that it is not just the end point, but that the value is in the doing.

Since I came to JSC, my focus has been to try and do the best that I can with what I have and in that way maintain my confidence, maintain my proficiency, and do my very best in my work. Fortunately I came under the management of Dr. Carolyn Huntoon, JSC Director, Space and Life Sciences and the leading JSC woman. She brought me to where I am now in my career without my knowing it. She tells me this now. She allowed me a few years without a lot of administrative burdens, not easy to do here at NASA with all the paperwork that is going around. When I had achieved a certain level of success, when I had developed the systems that I wanted to study and I had worked out data so that I was able to begin to publish and be recognized a little as a contributing scientist, she began to open the world of NASA to me. She said to me, "Okay, now you go do this, and now you have this responsibility," and slowly she exposed me to the key areas which I see now were pivotal for me to get to where I am now. That is the exposure she gave me, and the training she allowed or helped direct was important. I don't know if that is what you call a "mentor", but that is in essence what she has been.

Sometimes "mentor" sounds like someone who gets you there, and that is so offensive to me. I would like to think that I have some qualities as potential and that this, whoever it is, intelligent person, already established in the system sees you as an investment in the future of the organization in which they have put so many years. That is how I see my development, if you will. Mentoring is having someone in the work force who looks at your performance and says, "Okay, this person has the potential," and helps you. Again, my parents and professors couldn't have helped me do that. It took someone, this third person, third feature, to help me do that. I'm in that position now. We have young people becoming part of our staff which makes me feel old. We have a very good staff, but we have two women who are extraordinary potential leaders. I feel that it is now my responsibility, especially to the young one, who is just finishing her post-doctoral (she is real gung ho, an excellent scientist, and an excellent doer) to leave her time to develop her science first, as was done for me. Then in about a year or two I will start exposing her to the other lead-ins of the administration and management. She will be a visible entity to higher management, so they can see how well she does in terms of her work.

We have a mature person (if I said older, she would kill me) who is an excellent scientist, as well, but very well established. She came from Auburn University, was Chairperson of her department, and she is now on our staff. She has already developed a large capability for management and science. I think that she will be one of the blooming people here.

As I said, I am not finished in terms of my science or in terms of my role in NASA. I would like to fit where I can contribute best. I think, again, the key to that is to keep confident, to continue my education, not necessary through school, but by keeping proficient in my field and also in the NASA system - working within the system to learn how it operates, and learning how to interface with all the organization.

Again, the process is what's really important. It is hard work to instill in students that it is not this big jump with a lot of hardship, but it is really a wonderful process. I told my son the other day that I wanted to go study in a certain area, a course, and he looked amazed, "Why do you want to do that? I mean, you're already in your position at NASA." I thought of a quote in a little book that one of my sisters sent me, "That it is really wonderful when you're at a summit and you're looking out and you've really climbed along and you're up where you wanted to be. It's a certain degree. That's a wonderful feeling. But, the best of me comes out on the climb, not on the top." That's the reason why you need to continue the process to the very end. If you can instill that in young people, that will be their driver in their academic life, their professional life, in their whole career.

That is it, thank you.

# WOMEN IN MATHEMATICS-BASED FIELDS
## An Illustrated Progress Report

**Betty M. Vetter**

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American women made remarkable inroads into the community of scientists and engineers during the seventies and early eighties, but the increase in their participation has stopped, well before they achieved demographic parity or occupational equality with men. The obstacles they continue to encounter are formidable, but the nation's need for them is growing, and improved opportunities appear inevitable.

One of the several pragmatic reasons behind an increasing need to utilize the talents of women in science and engineering is the U.S. birth curve, which fell substantially after 1961, resulting in a 25 percent drop in the number of American babies born over the next 15 years. The number of freshman-age Americans started to drop in 1980 (fig. 1), and this decreasing population group will continue to affect enrollments of college students in the natural science and engineering fields through the rest of this century.

### THE PRE-COLLEGE YEARS

The problems of getting more women into science and engineering start very early, as infants are labeled with pink and blue blankets. They are treated differently throughout their childhood and school years, and into the world of work. Certain abilities and characteristics are assumed to be sex-linked, and little girls

find out very early that they are seen as less competent than boys; with less mathematical and mechanical ability. Their toys are chosen to emphasize these gender-perceived attributes. With little to encourage their participation or challenge their mathematical thinking, many girls drop out of mathematics as soon as they can, closing their options to a science or engineering career.

The serious deterioration of our public education system during the period of the Vietnam conflict and after illustrates another reason that the nation needs to add women to its roster of scientists and engineers. Although college-going increased markedly during this period, particularly among young men who might otherwise have faced the military draft, high school course requirements in math and science - and indeed in most of the other core courses previously required of high school students who sought entry to college - were dropped. Boys, but particularly girls dropped out of the mathematics course sequence required for engineering and science majors as early as ninth grade.

By 1982, about a fourth of American 17 year-olds of both sexes had ended their formal mathematics training with pre-algebra. At the top end of the scale, only six percent of the boys and five percent of the girls had taken or were taking pre-calculus or calculus, and less than 40 percent of either sex had completed Algebra II (fig. 2).

**FIGURE 1**

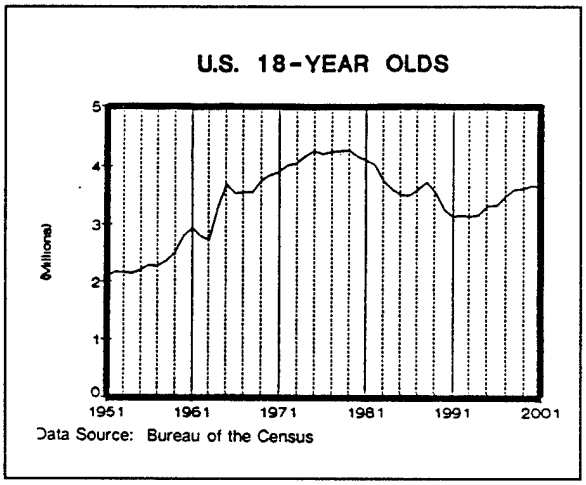
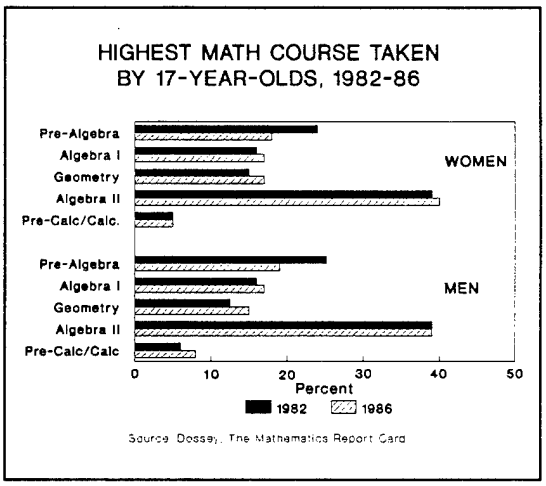



**FIGURE 2**




Mathematics is easily shown to be the most important single factor in determining admission and success in science and engineering careers, and oppositely, inadequate math preparation restricts major career choices, and is a stamp of exclusion from these fields. Despite increased graduation requirements in several states, mandating more math and science; and a resultant upward movement in math course taking, there has been little or no increase in the small percentage of women taking calculus, although the percentage of male graduates taking the course rose by two percentage points between 1982 and 1986.[1] Although girls are taking somewhat higher levels of math courses than was true in 1982, we also have seen a widening, rather than a narrowing of the achievement gap between boys and girls. Importantly, half of **all** American students drop out of math by 9th grade, and we lose half of them again each year from grade nine to the Ph.D. It is no wonder that our children cannot compete with those in the rest of the world!

Through five national assessments of mathematics proficiency among 9, 13 and 17 year old students, girls have scored only slightly below boys (fig. 3). The scores are identical at age 9, similar at age 13, and girls are only slightly below boys at age 17 - a difference that appears to be related to course taking[2].

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[1] Office of Technology Assessment. *Elementary and Secondary Education for Science and Engineering: A Technical Memorandum.* Washington, DC: U.S. Government Printing Office, December 1989

[2] Dossey, John A., Ina Mullis, Mary Lindquist and Donald Chambers. *The Mathematics Report Card: Are we Measuring Up?* Princeton, N.J: Educational Testing Service, June 1988

Nonetheless, it continues to be "common knowledge" that boys are better at math than girls, and this erroneous information is transmitted to girls at an early age, convincing many of them that anything they do not understand right away must be beyond their capacity to understand.

Science is a different matter. The NAEP science assessment shows a sex gap even at age 9 (fig. 4). Further, between the first science assessment in 1970 and the most recent assessment in 1986, the sex gap doubled for 13 year olds.[3] In other words, we are moving backward. By age 17, girls are far behind boys.

**FIGURE 3**

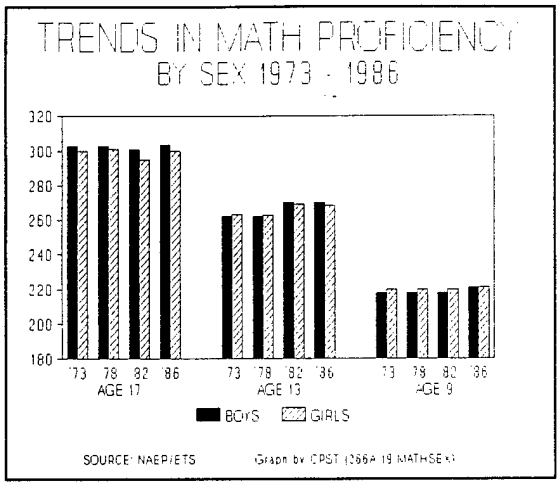
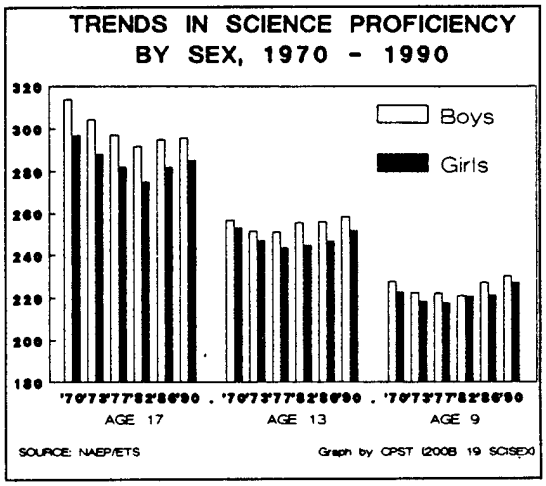



**FIGURE 4**




One reason that girls score so low is that they are never exposed to the kind of information needed to do well. We used to think most of the gap for girls was the result of differential course taking. We know now that this is not the case.

Research [4] shows a number of reasons for the score differences.

- As shown by several studies, one reason is that teachers of all ages and both sexes discriminate in the classroom. They have lower expectations for girls than for boys in science and mathematics. They call on and praise boys more than girls, let boys interrupt girls, but praise girls for being polite and waiting their turn. The discrimination is both unintentional and unrecognized by teachers, except after they have seen themselves teaching, by way of video tape. But teachers are not alone.
- Parents also discriminate against their daughters in failing to equip them with the most elementary training in the use of tools to build or repair mechanical things. American parents, unlike those of nations such as Japan, accept the myth that their daughters are less talented than their sons in mechanics and mathematics, simply because of their sex. Conversely, they believe them to be **more** talented with words! They praise their daughter's hard work in attaining good grades or honors in

[3] Mullis, Ina V.S. and Lynn B. Jenkins, *The Science Report Card - Elements of Risk and Recovery, Princeton, NJ:* Educational Testing Service, September 1988

[4] e.g. McDonald, Jean, Marianne Clarke and Eric Dobson, *Increasing the Supply of Women and Minority Engineers: An Agenda for State Action;* and Daniels, Jane, Raymond Landis, Minnie McGee and Paul Parker, *Realizing the Potential of Women and Minorities in Engineering: Four Perspectives from the Field.* Washington, DC: National Governor's Association July, 1990

The Task Force on Women, Minorities, and the Handicapped in Science and Technology, *Changing America: The New Face of Science and Engineering, Interim Report,* 1988, and *Final Report,* 1989. Washington DC: U.S. Congress

Oakes, Jennie, *Lost Talent: The Underparticipation of Women, Minorities, and Disabled Persons in Science,* Santa Monica, CA: The Rand Corporation, 1990

science and mathematics, but express delight at the talent shown by their sons by the same accomplishments.[5]

- Most K-8 teachers suffer from inadequate preparation in science so that they fear teaching science and lack confidence in using hands-on activities in the classroom. These activities are known to be essential to maintaining student interest and understanding for both boys and girls.

Women make up 94 percent of the teachers in K-3 classrooms, and 76 percent of those in grades 4-6. Teachers in these grades report very little confidence in their qualifications to teach science.[6] The role model relationship is obvious. The problem for higher education in providing those teachers with an adequate science and math background also is obvious.

At the high school level, students with higher math achievement scores will tend to take chemistry, and the higher the math scores, the larger the fraction who will enroll in chemistry (fig. 5). Males and females are approximately equal in this choice, when considered by math achievement level.[7]

**FIGURE 5**

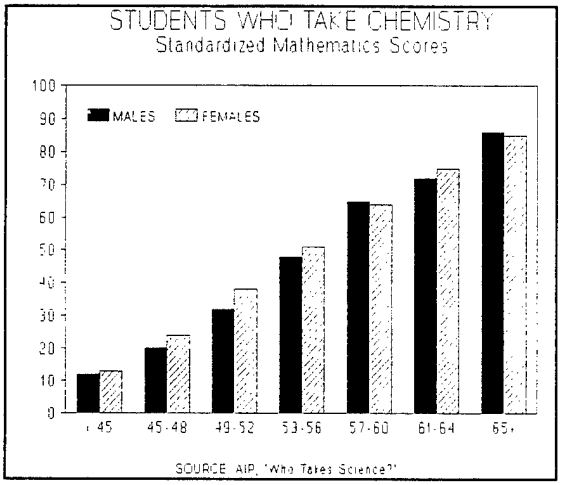
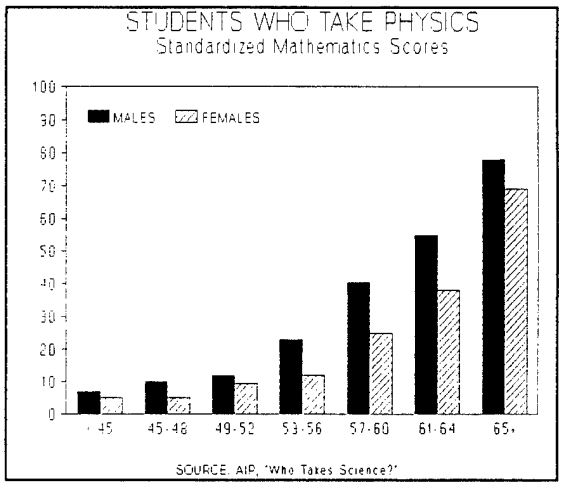



**FIGURE 6**




Physics, of course, is a different story (fig. 6). Regardless of mathematical excellence, girls are much less likely than boys to take physics. Some factor other than mathematical excellence obviously is at work. But it is equally important to note that 60 percent of **all American** high school seniors have taken **neither** physics nor chemistry; and more than 80 percent of seniors have had no physics! The women are even less likely than the men to have taken these science courses.

All of these conditions reflect in the score differentials of men and women on the mathematics section of college admissions tests, either the ACT or the SAT. As a group, women also score less well than men on mathematics and science achievement tests taken as part of the college assessment process.[8]

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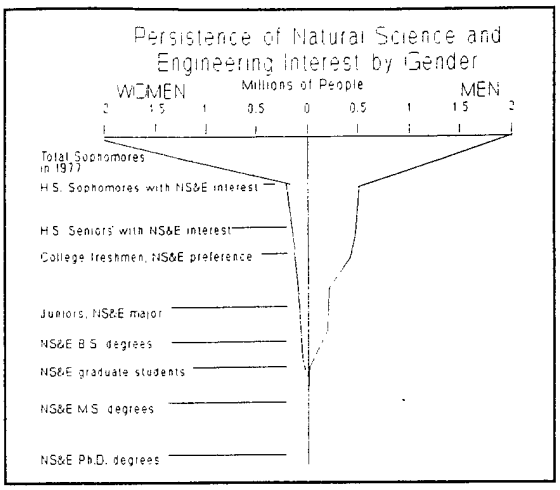
[5] Keynes, Harvey B., "University of Minnesota Talented Youth Mathematics Project (UMTYMP), Yearly Report No. 5: Academic Year 1988-89, University of Minnesota, and "The University of Minnesota Talented Youth Mathematics Program." *MANPOWER COMMENTS*, V. 26, No. 9, November, 1989, pp. 13-14

[6] Weiss, Iris, *Science and Mathematics Education Briefing Book*, Chapel Hill, NC: Horizon Research, Inc., August 1989

[7] Czujko, Roman and David Bernstein, *Who Takes Science? A Report on Student Coursework in High School Science and Mathematics*, New York: American Institute of Physics, 1989

[8] Vetter, Betty M., *Professional Women and Minorities: A Manpower Data Resource Service*, Eighth Edition, Washington, DC: Commission on Professionals in Science and Technology, December, 1989, Tables 1-14 through 1-17, pp. 14-15

**FIGURE 7**




It is no surprise, then, that by the time they are sophomores, only ten percent of the girls compared with one fourth of the boys express interest in the natural sciences. By the end of high school, about one fifth of the boys, but only one twentieth of the girls continue to indicate a potential career interest in these fields (fig. 7).[9]

## UNDERGRADUATES

Despite a significant increase in the proportion of American women who go to college, their participation in math-based major fields has increased only in proportion to their greater college attendance, and even this gain now appears to be threatened. One important thing that happens in college is that the already fragile self confidence of women students drops still further. They have been told all their lives that they are not as capable as men, particularly in science and mathematics. Those who choose a major in a math-based field are likely to receive further pounding from a college faculty which assures them by both word and deed that they are not believed to be as competent, nor as likely to be successful as their male colleagues. Faculty in these fields, often foreign faculty and teaching assistants from other cultures, but also American faculty, usually are male. They call on women students less frequently, give short shrift to their answers or suggestions, and praise male students for restating women's ideas as their own.

By the time they leave a college campus after four years, women's self-confidence has dropped several more notches.[10] This treatment continues, incidentally, not only through graduate school, but out into the working world of business and employment, where some recent new research has shown that not only are women given fewer opportunities for advancement than the men with whom they graduate, but that those women who assume a leadership role and have the temerity to lead discussions and make suggestions are frowned at by the listeners; while the identical suggestions from men draw smiles and nods of agreement.[11]

Like women at coed institutions, minority students on majority campuses get differential treatment by faculty and fellow students, who subconsciously believe that the minority students are intellectually inferior to the white males. It is not surprising that most black students accomplish more and are far more likely to complete a degree at one of the historically black colleges and universities than at a predominantly white institution, where their inferiority is assumed. Neither is it surprising that women's colleges traditionally send far higher fractions of their graduates on to Ph.D.'s and to high achievement than is true for co-ed schools of the same selectivity.

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9 Shakhashiri, Bassam. "U.S. Science Education." in *Human Resources in Science and Technology: Improving U.S. Competitiveness.* Proceedings of a Policy Symposium for Government, Academia and Industry. Washington, DC: Commission on Professionals in Science and Technology, July 1990, pp. 59-68

10 Astin, Alexander. *Four Critical Years: Effects of College on Beliefs, Attitudes and Knowledge.* San Francisco: Jossey Bass Publishers, 1978

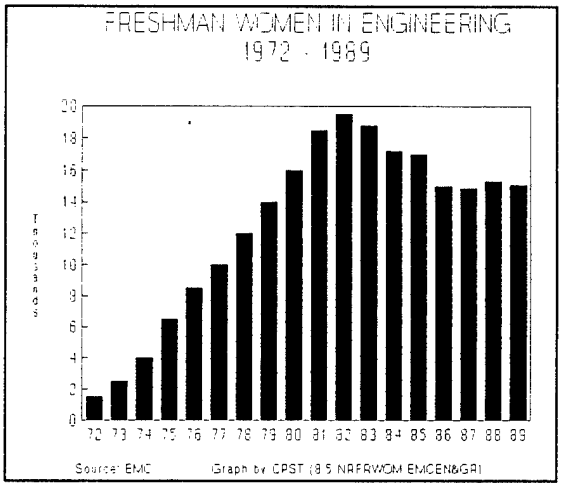
11 Bass, Alison. "The Bias Below the Surface," reporting on research by Florence Geis and Barbara Gutek in *Journal of Personality and Social Psychology* January, 1990. *The Washington Post,* March 20, 1990, page F5

We are a sexist and racist society. Deep down, most Americans accept the myth of white male supremacy, although most would be horrified to be associated with the Ku Klux Klan, and most of us deny being sexist, even to ourselves. It will be a real battle to change these innate beliefs in our society, and until we do, we can never get the best we could have had from our minority men and from our women students and workers.

## WOMEN IN ENGINEERING

Despite all these obstacles, a significant number of women enter college planning to major in a math-based field, and through the 1970s, that choice increasingly was likely to be engineering. However, women's undergraduate participation in this set of fields is now dropping numerically, because of decreases in the college age population, and their percentage of total enrollment stopped rising at the 15, instead of the 50 percent level that would represent parity.

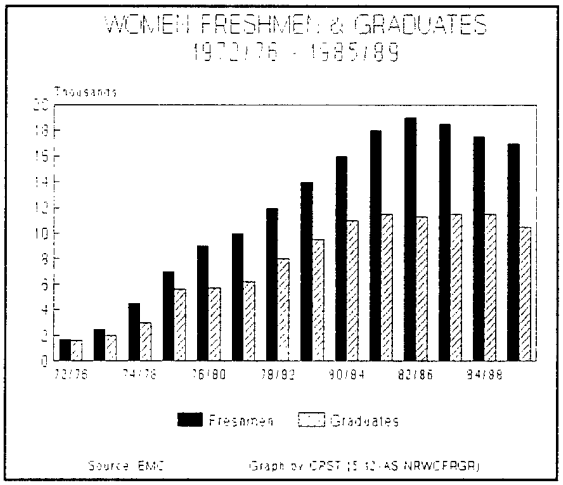
**FIGURE 8**




### Undergraduate Enrollments

Freshman enrollment of women peaked in 1982, and dropped by almost 4,000 women, or 19 percent of the total, over the next four years (fig. 8). The slight upturn in 1988 probably is related to the one year increase in births 18 years earlier, as shown in figure 1. Far too many of these women freshmen leave engineering before earning the baccalaureate, because they find they do not like the field, and transfer to another major; because they feel isolated; because they are made to feel incompetent; or for other reasons. Such transfers rarely are related to failing grades, because the women who have persisted to this point are a highly filtered, self-selected group of achievers.

**FIGURE 9**




Although not a true retention rate, measuring as it does the graduating class against the freshman class four years earlier, and thus ignoring the inflow of students after the freshman year, both from other majors and from two year institutions, the ratio of freshman women to graduates (fig. 9) gradually declined through the first half of the 1980's, and the drop-off for women continues since 1982 to be a little higher than for men.

**FIGURE 10**

## Bachelor's Degrees

Women never earned more than 15 percent of the bachelor's degrees, although at particular schools and in some engineering fields, their presence is much greater than that (fig. 10). Their relative share of bachelor's degrees is somewhat greater than the share earned by black, Hispanic and Indian graduates, but of course, in figure 10, minority women are counted twice, thus under-emphasizing the continuing predominance of white males among engineering graduates.

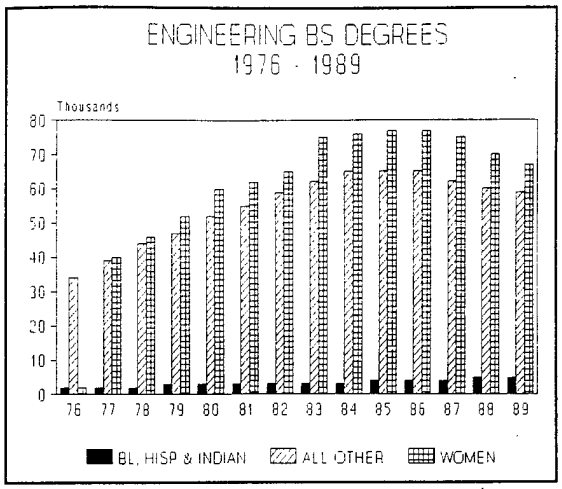



**FIGURE 11**

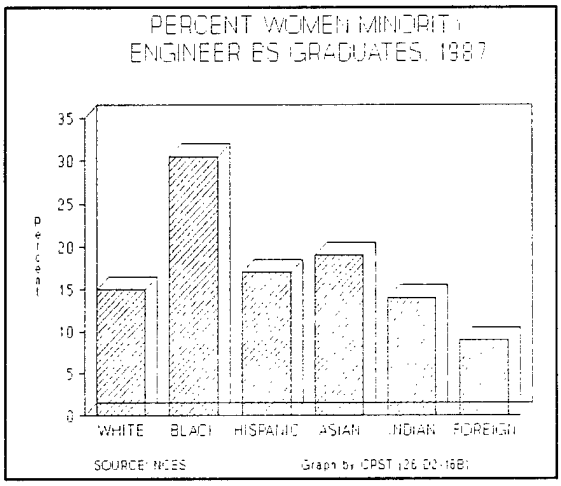
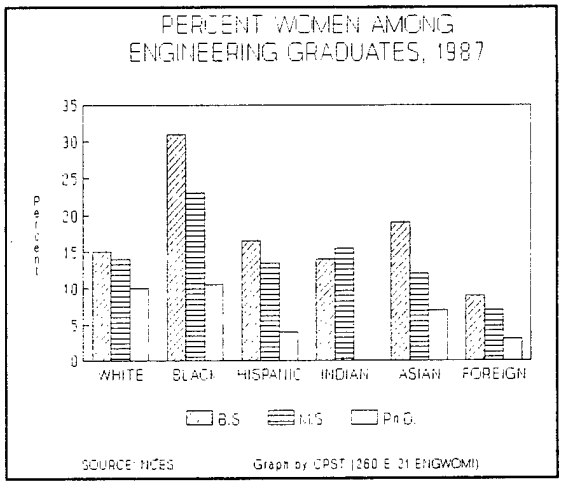



**FIGURE 12**




## Minority Women

As is true in most data bases providing breakouts for women and minorities, minority and foreign women have been double counted in the enrollment and degree data on engineers.[12] This will change beginning with the 1990 degree data, but in the meantime, the latest available information on degree awards by both sex and minority group, for 1987, indicates that women are somewhat better represented among minority engineering graduates than among white, non-Hispanic ones (fig. 11).[13] Black women make up almost one third of black B.S. recipients in engineering, compared with white women who are only 15 percent of white recipients. Both Hispanic and Asian women have higher representation within their racial/ethnic group than is true for white women. Women are least likely to be found among foreign graduates, and this, in turn affects women of all racial and ethnic groups because of the high preponderance

[12] Engineering Manpower Commission. *Engineering and Technology Enrollments. Fall 1989* and *Engineering and Technology Degrees 1989.* Washington, DC: American Association of Engineering Societies, Annual Series. 1972-1990.

[13] Vetter, Betty M., op. cit., Table 2-17, p. 65.

of foreign men among graduate students, teaching assistants, and faculty in engineering. A language barrier between American students and foreign teaching assistants and faculty affects both men and women, but the cultural differences of the foreign men relative to their feelings about the importance of helping women prepare for careers in traditionally male fields sometimes provides additional difficulty for women students, both undergraduate and graduate.

It is important to note that although black women appear to be entering engineering in higher ratios than other women, their representation among black graduates is almost as much the result of the poor showing of black men as it is of the higher participation of black women.

At higher degree levels, some differences also occur in the representation of women among white and minority populations (fig. 12). Once again, black women are better represented among black M.S. recipients than is true for women in other ethnic or racial groups. Both white and Indian women earn similar proportions of master's and bachelor's degrees, relative to men of the same group, while black women earn a smaller percentage of master's than of bachelor's degrees. At the doctoral level, Hispanic women are almost as poorly represented as foreign women. What is universally true, however, is that women of any racial or ethnic group are less well represented at the doctoral level than at the bachelor's level.

## Subfield Choices

Over the past decade, the subfield choices of women in engineering have changed (as also is true for men), with more of them selecting electrical and industrial engineering, while fewer were choosing chemical and civil engineering. The largest numbers of women graduates as well as men are in electrical engineering, but the numbers are now falling in each engineering field (fig. 13).

However, the percentage of women among graduates in chemical engineering is twice as high as in electrical/electronic engineering. Women's representation increased in every field of engineering from the mid-seventies, but is most notable in chemical and industrial engineering. Computer engineering rose and fell (fig. 14).

Because of a number of differences, it is interesting to examine some of the engineering fields separately.

**FIGURE 13**

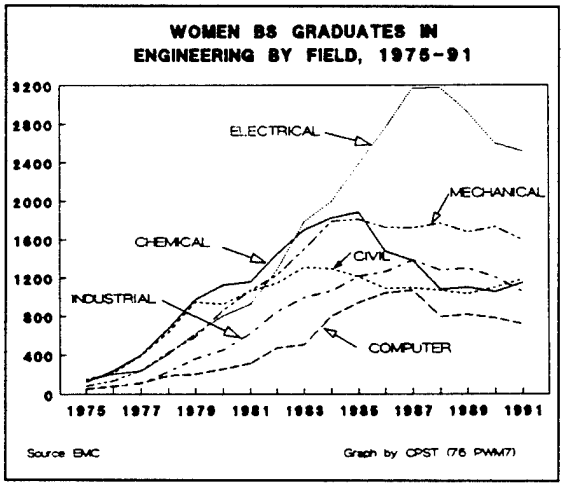



**FIGURE 14**

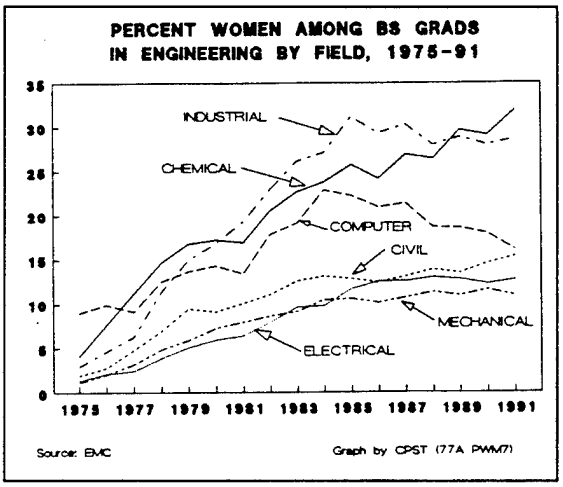


**FIGURE 15**

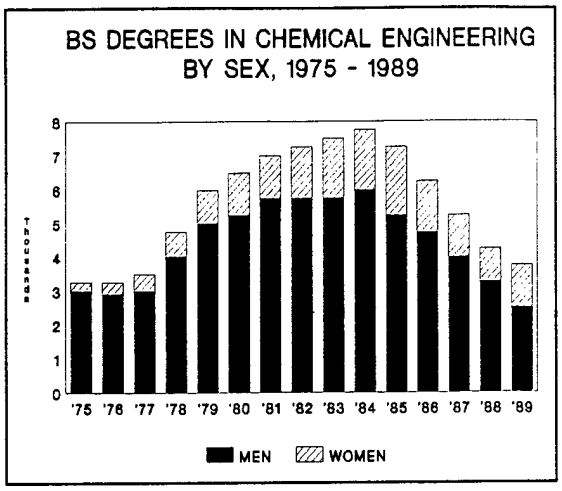
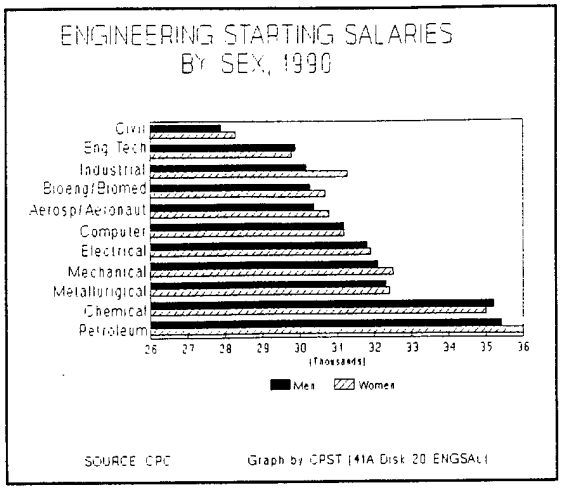



**FIGURE 16**




## Chemical Engineering

Chemical engineering has a high proportion of women among graduates, relatively speaking, but has fallen out of favor with both men and women. Degrees in chemical engineering rose sharply in response to heavy demand in the late 70's and early 80's, but fell even more sharply from 1984 to 1989 (a total drop of 52 percent) as the oil crisis gave way to a relative glut (fig. 15). In 1990, chemical engineers are in such short supply that salary offers to new B.S. graduates are up 8.1 percent from last September to an astonishing $35,084 average! The average for women was slightly less - $34,922, but women B.S. graduates in petroleum engineering drew the highest average starting salary offers among all 1990 baccalaureate graduates - $35,994 per year.[14]

Starting salaries in engineering, for both men and women, are higher than in other bachelor's fields (fig. 16), although they differ substantially by field, with chemical and petroleum engineering paying the highest salaries by a considerable amount. The invasion of Kuwait by Iraq and subsequent events appear likely to increase demand for chemical and petroleum engineers at an even more rapid rate.

For many years, engineering was unique as the only area where women baccalaureate graduates receive higher starting salary offers than men, as they did and still do in several engineering disciplines. Average offers to master's graduates in chemical engineering are $38,055, and offers to doctoral candidates average $50,570! So although the starting salary offers are a strong temptation to any B.S. graduate, the Ph.D. offers also are excellent. Women earned 30 percent of the baccalaureate awards in chemical engineering in 1989, but only 11 percent of those in petroleum engineering.

[14] College Placement Council, *Salary Survey. Final Report 1990*, Bethlehem, PA, September, 1990

**FIGURE 17**

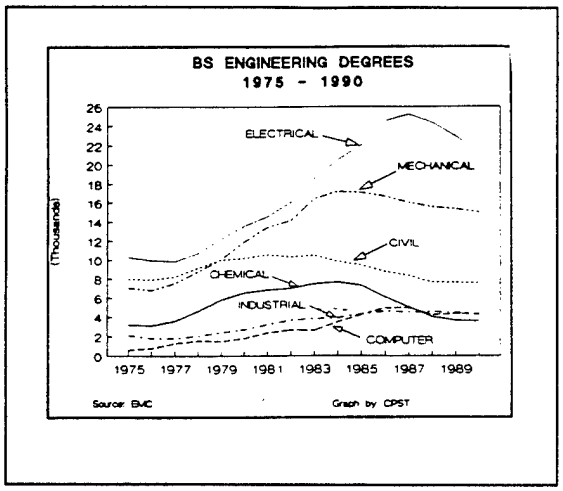
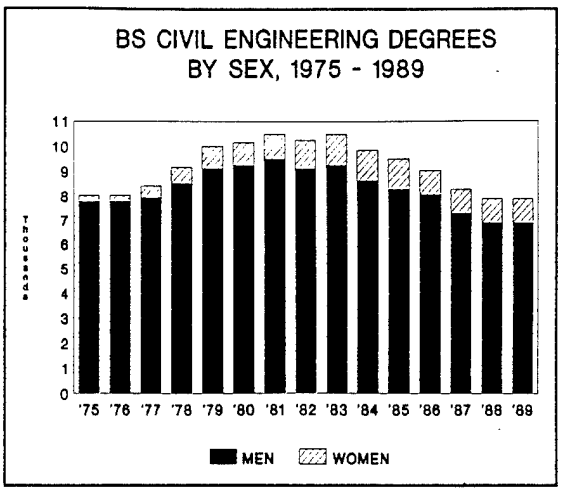



**FIGURE 18**




Electrical/electronic Engineers

Although more women earn E.E. bachelor's degrees than are earned in any other field of engineering, their percentage of total degrees in the electrical/electronic field has never reached the 13 percent level because E.E. also has become the largest field of choice for men and for foreign students, also mostly men (fig. 17). Salary offers to this group also are very high, averaging $31,817 at the bachelor's level, $37,376 at the master's level, and $52,887 for Ph.D.'s. Women at the bachelor's level had 1990 offers averaging $150/year more than men's.

Civil Engineers

In contrast, civil engineering has been losing ground to other engineering disciplines over the past decade and a half, dropping from 21 percent of B.S. engineering degrees in 1975 to 11 percent in 1989 (fig. 18). Because supply has been sufficient to fill demand through most of these years, starting salaries have lagged in this field, along with student interest from both sexes. For comparison, 1990 starting salary offers average $28,040, $32,260 and $43,632 at the three degree levels. Women average 13.2 percent of B.S. graduates in recent years. Their starting B.S. salary offers are $429 more per year than the average offers to their male classmates.

Although the number of B.S. graduates in some fields continued to increase for several years after others had turned down, the number of degree awards at the B.S. level is now dropping in every field (fig. 19), both for men and women.

**FIGURE 19**

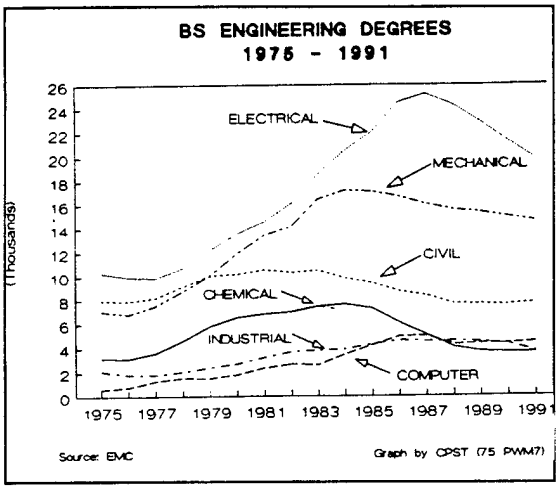
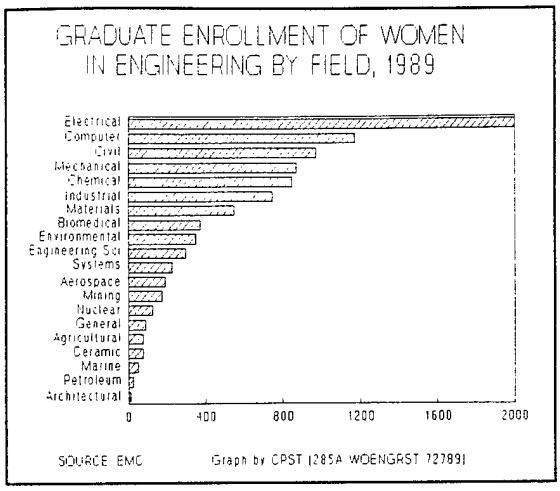


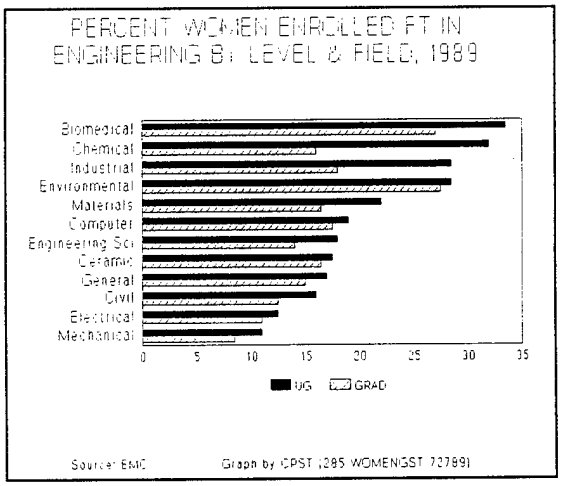

**FIGURE 20**




## Graduate Enrollments

Graduate enrollments and degrees depend on bachelor's graduates. Although women stopped increasing their share of baccalaureate enrollments and degrees some time ago, so that graduate enrollment has had a chance to catch up with the steady increases in bachelor's degrees experienced earlier, women are not enrolling and remaining in graduate school in the same proportions as their undergraduate participation. This is unfortunate because employment opportunities for women engineers with graduate training are excellent and expected to get even better.

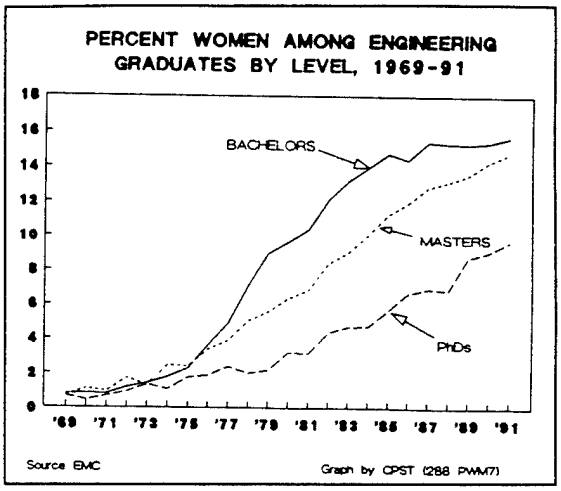
**FIGURE 21**




Numerically, the largest numbers of women enrolled at the graduate level are in E.E., followed by computer, civil, mechanical, chemical and industrial engineering (fig. 20). However, the higher percentages of women enrolles at the graduate level are in biomedical and environmental engineering, where there are fewer students of either sex enrolled (fig. 21).

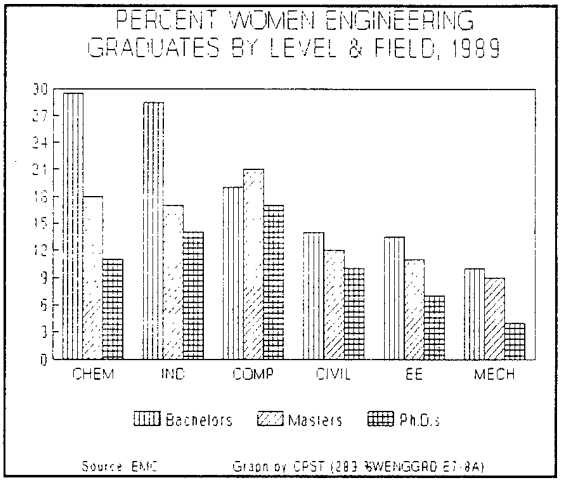
It is also interesting to compare the percentage of women enrolled at the undergraduate level with the percentage among graduate students in these same fields. Women's representation among graduate students in chemical engineering, for example, is only half of their representation among undergraduate majors in this field. There are no engineering fields where women's share of graduate enrollment equals or exceeds their share of undergraduate enrollment.

**FIGURE 22**




Comparing women's share of total enrollment, by level and attendance status (fig. 22) shows that among part time graduate students, the percentage of women had reached the level of full time undergraduates by fall 1989. Probably most of the part time graduate students are employed full time, and seeking a master's degree. Among full time graduate students, however, the percentage of women levelled off from 1985 to 1988, well below the percentage of women enrolled as full time undergraduates.

**FIGURE 23**




## Graduate Degrees

By 1989, women earned a substantially higher percentage of chemical and industrial engineering bachelor's degrees than was true for either master's or doctorates, but other major fields show somewhat closer outcomes (fig. 23). Chemical engineering is the one field of engineering where current data can be cross checked from two sources - namely the Engineering Manpower Commission and the American Chemical Society.[15] Both report women earning 30 percent of the bachelor's degrees in chemical engineering, 19 percent of the master's degrees and only 12-13 percent of the Ph.D.'s in 1989.

Why do women drop off the educational ladder in chem engineering at so much faster a pace than men, and faster than they do in other engineering fields? This drop-off is especially worrisome because chemical engineering is second only to materials engineering in the proportion of doctorates among its practitioners (fig. 24). Are undergraduate women in this field (and others) getting good advice about graduate study?

Of course, men in the engineering workforce are substantially older than women in the field (fig. 25), and women may not yet have had sufficient time to catch up in graduate programs, at least to their baccalaureate level. However, the age difference also means that men will be retiring, and women prepared for the research and teaching positions that are being vacated will be well ahead of the game.

[15] American Chemical Society Committee on Professional Training. "ACS Committee on Professional Training 1989 Annual Report." *Chemical and Engineering News*, April 30, 1990, pp. 29-35

**FIGURE 24**

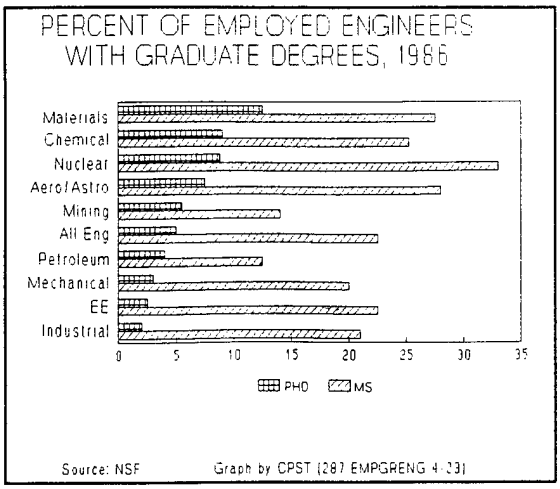



**FIGURE 25**

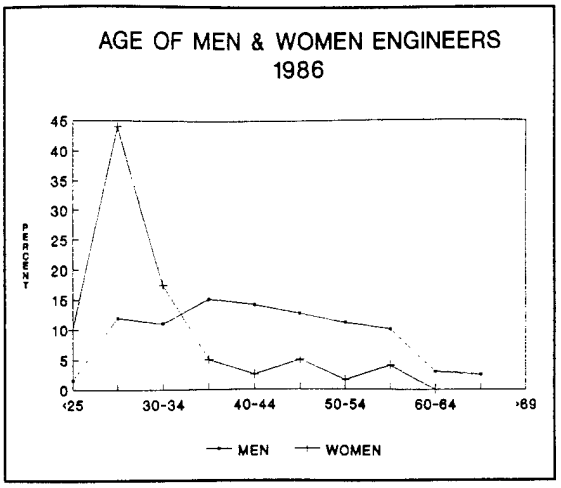



**FIGURE 26**

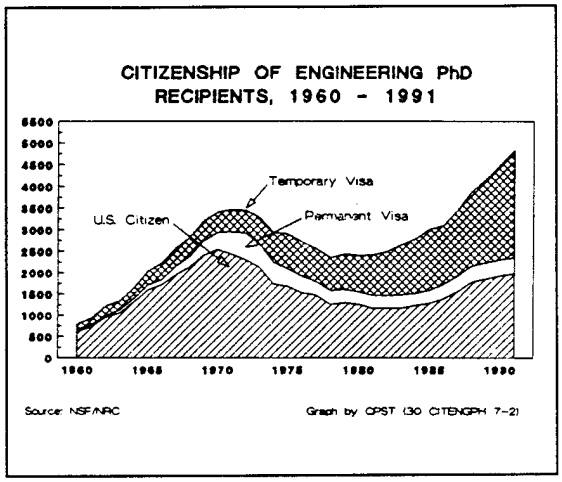
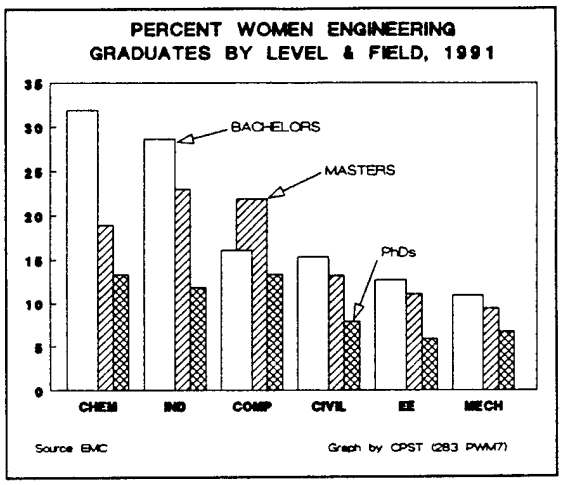



**FIGURE 27**




## Doctorates

More than half of all engineering Ph.D. awards from American Universities since 1980 have been made to foreign citizens (fig. 26).[16] Some of them have permanent visas and will undoubtedly become a part of the American labor force; and some, even with temporary visas, will want to and be able to change their visa type at some later stage. They are an important addition to our workforce. But these foreign graduates are even less likely to include women than is true for American students!

Despite several years of stable output at the bachelor's level, women have not moved very close even to that small 15 percent participation for master's and doctoral degrees in engineering (fig. 27). The sharp increase in Ph.D. awards to women in 1989 is encouraging, but the numbers are still so small that even if half of all Ph.D. women wanted to accept faculty positions, and every engineering school wanted women faculty, each school could hire only one woman every four years for one of its departments! It is difficult

[16] National Science Foundation. *Early Release of Summary Statistics on Science and Engineering Doctorates, 1989*, manuscript, March 1990

to see much chance to increase the percentage of women on engineering faculties beyond its present 2.7 percent[17] at present rates of production. And it is notable that despite the small fraction of women among the foreign doctoral graduates (4 percent), the fact that the majority of doctoral graduates in engineering are foreign citizens means that only two thirds of the 373 women earning engineering doctorates in 1989 were American citizens.

Looking only at American recipients, and specifically at women and minority men, we see a very discouraging set of numbers (fig. 28). The 209 white women and 23 Asian American women earning doctorates in 1989 are up sharply from 1988, but only eleven doctorates were awarded to black, Hispanic and American Indian women combined! Women faculty as role models still will be rare as we enter the next millennium!

**FIGURE 28**

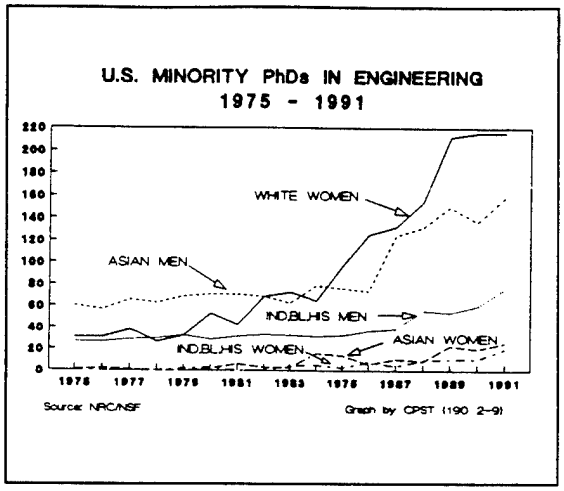
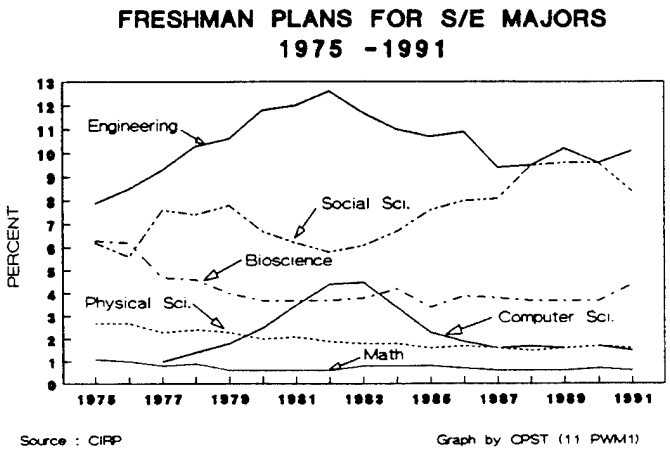



**FIGURE 29**




## WOMEN IN NATURAL SCIENCE

Undergraduate women who are attracted to math-based fields are also likely to choose majors in one of the physical sciences, computer science, an environmental science, or mathematics itself. About half as many women choose an undergraduate major in the math based fields as choose majors in the biological sciences, which generally require less mathematical background than physics, chemistry, astronomy, geology, or mathematics. About the same number choose computer science as choose all of the physical sciences and mathematics combined.

Unlike engineering, there is no data base providing undergraduate enrollment data by field of science, although the American Geological Institute does provide enrollment data on junior and senior majors in the geosciences.[18]

However, there is an important data base, now more than 20 years old, that provides information about the plans of freshman in regard to their probable undergraduate majors.[19] Although students change their majors during their undergraduate years, and about half of them drop out before finishing a bachelor's

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[17] Doigan, Paul and Mack Gilkeson. "Who Are We? Engineering and Engineering Technology Faculty Survey, Fall 1987. *ENGINEERING EDUCATION*. October 1988, pp.62-65 and November, 1988 pp. 109-114

[18] Vetter, Betty M., *Op. Cit.* Table 6-28, pp. 152-153

[19] Astin, Alexander, *et al. The American Freshman: National Norms for Fall 1973* through *Fall 1989*. Los Angeles: American Council on Education/Cooperative Educational Research Program, UCLA Graduate School of Education

degree in any field, the field distribution of graduates four years later is generally similar to the distribution of planned choices indicated at the freshman level.

Since 1982, each national freshman class has shown a declining interest in majoring in mathematics or a mathematics-based field (fig. 29). The declining interest is not confined to either sex, so that a smaller percentage of women as well as of men indicate plans for such majors (fig. 30), and the percentage of the women in the freshman class of 1989 who are planning majors in all of these fields combined is only 5.6 percent. Thus, if the students in recent freshman classes follow their plans, the number of bachelor level graduates in each math based field will continue to fall, as has been true for each of these fields since 1986 (fig. 31).

**FIGURE 30**

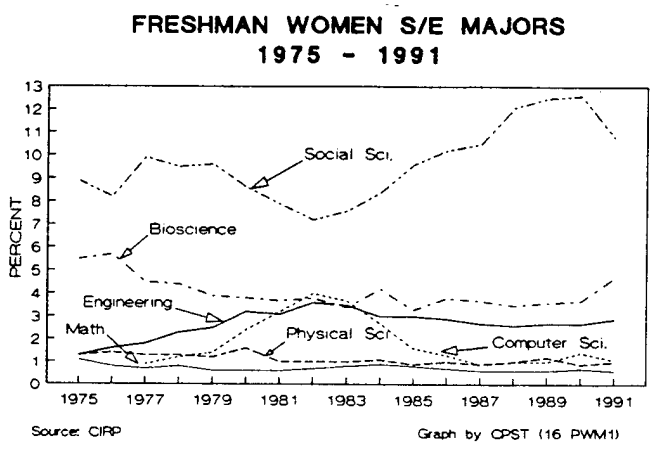
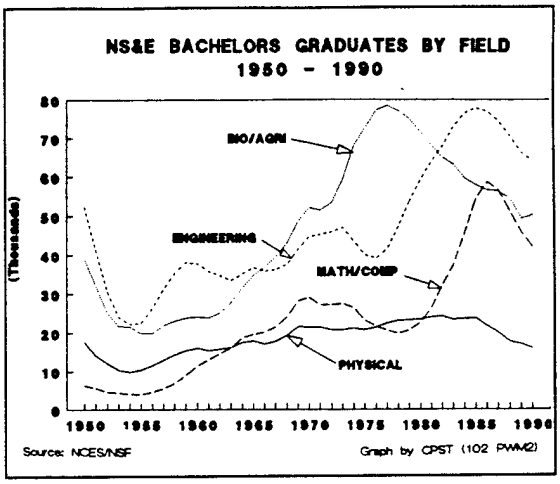



**FIGURE 31**




Equally disturbing is that the percentage of merit scholars choosing majors in the natural sciences is down from 23 percent in 1983 to 19 percent in 1988; the percentage choosing engineering has dropped from 20 percent to 16 percent.[20] The drop in interest is seen across both sexes (fig. 32), but is greater for women than for men.

Already, the number of bachelor's degrees awarded to women in engineering, in the physical sciences, in mathematics and in computer science is dropping, as it is for men (fig. 33). Degree awards to women in the social and behavioral sciences and in the humanities continue to increase. The percentage of women among physical science graduates increased slightly in 1988, after dropping in 1987, but any further increase beyond the present 30 percent appears unlikely without some intervention (fig. 34).

## The Physical Sciences

It is useful to disaggregate the data for some of these math-based science fields, because they are so different. Women now earn almost 40 percent of the bachelor's degrees in chemistry, but their representation drops to one fourth at the doctorate level. Numerically, the number of women B.S. graduates peaked in 1985 at 3,416, dropping nine percent to 3,097 by 1989[21] (fig. 35). Women's presence among physics graduates is less than 300 per year, (15 percent of the total), and in the geosciences, the gain

[20] National Science Board, *Science and Engineering Indicators, 1989*, Washington, DC: U.S. Government Printing Office, 1989, p. 214

[21] American Chemical Society Committee on Professional Training, op. cit., p. 29

of the seventies and early eighties has been wiped out in the past three years. Both men and women have moved out of the geoscience fields, and the percentage of women among baccalaureate graduates has stabilized between 25 and 26 percent.

FIGURE 32

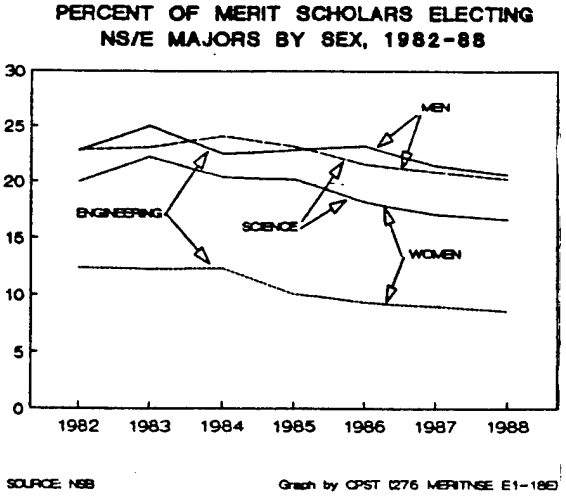



FIGURE 33

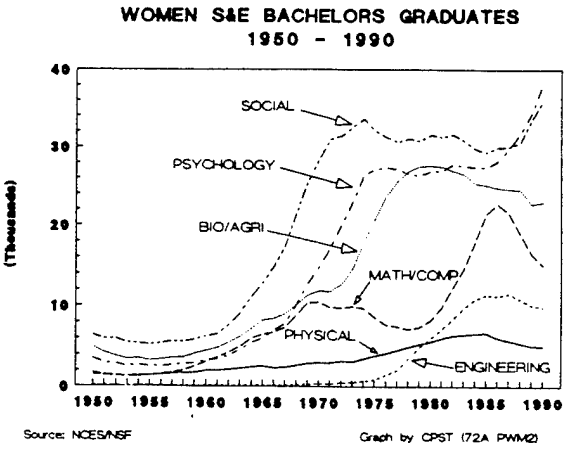



FIGURE 34

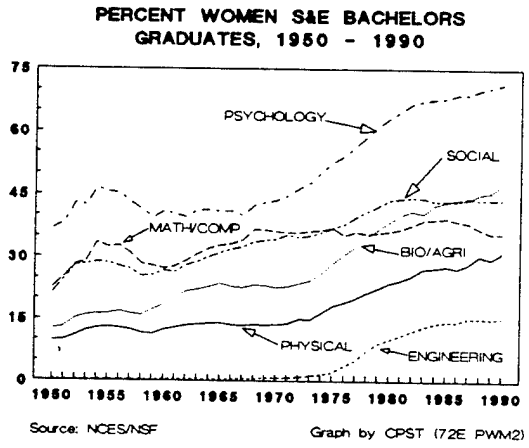
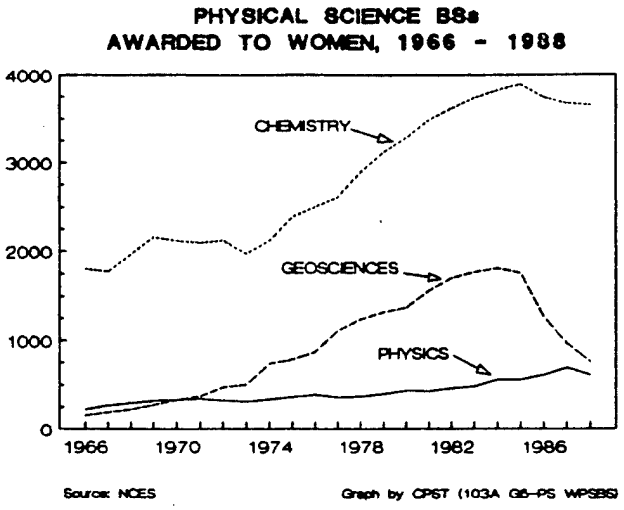



FIGURE 35




## Mathematics and Computer Sciences

Women have been majoring in mathematics in significant percentages ever since data on degree awards began being maintained by sex. They have earned at least a fourth of the bachelor's degrees in every year since 1951, and more than 40 percent since 1973 (fig. 36).[22] This is particularly astonishing in light of the widely held belief that men are significantly more mathematically talented than women. In computer science, which has been counted as a separate field since 1965, women moved quickly from less than ten percent of graduates to 37 percent in 1984, but are now dropping back steadily, so that they earned only

[22] U.S. Department of Education. *Earned Degrees Conferred by Institutions of Higher Education*, continuing series, 1948-1988

32.5 percent by 1988. The number of degree awards in computer science dropped by 7,300 from 42,195 in 1986 to 34,869 in 1988, a 17.3 percent drop in just three years, just as the freshman plans had indicated that it would (fig. 37). Mathematics bachelor's degrees have dropped so far that the base for graduate degrees now is significantly eroded.

**FIGURE 36**

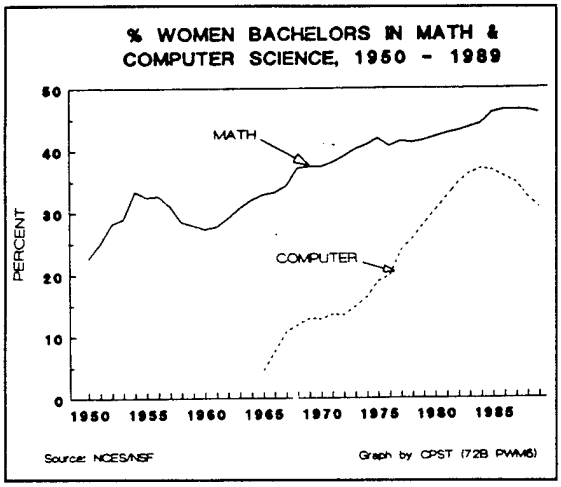



**FIGURE 37**

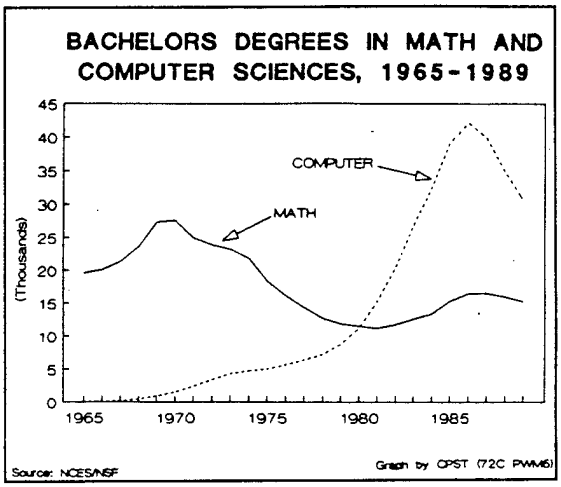



**FIGURE 38**

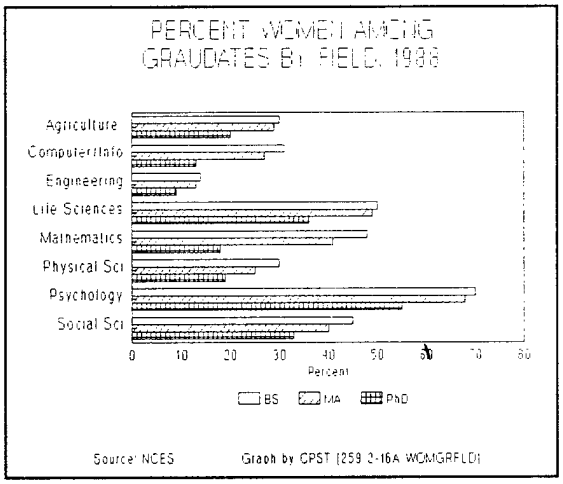
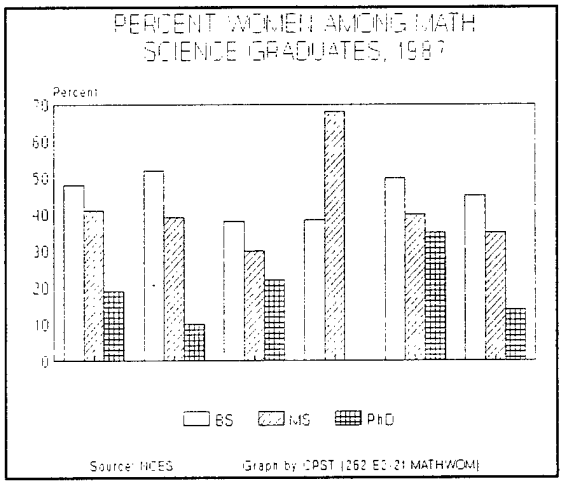



**FIGURE 39**




Women did not achieve parity in any math based field, even by 1988, although they earned a majority of all bachelor's degrees as early as 1983. Their representation drops at each higher degree level, regardless of field (fig. 38).

## Minority Women

As in engineering, minority women are somewhat differently represented within their racial or ethnic groups than is true for white women as a proportion of white degree recipients. In all the math-based fields, as well as for total baccalaureate fields, black women earn a much larger share of degrees awarded to blacks than is true for the women of other racial/ethnic groups, and foreign women earn the smallest

share. However, in the math/computer science fields (fig. 39) women of all races earn a higher fraction of the degree awards at every level than is true in the physical sciences (fig. 40). The large percentage of women among the American Indian recipients of math and computer science master's degrees is a reflection of the very small numbers of American Indian graduates of either sex, rather than an indication of significant difference for Indian women.

**FIGURE 40**

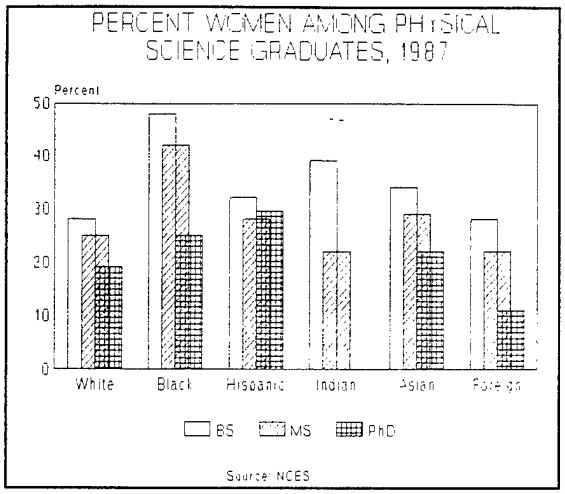



**FIGURE 41**

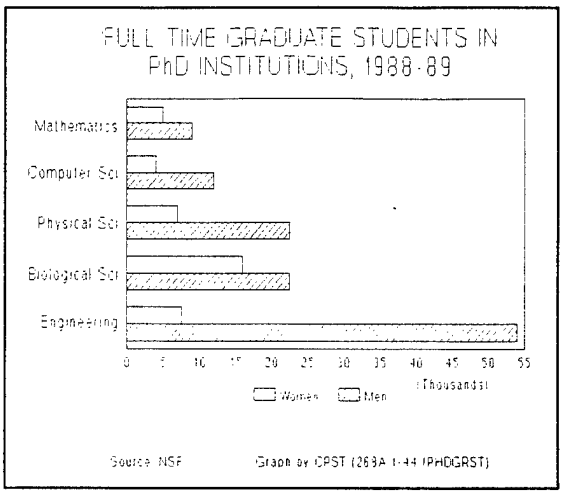
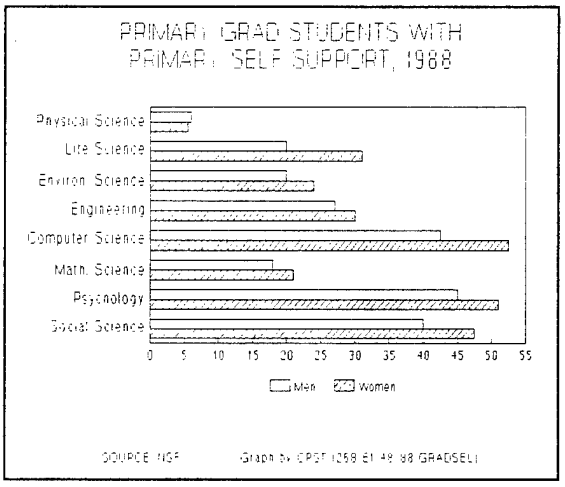



**FIGURE 42**




## Graduate Study

Graduate enrollment in the sciences has continued to increase through fall 1988, although much of the increase has been and still is made up of foreign students. Women are less than a third of full time graduate students in any of the math based fields (fig. 41).[1]

Within the physical sciences, the number of full time U.S. students enrolled in chemistry at the graduate level, which held steady at about 11,500 in each year from 1983 through 1986, has dropped to 10,800 over the past two years. Only one fourth of them are women. Almost half (42 percent) of full time physics graduate students are foreign citizens, and only 13 percent are women. In the geosciences, less than a fourth of graduate students are women - just slightly more than the 19 percent who are foreign.

Graduate enrollments in mathematics and computer science also are dominated by foreign students - 43 percent in mathematics and 46 percent in computer science. Women are 27 percent of the total enrolled in mathematics and 22 percent of those in computer science.

## Financial Support for Students

Although the majority of graduate students in the math-based fields are supported during their graduate years, women are more likely than men to have to support themselves (fig. 42); and are considerably less likely than men in the same fields to obtain federal support for graduate study (fig. 43). They are somewhat

more likely than men to have institutionally sponsored teaching assistanceships, which provide less opportunity for research.

**FIGURE 43**

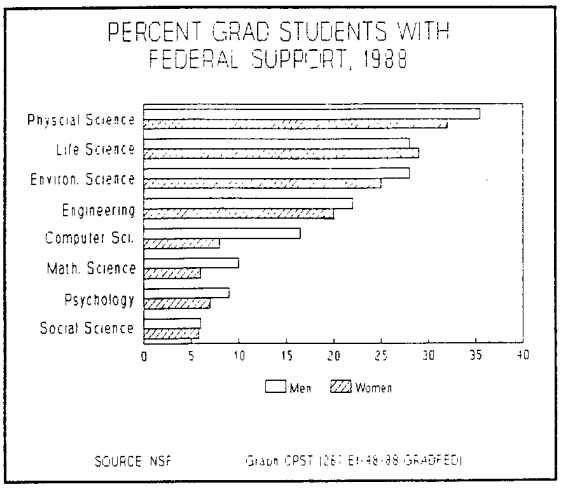
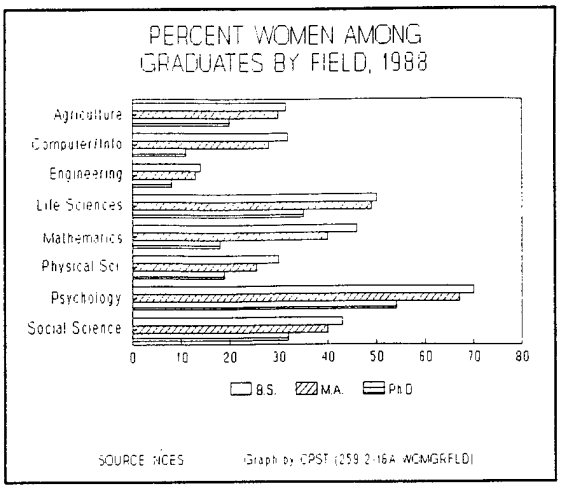



**FIGURE 44**



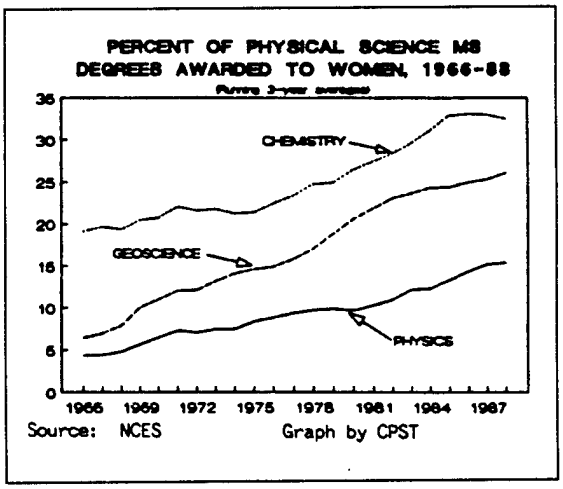

## Graduate Degrees

The master's degree is difficult to evaluate. In some instances, the degree is awarded as an indicator of progress toward a Ph.D., while in other cases it is a terminal degree, or is awarded as a consolation prize to students in doctoral programs who do not complete the Ph.D.. Some master's degrees require two full time years; others only one. Women are more likely than men to seek a master's degree without planning to continue further graduate study.

Field differences also determine the importance of a master's degree. In the geological sciences, the master's is considered the appropriate entry degree for professionals. In chemistry or physics, the Ph.D. is more likely to be required for research positions as well as for academic openings. Mathematics and computer science master's degrees are professional level except for employment in academic institutions.

**FIGURE 45**

In general, women earn almost the same percentage of master's degrees in the math-based fields as of bachelor's degrees, with the large drop occurring at the Ph.D. level (fig. 44). A break-out of master's degrees in chemistry, astronomy and physics (fig. 45) shows that although women have earned an increasing proportion of these degrees, they still earn less than a third of the master's degrees awarded in any of these fields. In both physics and chemistry, the percentage of master's degrees earned by women dropped in 1988.




As was shown in figures 39 and 40, minority women are not substantially different than majority women in earning a share of the graduate degree awards in the physical sciences or the mathematics/computer science group, except that

Hispanic women earn a smaller proportion of master's degrees in the math sciences, and black women earn a higher percentage in the physical sciences. Black women also show the smallest share of Ph.D.'s in these math-based fields, relative to the men in their group.

## Doctorates

The presence of women among the doctorate recipients is of great consequence in determining whether significant numbers of women will be eligible and available to rise through the glass ceiling into top research and leadership positions if that ceiling ever shatters; and into faculty positions in math-based fields, where they serve also as role models. Although the numbers and percentages of women earning bachelor's degrees in some of the math-based fields has been substantial for several years, as in chemistry, mathematics and computer science, the percentage of women among Ph.D. recipients never rises to one third in any of these fields.[23]

**FIGURE 46**

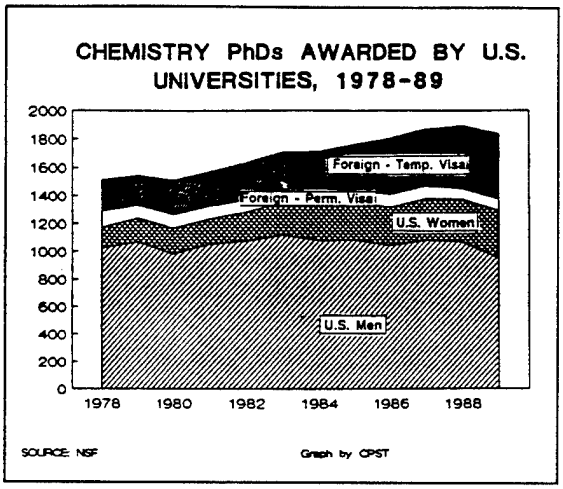



**FIGURE 47**

**AMERICAN WOMEN EARNING PHDS IN 1989**

| | | |
|---|---|---|
| PHYSICS/ASTRONOMY | | 58 |
| CHEMISTRY | | 340 |
| EARTH/ATMOS/MARINE SCI | | 114 |
| MATHEMATICS | | 93 |
| COMPUTER SCIENCE | | 72 |
| ALL MATH-BASED FIELDS | | 677 |
| Minority Women included: | | |
| American Indian | | 3 |
| Asian American | | 20 |
| African American | | 11 |
| Hispanic | | 24 |
| TOTAL | (8.6%) | 58 |

SOURCE: NRC Chart by CPST (300)

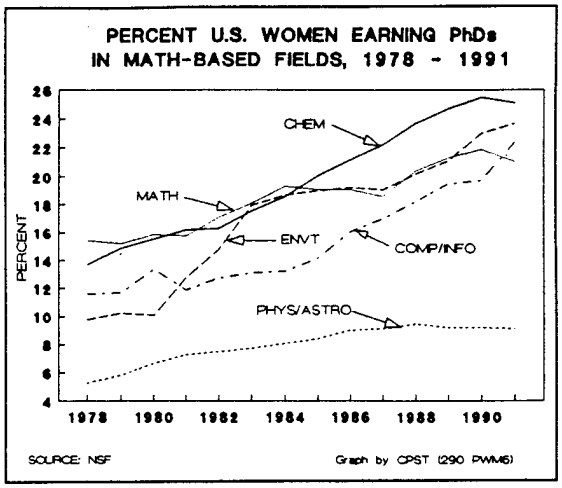
Given the drop in graduate enrollment in chemistry, it is no surprise that the number of doctorate awards in chemistry also dropped in 1989, with essentially all of the decrease consisting of American men (fig. 46). Foreign citizens have earned an increasing proportion of the doctoral awards in chemistry from U.S. universities, earning 34 percent of the 1,971 doctoral awards in 1989.

The 1,292 American citizens who earned a chemistry doctorate in 1989 differed little from the previous five years, except that there were six percent fewer of them in 1988 - a figure resulting from an 11 percent drop in American men and an 11 percent increase in American women. But despite that increase, only 26 percent of the American Ph.D.'s were women.

Numerically, chemistry continues to dominate the physical and mathematical sciences, both in total number of doctorates awarded and in the number awarded to American women (fig. 47), although thenumber of awards in 1989 was 7 percent below the number awarded a decade earlier (Table 1). Chemistry also has the highest percentage of women among all Americans earning doctorates in these fields (fig. 48), but that percentage is only 26 percent, even in 1989.

[23] National Research Council Office of Scientific and Engineering Personnel, *Summary Report: 1989 Doctorate Recipients from United States Universities*, in press, and previous annual reports in the series from 1972

**FIGURE 48**




In physics, women earned only nine percent of the U.S. Ph.D. awards in 1989, down from ten percent in 1988. In the environmental sciences (earth, atmospheric and marine sciences) the percentage of women among U.S. recipients rose slightly, but stayed under 22 percent. Thus, it appears that except in chemistry, women have stopped increasing their representation among new doctoral graduates in the math-based fields, at less than one fourth of the total, or half the level required for parity.

The increasing numbers of foreign nationals among doctoral recipients in the math-based fields reduces further the percentage of women among the graduates. Looking only at U.S. citizens, the number of women earning doctorates in math-based fields in 1989 totals 58 in physics and astronomy, 340 in chemistry, 114 in earth, atmospheric and marine sciences, 93 in mathematics and 72 in computer science, for a total of 677 American women, nation-wide. Within this group, 3 were American Indians, 20 were Asian Americans, 11 were African Americans, and 24 were Hispanic, for a total minority representation of 8.6 percent.

## BARRIERS TO WOMEN

Why are there so few women achieving professional status in these fields? While the answer to that question is complex, some of it can be explained by the many barriers, both apparent and hidden, to increasing the interest and participation of women. As discussed earlier, those barriers begin almost at birth, but new barriers appear as women enter and complete each stage of their formal education in one of the physical or mathematical sciences, and as they enter the work force. Women aspiring to careers in science face a "triple penalty" of cultural, attitudinal, and structural impediments.[24] This accumulation of disadvantages results in higher rates of attrition and in lower achievement for those who remain in science. It also restricts substantially the number who are qualified to choose a science career.

Although both the executive and legislative branches of the government have publicly expressed concern over the need to widen the pool of talent to include more women and more minorities, and have set aside funds for various programs designed to encourage selected minorities in these fields and to make up for some of the impediments facing minorities in a majority society, there has been little more than an expression of concern regarding the addition of more women to that talent pool. Efforts to lessen some of the burdens on women by making child care services more available, equalizing salary levels, enforcing equal opportunity mandates or providing more scholarship or fellowship assistance generally have not succeeded. Those passed by the Congress have vetoed by the President. Those that have passed often are not enforced.

Some of the barriers placed in women's way, both subtle and not so subtle, are deeply ingrained in societal values, and immense effort will be required to effect change. Although disentangling the web of causality is immensely complicated, some barriers would be relatively simple to remove, if employers wanted them changed, if the government wanted them changed, or if the majority of the population wanted them changed. When only women (and not always a majority even of women) want the change, it comes about very slowly, if at all.

[24] Cole, J.R., *Fair Science: Women in the Scientific Community*. New York: Free Press, 1979, p. 255

## Salaries

One of the barriers to women is differential salaries, and the consequent statement made by this differential because, in a democracy, salaries generally are equated with worth. Like men, women need to be assured that society values their abilities, their work, and their achievements. The present salary message is denigrating to women.

Many things affect salary, including amount of education, field of specialization, years of experience, type and size of employer, and geographic location; as well as shortage or surplus of workers with similar qualifications. But when all of those have been controlled, the differential that remains is related to the sex of the worker.

Fields dominated by women are assumed to be worth less than those dominated by men, and this has little or nothing to do with the level of demand for such workers, or any shortage or surplus of supply. For example, in occupations requiring a bachelor's degree, those that are dominated by women, such as elementary teaching or nursing, pay salaries that are far below the salaries paid to bachelor's level graduates in the fields of engineering that are dominated by men. Even in these female dominated fields, men are paid more than women, although, as discussed earlier, starting salaries for women are slightly higher than for men.

For example, 1990 starting salary offers to new baccalaureate graduates in elementary education are $20,351 for men; $18,941 for women.[25] Starting salary offers in engineering (all fields averaged together) are $31,706 for men; $32,333 for women.

Among full time workers, persons with no more than a high school education who operate heavy equipment, almost all men, earn about four times as much as persons with a similar amount of education who provide day care for small children, almost all women.[26] Surely responsibility for children is as important and as demanding as responsibility for equipment! This occupational wage or salary differential, determined by the proportion of women in the field, explains why, among all full time workers, women with four or more years of college earn average salaries ($22,412) that are less than the average salary ($24,701) of men with only a high school diploma.[27]

However, it is generally assumed that because the law decrees equal pay for equal work, that women earn as much as men working in the same kind of job for the same kind of employer, when their educational credentials and experience levels are the same. Unfortunately, this is not true, although it certainly is true that women working in a field strongly dominated by men, such as engineering, will earn far more than women working in a female-dominated field requiring the same amount of education.

Even starting salaries for men and women with new bachelor's degrees in the same field are different (fig. 49), and until this year, the difference always favored men, except in some of the engineering fields. While that continues to be true for most fields, for the first time in 1990, average offers to women graduates in physics, chemistry, and mathematics/statistics are higher than for men. This is in contrast to the biological sciences, where women baccalaureate graduates had average offers of $20,045, while men's offers averaged $22,519[28] The differences are much wider in geology, where women received average offers of $16,358, compared with offers averaging $24,892 for their male classmates. In some ways, this is easier to see when women's salary offers are presented as a percentage of men's (fig. 50).

However, as satisfying as this 1990 development appears to be, it does not necessarily mark a significant change in pattern. It is likely that the combination of small numbers of offers to either men or women in 1990 make the positive change for women more apparent than real. Indeed, information on starting salaries in chemistry from the 1990 survey by the American Chemical Society[29] indicates that new women graduates

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[25] College Placement Council. op. cit., pp. 6-7

[26] Bureau of Labor Statistics. *Employment and Earnings*. January, 1990

[27] The Women's Bureau of the U.S. Department of Labor, "Twenty Facts on Women Workers," reported in *MANPOWER COMMENTS*. April, 1990, p. 16

[28] College Placement Council. op. cit., pp. 6-7

[29] American Chemical Society. *Starting Salaries, 1990*. in preparation. Personal communication, September 18, 1990

are earning about $2,000 less per year than their male classmates. In physics, the salary difference reported in 1989 by the College Placement Council showed men's offers to be $326 higher than women's. And in the geological sciences, where women's offers average only 65.7 percent of men's in 1990, they averaged 97 percent in 1989.

**FIGURE 49**

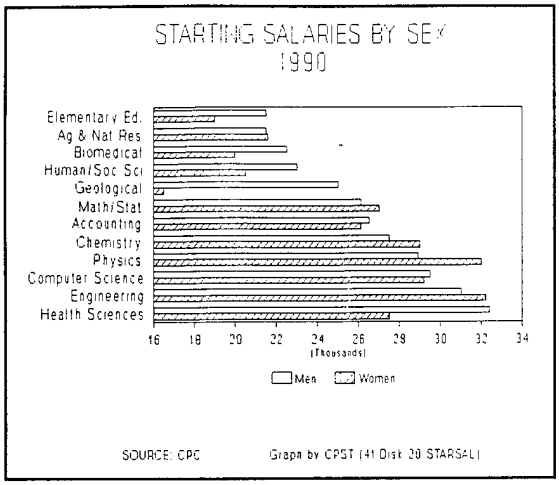
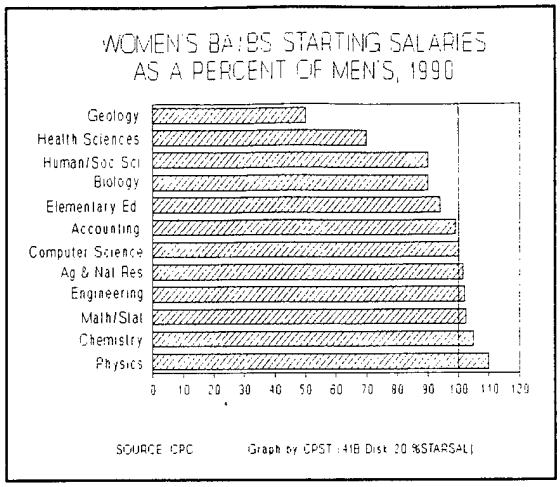



**FIGURE 50**




The somewhat higher starting salaries for women in most engineering fields as shown in figure 16 are following a well-established pattern. However, because promotions for women take longer than for men, salaries paid to women with bachelor's degrees in engineering a few years later are less than those paid to men at the same experience level.

Other surveys of salaries in math-based fields, where the data are less recent, show women's starting salaries that are below men's. For example, among 1986 and 1987 bachelor's graduates in mathematics surveyed in 1988, women were earning $22,900 and men, $25,000.[30]

Among scientists and engineers with doctorates, salaries paid to women are lower than those paid to men, even at the first position after the doctorate (fig. 51). Women also progress more slowly in terms of salary increases, being less likely to be moved into management positions, so that the differential increases with years of experience. The salary gap between men and women doctoral scientists averages about $9,000 per year, but is less in some fields than in others, and is less among those with comparable experience levels. For example, women doctoral chemists with 10-14 years of professional experience earned median salaries of $44,700 in 1987, compared with $51,200 for men at the same experience level.[31] Median salaries of mathematicians with 15-19 years of experience were $48,800 for men and $42,400 for women Ph.D.'s. Doctoral engineers with 5-9 years of experience had median salaries of $51,800 for men, $49,900 for women.

Over a lifetime, it is easy to see why women should be discouraged by the salary differential. They are, after all, charged the same fees and tuition as their male classmates while they earn the Ph.D., and they pay the same prices as men for food, mortgage loans, cars, and other essential goods and services.

The salary difference extends across all science fields, and has changed very little over the eight biennial surveys of the doctoral population that have been carried out by the National Research Council as can be seen by examining women's salaries as a percentage of men's (fig. 52).[32]

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[30] Babco, Eleanor, *Salaries of Scientists, Engineers and Technicians*, Fourteenth Edition, Washington DC: Commission on Professionals in Science and Technology, February 1990, Table 47, page 51.

[31] Ibid., Table 39, p. 43

[32] National Science Foundation, *Characteristics of Doctoral Scientists and Engineers in the United States: 1973* through *1987*, Biennial Series. Washington, DC: National Science Foundation, 1975, 1977, 1979, 1981, 1983, 1985, 1987 and 1989

**FIGURE 51**

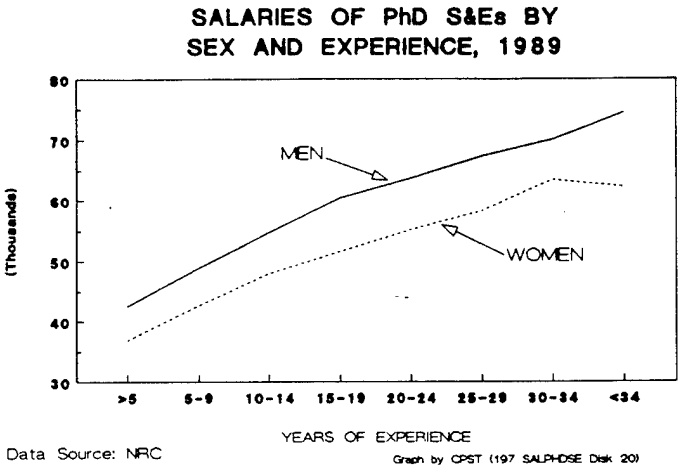



**FIGURE 52**

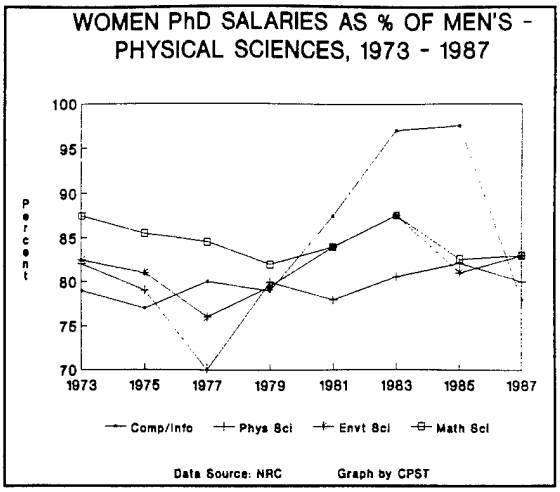
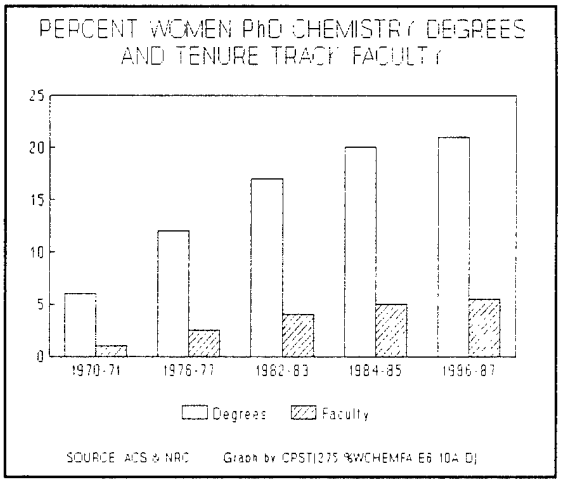



**FIGURE 53**




## Academic Employment

Among doctoral scientists employed in academic institutions, women earn less than men at every rank, in every type of institution and in every field. They also find it much more difficult than the men with whom they graduate to find employment in academic institutions or elsewhere; to achieve tenure when they do receive academic appointments; and to advance in rank.

Women doctorates in chemistry, for example, have earned an increasing percentage of the doctoral awards in chemistry every year since 1960, but their presence among tenure track faculty has not grown commensurately. Indeed, women made up only 5 percent of the tenured and tenure track faculty even in 1987, although they have earned more than five percent of the chemistry Ph.D.'s awarded by these same institutions each year for the past three decades (fig. 53). Doctoral women chemists who are employed in academic institutions earn substantially lower salaries than their male counterparts - i.e. $6,877 less among full professors in 1989, $2,400 less among associate professors, and $3,480 less among assistant professors.[33]

[33] Babco. Eleanor *op.cit.*. Table 207. p. 193.

A new study of a matched set of men and women Ph.D.'s who received prestigious NSF or NRC postdoctoral fellowships after completing their doctorates[34] found that women, and particularly those in the physical science, mathematics and engineering (PSME) fields, were far less likely than the men to be tenured, and that their academic rank is a full step less. Among those who had received their doctorate before 1978, with the four academic ranks scaled from one to four, men in PSME fields averaged a rank of 3.6, while women averaged 2.9. In this same group, 89 percent of the men as compared with 77.6 percent of the women were tenured.

Among those whose doctorates were earned after 1978, men averaged 2.6 in professorial rank and women averaged 1.7. Half of the men in the PSME fields but only six percent of the women have received tenure. Combining tenure and tenure track together, 53 percent of the women and 85 percent of the men were either tenured or on a tenure track. It is notable that differences between the men and women in these matched samples were greatest in the PSME fields, while the careers of women in the biological and social science fields looked, statistically, more like slowed-down versions of the men's careers. In other words, women encountered the fewest career obstacles in the biological sciences, where they are represented in relatively high numbers, while "in the physical sciences, mathematics, and engineering, the few women have, as a group, had less successful careers than the men."[35]

This study supports other surveys[36] in finding that women in math-based fields also are significantly slower than men to attain tenure, and are more than twice as likely as men to be appointed to non-tenure track positions (fig. 54).

**FIGURE 54**

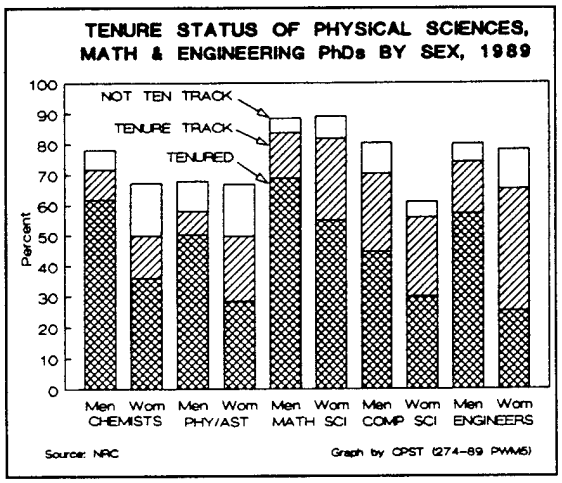
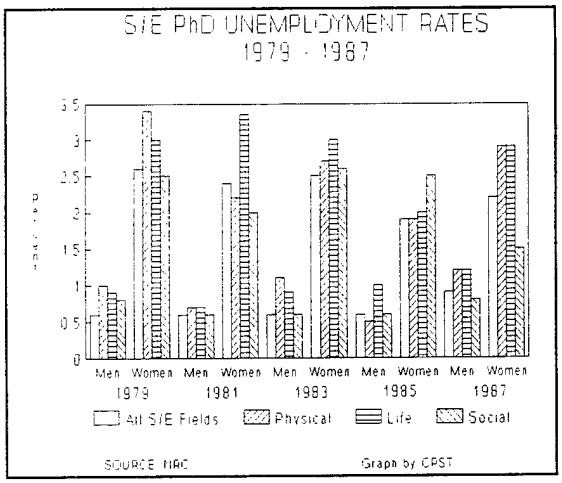



**FIGURE 55**




## Unemployment

Women not only advance more slowly than men with comparable credentials, and are less likely to find permanent positions that put them in line for promotions or tenure, but they also are more than twice as likely to be unemployed and seeking employment. Despite a very low unemployment rate among doctoral scientists and engineers that averages only about one percent overall, the unemployment rates for women in every survey of the doctoral population over the past 15 years have been two to five times higher for women than for men in the same doctoral field (fig. 55).

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[34] Sonnert, Gerhard, "Careers of Women and Men Postdoctoral Fellows in the Sciences," 1990, unpublished manuscript, quoted with permission

[35] *Ibid.*, p. 14

[36] Vetter, *op cit*, Table 5-4, p. 119

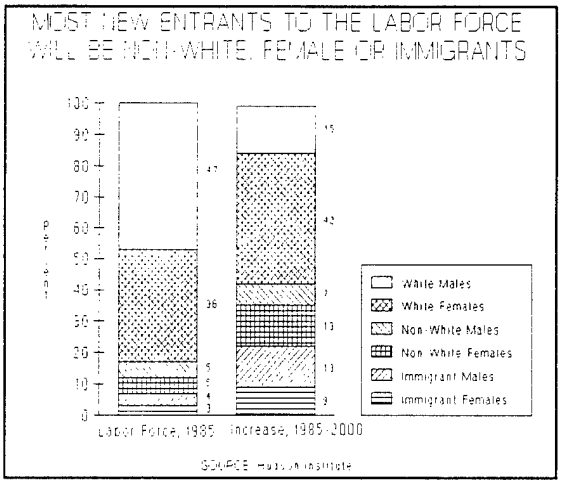
Unemployment among doctoral scientists and engineers is not expected to be the most significant problem in the coming decade or two, but past and present patterns all indicate that when unemployment exists, women are more than twice as likely as men to win this unenviable status, and when overall unemployment is highest, the gap between the unemployment rates of men and women is greatest.

## SUMMARY

Women have increased their presence less in the physical sciences and engineering than in most other professional occupations. They also appear to have made less progress in breaking down the barriers that continue to restrict their advancement among their peers in these fields than is true for women in other fields of science, in medicine, in law, and in general business careers. Relative to men with similar credentials and experience levels, they earn lower salaries, experience higher unemployment rates, are more likely to be in temporary positions, and find fewer and slower opportunities to advance, either in rank or toward management, or to obtain security in the form of tenure.

On the basis of these findings, it might appear logical to encourage women to boycott, rather than to enter these discriminatory fields. But the more useful conclusion is that the discrimination will end only when the numbers of women in these fields are sufficient to assure equalization of opportunity and advancement.

## FIGURE 56




If the United States is to remain competitive in an increasingly technological world, it will need to prepare and utilize more physical scientists, mathematical and computer specialists and engineers than it can obtain from the pool of native born white males. The Hudson Institute's widely quoted report on the workforce at the turn of the century[37] points out that only 15 percent of new entrants to the labor force between 1985 and 2000 will be native born white males, while 64 percent will be women, 7 percent will be native minority males, and 13 percent will be male immigrants (fig. 56).

All of the available forecasts of supply and demand imbalances over the next decade or so indicate potential shortages of significant magnitude in these fields, particularly at higher degree levels, so that for the first time in two decades, the demand for professionals is expected to exceed the supply, and opportunities for women should be better than they have ever been in this century. Because present layoffs, budget problems and a mounting national debt have resulted in cutbacks in research funds and a general belt-tightening across all employment sectors, there are few shortages in any fields for current graduates, despite smaller graduating classes in these fields. For this reason, many potential scientists and engineers who are today's students cannot see beyond today's marketplace (which they cannot affect one way or another) to the probable conditions at that future time when they could have completed their formal training. Young women with the foresight to recognize the opportunity in that fact should be encouraged to prepare for that future.

[37] The Hudson Institute, *Workforce 2000: Work and Workers for the Twenty-first Century*. Indianapolis, Indiana: Hudson Institute, June 1987, p. 95

# WOMEN IN MATH-BASED FIELDS: A PROGRESS REPORT

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## ACKNOWLEDGEMENTS

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Figure 7 is from a paper by Bassam Shakhashiri published in the conference proceedings, *Human Resources in Science and Technology: Improving U.S. Competitiveness,* by the Commission on Professionals in Science and Technology.

Figure 56 is from *Workforce 2000: Work and Workers for the Twenty First Century,* prepared by the Hudson Institute for the U.S. Department of Labor.

All remaining figures were prepared by Richard C. Vetter, utilizing data from the source noted on the figure and published in the eighth edition (December 1989) or the upcoming ninth edition of *Professional Women and Minorities: A Manpower Data Resource Service,* published by the Commission on Professionals in Science and Technology.

Complete references are included at the end of this report.

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*HUMAN RESOURCES IN SCIENCE AND TECHNOLOGY: IMPROVING U.S. COMPETITIVENESS.* May 1990 (in preparation). Members $25; Non-members $30.

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Report to the National Science Foundation on the results of two day workshops on personnel data needs and screening criteria that should be applied to defining individuals as physical, life, or social and behavioral scientists, and methodologies for collecting data in the next decade.

***THE TECHNOLOGICAL MARKETPLACE*** - *Supply and Demand for Scientists and Engineers,* May 1985.* Members $20; Non-members $25.

This 54 page report, which includes over 50 tables and charts, examines past, present and future imbalances in the supply of and demand for scientists and engineers.

***OPPORTUNITIES IN SCIENCE AND ENGINEERING - A Chartbook Presentation,*** Second Edition, November 1984, 96 pages. $15.

Full page charts and accompanying text outline educational preparation and employment opportunities for men and women.

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# COMPUTER EQUITY FOR GIRLS: WHAT KEEPS IT FROM HAPPENING?

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Among the many things I have learned in ten years of working on sex equity and technology, perhaps the most significant are the everyday, human reasons for the lack of progress in equalizing girls' computer use in schools with that of boys. The lack of progress is especially frustrating in view of the fact that it is far easier to close the computer gender gap in a school than to get a faculty started on addressing the problem in the first place.

Equity and technology work is an excellent vantage point from which to make observations about the state of sex equity in our schools, focusing as it does on academic courses, career exploration and preparation, and employment issues for girls and women. This work has taken me into elementary school, junior high and middle schools, high schools, postsecondary community colleges, technical institutes, and vocational-technical schools. I have worked with students (children to adults), classroom teachers, administrators, counselors, recruitment and placement staff, and employers; researchers and analysts, policy developers, and government officials.

This talk, then, is a report from the front lines, from someone who "translates" theoretical education research into programs and materials that are used in schools for enabling girls and women to lead lives of self-respect and economic self-sufficiency.

A recent incident provides the context. A math and science magnet high school history teacher invited me to teach a lesson on women in modern society to his students. After the class I showed him the material I had brought with me on women in the labor force, housework, women in politics, science and business, and more. I showed him the figures on women in technology occupations: in 1987, 7 percent of engineers, 33 percent of systems analysts, 8 percent of physicists and astronomers, 11 percent of geologists,

9 percent of engineering technicians, 4 percent of airplane pilots. I showed him how men out earned women in every case. He seemed pleased to have all this information, saying he would use it in his classes.

Suddenly, he looked up and exclaimed with great consternation, "Hold it, I think I'm getting the picture. You're not talking about equality of opportunity. You're talking about equality of results!" It is a profoundly important distinction.

> ***"If, however, they are inherently equal at birth and we permit environmental conditions to make them unequal as adults, we have committed a great injustice."***

Behind what he said is a conflict at the heart of the historic American ideal of equality of opportunity, our conviction that like WP WP, each of us can rise as high as our talent permits. Recognizing that this ideal was gravely flawed in practice, the civil rights movement of the sixties expressed itself in legislation promising that henceforth all artificial barriers to citizens' accomplishments in public life would be removed, freeing everyone to attain the best education and job she or he was capable of, regardless of race, sex, national origin, or disability.

Special educational and employment programs for groups at the bottom of the national scale were initially approved as a means of dismantling the artificial barriers of discrimination.

After a decade or two of civil rights legislation and special programs, equality of opportunity is now widely thought to be a reality. Any remaining differences in educational, occupational or economic attainments among individuals or groups are seen by many as due to inborn factors which are unchangeable, their outcomes simply a fact of life. Any further attempts to raise the attainment level of underachieving groups is now given the pejorative term "social engineering," meaning the artificial enhancement of an undeserving group usually at the expense of a deserving one. This is where the consternation in the teacher's voice came from.

I freely admit that my assumption that females and males are, in the aggregate, equal in their abilities is just as unprovable. It is precisely the unprovability that makes me assume it. After all, if males and females are unequal at birth and we try to make them equal as adults, all we have done is give ourselves useless trouble. If, however, they are inherently equal at birth and we permit environmental conditions to make them unequal as adults, we have committed a great injustice. We are therefore obliged to assume that equality of results is the norm. Special efforts and programs designed to equalize male and female achievement in technology are thus necessary for as long as it takes.

To my mind, equity is what we do to achieve equality of outcomes. The process of equity is quite straightforward: *awareness* of a sex imbalance to the detriment of girls and women, *concern* about it, and *results* that eliminate it, thus achieving equality -- of educational, occupational, and economic attainments, and therefore equality in self-fulfillment, self-reliance, and the ability to create a decent life for oneself and one's children.

It is because these goals are essential that vigorous sex equity efforts in schools are critical. And because technology is the key to our economic future, equity efforts to encourage the full participation of girls and women in technology education and careers simply must be accomplished in our schools.

Nevertheless, equity is often quite difficult to carry out in schools. Although in my experience computer equity is the easiest kind to accomplish, there are many real-life problems that get in the way of achieving it. I've grouped them into four areas: the legacies of history, sex-biased attitudes, how the way schools operate hinders equity, and some thoughts about value, choice, and responsibility.

## THE LEGACIES OF HISTORY

We are who we have been. Here are a couple of ways I have noticed the impact of the past on the present, with results that are not helpful in equalizing the educational and occupational potential of girls and women.

## Generational Lag

In my computer equity work, I've spoken with many classroom teachers about the educational and especially the occupational value of computer knowledge and skills for girls. I've discussed the changes in the economy and the labor market, and presented figures on the salary and sex differences between jobs that involve computers and those that don't. I've asked then for male/female enrollment breakdowns in their own schools for elective computer classes and optional computer clubs, and they nearly always come up with substantial imbalances. To my mind, the case is pretty clear.

It may be clear, but frequently it's not compelling. Many teachers leave the room *aware* of the computer gap, but fewer of them are *concerned* about it.

It's natural to gauge the importance of an issue by the role it plays in our own lives. A person who invests in the stock market, for example, will pay much more attention to the Dow Jones averages than someone who doesn't. Similarly, 50-year-old classroom teachers have managed to grow up quite well without computers. They learned how to read, write, and do arithmetic without any software at all. They don't need to spend a great deal of time considering the impact of computers on their future careers -- they already *have* careers and get along nicely without computer skills. Their districts may be spending fortunes on computer hardware and software and the teachers may be "encouraged" to learn how to use it all, but they know they will not be fired if they don't. Computers are obviously not a burning personal issue for many teachers.

Their students, however, will live in a society in which technology plays a vastly more pervasive role than it does today. Communications, health care, finances, entertainment, production, consumption -- all will be increasingly affected by technology. In ways we cannot imagine today, tomorrow's adults will need to be technologically literate as citizens and technologically skilled workers.

If I am correct in my conjecture that teachers who live quite comfortably without computers and other modern technology are the least likely to encourage girls' computer use, I wonder whether a substantial introduction of technology into their personal lives would have a positive effect on their motivation to achieve computer equity.

## New Converts Are All Alike

Sex equity in education is a delicate topic. It raises the most personal issues in each of us: how we feel about ourselves and the opposite sex, our role in the world, how we bring up our children. It is understandable that educators don't exactly welcome upheaval in these areas. However, I and other sex equity advocates may have contribute to the problem of sex bias in the schools years ago when we were new converts to the women's movement.

We were angry because we saw so clearly the myriad ways that schools unintentionally mirrored and institutionalized sex discrimination -- the readers that showed little boys exploring and little girls waiting, the math texts that had boys solving velocity problems and girls solving recipe problems, the assignments of boys to shop class and girls to cooking class, the much higher athletics budgets for boys' teams than girls' teams, and on and on.

In the heyday of schools' attention to the sex equity issue in the mid-to late 70's, many sex equity trainers fell into the new-convert trap: our passion and our anger at the unfairness of it all and the damage to girls came through clearly to the teachers who were required to attend these in-service sessions. With hindsight, the result was predictable. Since no one likes to be blamed for oppressing poor defenseless little girls, teachers who had been neutral about sex equity distanced themselves from it, and teachers who had been actively sexist found in their resentment an excuse for being so.

Any sex equity trainer working in the schools today must remember that some groups of educators, particularly those attending mandatory sessions, may be angry before the workshop even begins. Because of past experience with an accusatory trainer (or perhaps because of a guilty conscience!), they're probably expecting us to call them bigots and point out their faults one by one, even faults committed by textbook publishers or parents or television. This means that a sizable amount of time must be spent defusing their resentment before trainers like myself can hope to convey our message.

*"I talk about the importance of increasing girls' computer participation, for educational and especially occupational reasons."*

## SEX-BIASED ATTITUDES

While it's nice to say that educators are entitled to all the sexist attitudes they want as long as their behavior with students is sex-fair, in reality attitudes tend to control behavior. Here are some of the ways it happens.

### Don't Lift That Stool!

Most teachers believe that sex bias is overt and easily recognizable -- the counselor who says "A pretty girl like you doesn't need to take programming," or the teacher who always gives the boys first crack at the computers. Since most teachers rarely if ever witness such scenes, or even hear about them (and they *know* they haven't done such terrible things themselves), teachers often don't believe people like me when we say that sex bias occurs all the time.

Recently a friend told me about just such an incident. Her daughter, a high school senior, had after much hesitation chosen to take advanced physics rather than advanced biology. She came home from the first day of school very upset. "I'm the only girl in the class, Mom. I hate it. And after class a bunch of the guys and I were walking down the hall when we ran into our physics teacher from last year. He called out, 'Well, here's the advanced physics group -- and here's the advanced physics groupette!' I don't think I can stick it out, Mom." I can't believe the teacher intended to pressure this girl to drop the course, but nevertheless that's what he was doing.

### The Equity Trap

It's obvious to me that since girls are socialized differently from boys, schools that want to equalize girls' and boys' computer behavior have to take sex differences into account. Many educators are now sensitive to sex differences. This sounds like progress, doesn't it? This sensitivity, however, can be a big trap, and here is how it works.

Let's say I'm talking with teachers about girl's computer avoidance -- how girls observe that it's mostly men and boys who use computers in school, at home, in the media, in video arcades, and so forth, and how they conclude that computers are a male thing. I talk about the importance of increasing girls' computer participation, for educational and especially occupational reasons.

One of two things can happen. A teacher will triumphantly tell me that in his or her school they no longer have a computer equity problem: since many girls like to write, the faculty now encourages girls to use the computer for word processing. Or else a teacher will hear me say that an effective computer equity strategy is to use the computer for writing (which many girls really *do* enjoy), and accuse me of sex bias for not having suggested spreadsheets.

One way to get out of the trap is to say that since girls like to write, it's sensible to use writing *initially* to establish their interest in computers and go on to spreadsheets once that interest is hooked. It's also essential to remember that some girls will initially be far more interested in spreadsheets than word processing. I'm not totally satisfied with this solution, however.

To illustrate why, I am told that there is cosmetics software on the market. You select a face shape, then you experiment with lighter or darker lipstick, eye shadow only on the eyelid or up to the eyebrow, and such. I strongly suspect that a lot of computer-avoiding adolescent girls would love to use this software, and presumably a competent teacher could move then on at some point to spreadsheets, programming and beyond. Although I do believe that all good teaching starts with where the student is and then moves her on, I admit that I can't stand the idea of using a cosmetics program, as successful as it would be, to get girls interested in computers.

> ***"Equity in technology is in a sense a negative issue, an issue about what isn't rather than what is."***

The fundamental problem is that a sex-biased society teaches girls to have sex-stereotyped interests. When we initially appeal to girls' interests in writing, or heaven forbid, cosmetics -- even when the appeal is a ploy to get them eventually to move on to more advanced computer uses, aren't we strengthening the very sex-biased attitudes we are trying to eliminate? If so, then we must propose spreadsheets and programming directly, to bypass the traditionally female, stereotyped interests. But most girls won't be interested in these traditionally male activities, so we reinforce their computer avoidance. Where is the way out of the equity trap?

## THE WAY SCHOOLS OPERATE HINDERS EQUITY

Into this category I placed a few situations which, although they may have nothing to do with computer equity *per se*, nevertheless hinder or prevent it from happening in a school.

### Acute vs. Chronic

Computer equity progress is often hindered because equity is only one of many programs, initiatives, and concerns that schools would like to address: beef up the library, get more computer hardware, revise the language arts curriculum, expand the health services, create a family life course, get new uniforms for the football team, patch the roof, hire more science teachers, develop a better discipline policy, and on and on. Since most public schools are underfunded in relation to what government and parents expect them to accomplish, it is inevitable that the "squeaky wheel" rule prevails and the most acute or crisis-laden needs are addressed first.

Equity in technology is in a sense a negative issue, an issue about what *isn't* rather than what *is*. When advanced electives are completely enrolled -- with mostly males, and when girls avoid the courses because they are socialized to believe that computers are something boys do and thus don't complain about the imbalance, there is no squeaky wheel to be heard. It is hard to perceive such a quiescent and superficially acceptable situation as a problem, especially compared to a roof that leaks and parental complaints about drug use in the schools.

To exacerbate the difficulty, it takes no effort to maintain the imbalanced enrollments while it may take substantial time, energy and possibly some money to balance them. It's hard to challenge this *status quo*.

### It Doesn't Always Trickle Down

When I worked with teams of junior high classroom teachers and administrators to develop strategies for encouraging greater computer use by girls, they reasoned that it was necessary for teachers and parents to become familiar with computers first in order to encourage girls to do so. Accordingly they carried out a variety of formal and informal sessions with both groups to teach them how to use computers, stressing the need for special encouragement for girls.

These indirect strategies turned out to have very little effect on girls' computer use, compared with others that targeted girls directly. I finally figured out that the teachers and parents got sidetracked before their new computer knowledge ever reached girls. In one pattern, the adults became so enamored of the technology for their needs that they forgot about the girls. In another pattern (especially frequent among teachers!), adults felt they had to be "expert" before actually teaching computing to their female (and male) students, and kept delaying until they were really expert. You can imagine how long *this* can take.

When sex equity progress depends on increasing teachers' skills or changing their behavior, it often falls into the trap of *assuming* that the new skill or behavior will be conveyed to the students, which in turn will lead to the desired changes in students behavior such as higher female enrollment and completion of computer electives. Without built-in plans and schedules for the adult-to-student transmission, the assumption isn't always justified.

### The Lack of Followthrough and Followup

One of the reasons we often accomplish relatively little from all the time and effort we spend on educational innovation is that provision for followthrough is rarely made. This year's successful school program is displaced by next year's new program: educators don't have enough time to do both of them well, and the new one usually has a more insistent constituency. In this way the benefits of the successful program stop with this year's students.

The followthrough problem also relates to the fact that children move on through the grades. Next year's 8th grade teacher may not care as much about Katie's interest in computers as her 7th grade teacher does. When Katie enters 9th grade in the high school building, those teachers may not even be aware that computer equity is an issue. Without active and continued encouragement from all her teachers during the years when traditional sex-role influences are at their most powerful, Katie may well decide to leave the computers to boys after all.

Followup is a problem as well. Educational program development grants rarely include funds for longitudinal followup. I am not the only program developer who uses control groups to test the effectiveness of a model program rather than comparison over time because of funding constraints. As a result we know when new programs are effective in the short run, but often have no idea whether the effect remains or dissipates in time.

While the lack of followthrough and followup is a pervasive problem for educational research in general, it is even more critical for equity research. Girls constantly receive messages from society -- parents, peers, teachers, the media -- that technology as a school subject and career is more appropriate for males. Without followthrough or continued active encouragement, society's male-only message ceases to be counteracted and many girls are likely to take the path of least resistance. Without followup, we have no way of documenting that this is happening.

## VALUE, CHOICE AND RESPONSIBILITY

In addition to the legacies of history, sex-biased attitudes, and school operations, I would like to conclude my consideration of computer equity with a couple of broader issues of value, choice and responsibility.

### Required vs. Optional

Beyond the required introductory course of a few weeks to a year that is usually given in the middle school grades, computer instruction in the United States is usually offered on an optional basis thereafter. Preparation for a career in technology at any level is also elective. The result of all this free choice is that girls take fewer computer courses than boys do, repeating the pattern we have seen for years in mathematics and science.

After twenty years or so of research, we know a great deal about why so many girls drop math and science as soon as these courses are no longer required. Some girls are overtly or subtly discouraged by teachers, counselors, parents, and friends. Most, however, are simply allowed to fulfill the societal

expectation that math and science are male endeavors. When the deck is stacked, no great effort is required to reach the predictable outcome.

I think the unbalanced outcome in computer study should make us reconsider required vs. optional courses. We already make this distinction in some educational environments. We don't let kids choose between reading and recess, for example, because we know that reading skills are essential for all children if they are to function in our society -- and also because we know that given the choice, most kids would choose recess! So reading is required. On the other hand, courses such as advanced calculus and music composition develop skills and interests that vary from person to person, and as such are properly optional.

*"I think we need to recognize that we are asking them to operate in a manner that runs counter to the sexism that permeates all of society."*

Where should computer study be placed on this spectrum? If we believe that computer ability is essential -- occupationally and/or in terms of one's ability to understand and participate in the world around us -- for a fully functioning adult in the first half of the twenty-first century, then a semester's course in the 7th grade is grossly inadequate. If we believe that most people will be able to get along just fine without any knowledge of computers, then why do we require children to study computers at all?

This fence-straddling is perhaps inevitable, given the newness of computers and the extremely rapid changes technology has made in our lives. At some point, however, we are going to have to come down on one side or the other of the question. Until then I suspect that the computer equity issue will remain one of persona; philosophy: since boys' society-taught enthusiasm for the computer leads them to take more computer courses, to what extent do we have an obligation to ensure that girls obtain computer knowledge and skills on a par with boys?

## Swimming Up Stream

The last issue I would like to mention today concerns the educators whom we ask to promote computer equity for girls. I think we need to recognize that we are asking them to operate in a manner that runs counter to the sexism that permeates all of society. Parents call their newborn son "the big guy" and their newborn daughter "the little doll." Toy doctor kits show boys on the package; toy nurse kits show girls. Children's books and television programs present boys who have adventures. In elementary school kids have women teachers. They read in their textbooks about more men than women and more boys than girls. The authoritative voice-overs in TV commercials are male. The principal is male. Mommy is the parent who reminds the kids to take their lunch money. And this is only the world of children. The sexism continues into the adult world, perhaps more subtly but not less powerfully.

This is not to blame anyone. Because society has been sexist, it inevitably leaves us a sexist legacy. Adults can only teach children what they know themselves.

The educational equity movement is built on the belief that beyond simple justice our society can no longer afford sexism (if it ever could). Computer equity promotes the equal participation of girls and women in computer studies and jobs because we are unwilling to discard half of our talent pool, and because unfulfilled, dissatisfied women benefit no one.

But to accomplish equity -- in this case, to encourage girls' interest in and involvement with computers, to encourage girls and women to enter technology-related careers -- schools swim against the current of many streams. For every teacher who insists that girls become knowledgeable about computers, girls are receiving the constant message from television, the print media, families, friends, other teachers, even the video arcades, that this interest is *really* for males. The pull of all these forces is very strong. Educators who resist them need a great deal of support. How can we support each other better?

If we had answers to some of these questions, I and other computer equity advocates could do a better job of helping educators to recognize that sex bias has causes which lie in the past but have present

consequences, such as parents who put the children's new computer in the boy's room, or causes which are subtle but have powerful effects, such as teachers who call on boys for interpretative answers but girls for fact answers. We want to help educators refuse to accept the stacked deck, refuse to permit girls to say "no thanks" to technology just because the stereotype leads them to say it. Finally, we want to help educators insist on nothing less than equity: determined, persistent efforts to overcome the consequences of sex bias, so that every single one of us has a real shot at being superior.

# LUNCHEON GUEST SPEAKER

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*Dr. Jemison has a background in both engineering and medical research. She has worked in the areas of computer programming, printed wiring board materials, nuclear magnetic resonance spectroscopy, computer magnetic disk production and evaluation of trophic factors for C epididymides. She completed her internship at Los Angeles County/USC Medical Center in July 1982 and worked as a General Practitioner with INA/Ross Loos Medical Group in Los Angeles until December 1982. From January 1983 to June 1985 Dr. Jemison was the Area Peace Corps medical Officer for Sierra Leone and Liberia in West Africa. Her task of managing the health care delivery system for U.S. Peace Corps and U.S. Embassy personnel included provision of medical care, supervision of the pharmacy and laboratory, medical administrative issues, and supervision of medical staff. She developed curriculum for and taught public health/safety issues for volunteer placement and training sites. Dr. Jemison developed and participated in research projects on Hepatitis B vaccine, schistosomiasis and rabies in conjunction with the National Institute of Health and the Center for Disease Control. On return to the United States, Dr. Jemison joined CIGNA Health Plans of California in October of 1985 and was working as a General Practitioner in Los Angeles when selected to the astronaut program. Dr. Jemison was selected as an astronaut candidate by NASA in June 1987. She completed a one year training and evaluation program in August 1988 which qualified her for assignment as a mission specialist on Space Shuttle flight crews. Her technical assignments have included astronaut office representative to the Kennedy Space Center, Cape Canaveral, Florida, which involved participation in the processing of the Space Shuttle for launch, especially its payloads and thermal protection system, and launch countdown; work in the Shuttle Avionics Integration Laboratory (SAIL) performing verification of Shuttle computer software. Dr. Jemison's current assignment is as a mission specialist on STS-47, Spacelab-J. This mission is scheduled for June 1991. Dr. Jemison received her bachelor of science degree in Chemical Engineering and also fulfilled the requirements for her B.A. in African and Afro-American Studies at Stanford University in 1977. She went on to receive her Doctorate in Medicine degree from Cornell University in 1981.*

Good Afternoon. It's really exciting to be here and also a little bit intimidating, because usually I'm off speaking to groups who have limited backgrounds in science and space. Today I have to tell the truth because you guys already know all of this stuff. So I'm going to deviate a little bit, and I won't spend as much time talking about the space program because I know that you are already very enthusiastic about it. What I'd like to do is to be able to spend a little time talking with you about just things that go on in my mind that are important to me and that I know are important to you also. I will spend a little time talking about science, education, technology, and what kind of an effect technology has on our community.

First of all, I'd like to get a couple of things out of the way. I'm not an adult like the rest of the people in this room. I'm a child. The reason why I say I'm a child, and I think I should have probably included a few more people in here who are children also, is because I like to think that I am still learning and growing, still having an interest in watching things grow. So many times I'm really struck by the fact that parents come up to me and may say things like, "What can I do to get my children to grow, to learn, to achieve?" I assume they know I have the answers, but for me, I don't think it's a problem with the children; I think it's a problem with parents, adults, and teachers. If we try to learn, try to grow and try to achieve our aims, then children will follow us.

***"I think that lots of people in science and technology misunderstand science and technology."***

When was the last time some friends of yours may have read a really good book, and then shared those ideas with you from that book? Sometimes it's tough to share ideas about Sheila's secret love, but there are other books you can share and spend time learning and growing. Sometimes it's important to just set a goal -- to achieve something that you want to do in your life. Sometimes it's important to push yourself to the point that you can get rid of an old idea that was holding you back and substitute a new idea that will let you go forward.

Sometimes people come up to me and say, "Oh I really wish my children could have seen you, so that they can see what young people and women can do. You're such a good role model." You know if there's something in an individual's attitude, or style, or something you like about that individual, you can incorporate it into yourself no matter how old you are. In fact children mimic their parents, they mimic people who are close to them, not people who they see once in a flash on the news screen. It's important for teachers and parents and adults to be role models for the children that they are around.

Another thing that always gets to me is that people come up to me and say, "Well, what can we do for the children so that we can make sure that they're better leaders, and that they can lead the world tomorrow?" We could lead it <u>today</u>, we could do a really good job. Or if not, we're sort of planning to sit back and leave a mixed-up world, one that's mismanaged, and misogynous. Then sit back on Social Security and let kids straighten it out.

It's important for all of us to understand that we are continuing to grow every day and that the world is full of amazing discoveries --and that we're on a long journey. Now this conference is on science and technology, and I think science and technology are something that's really very misunderstood. I believe that people feel very foreign, feel like outsiders, as if they are outside of it, and many misunderstand it. I think that lots of people in science and technology misunderstand science and technology. Many folks think that science is basically something like $E=MC^2$, or the three laws of thermodynamics, or the world is in constant increasing entropy, or there was a new quasar discovered in such and such quadrant in the sky. Yes, that's part of the language of science, but also, the language of science is - I think, I wonder, and I understand; and I truly believe that science is a search for understanding. Technology is putting that understanding to some practical use. It's to help produce solutions for problems that we have. I believe that all of the issues that face our world today, that you face, that I face, and perhaps those our children will face, all of their solutions are 50 percent planned through technology. The other 50 percent are probably random luck, random chance.

Now, wait a minute. I know there are some people in here who may say, "Wait a minute, she's getting carried away. Science isn't all of that." Yes, but it is, because you need to understand the psychology of drug use and the effect it has on your body, and you need a trained and competent work force in order to produce new things in the economy. Basically that meant to me that no matter how many Wall Street maneuvers you had, how many companies were bought and sold, unless you actually had a labor force that was trained in technology and that you had some research and development, the economy was going to be stifled. You know all companies want to know what's the bottom line on an endeavor; how much money

are we going to make. The bottom line is that if we don't use all the children that we have, and give them an opportunity and encouragement to learn mathematics and science, to be literate, the bottom line is no one is going to make any money at all.

*"I think it's really cruel to take students, high school seniors, put them in college and tell them, "We're going to give you a chance to work in this engineering program," and they haven't had the mathematics to begin with or the science."*

Now, I know you are going to get lots and lots of statistics here today. However, I have to give you a couple, because it is a must. I understand one thing is very striking. In the year 2000, only 25 percent of the graduating classes will be white male. And that's the group that traditionally has been the source for the engineers and scientists. Right now Blacks and Hispanics account for less than two percent of the Ph.D.'s that are given in the Physical Sciences and Engineering. By the year 2020, Blacks and Hispanics will make up over 1/3 of the United States population. In 1985 and 1986 women received only thirteen percent of Engineering Bachelor of Science degrees, only seven percent of Engineering Ph.D. degrees. Only fifteen percent of the Physics B.S. degrees were received by women, and only nine percent of the Ph.D. degrees in Physics. We know that women make up over half of our population. So we're losing lots of talent and potential. Over 75 percent of the potential resources we have in this country are being lost, when we do not include women and minorities as a potential crew for developing science and technology expertise.

Now, I know that there's no one in this room guilty of this, but I want to arm this group with information to take out to your friends. You can raise your hand if you have a friend that you know who's said this before. You know how it is when kids come home with their report card and they don't want to show it because they have a bad mathematics or science grade. I'll bet at least one of you had a friend who said, "Oh yeah, baby, don't worry about that, mathematics and science are hard. Everybody can't do that. I couldn't do it when I was a little kid either." That's ridiculous. Anybody can do mathematics and science. If you think about it, in the 1800's and 1900's, they said everybody couldn't learn to read and write, and we know that is wrong. But you have to start really early; you can't start late.

I think it's really cruel to take students, high school seniors, put them in college and tell them, "We're going to give you a chance to work in this engineering program," and they haven't had the mathematics to begin with or the science. It's cruel. It's not going to work. For me it's like telling somebody how to go to the bank, what the bank account number is, how to get the money out, but doing it in Japanese. You're not going to get any money. But you know you have to start early. You have to start with the very basics, you have to start with addition because in order to do subtraction you have to know addition. You need subtraction to do division, you need division to do algebra, you need algebra to do geometry, you need geometry to do trigonometry, you need trigonometry to do calculus, you need calculus to do differential equations, you need differential equations to do partial differential equations, and without partial differential equations, the shuttle's not going anywhere.

Many times I used to be asked by people in the news, when I was first selected, "What motivated you?" That was really tough. I figured I must come up with a good answer, because people kept asking me this question, and yet I couldn't come up with an answer. I finally figured it out. The reason why I couldn't come up with an answer is because I was always motivated. Just like every other child, children are born motivated. What happens is that people de-motivate them. Folks tell them what they can and cannot do, and I was lucky enough to have parents who didn't tell me that. They told me that I was capable of doing anything. My parents and teachers were excited about my motivation and aggressiveness. They didn't have this image that they wanted to fit me into. Although my mother used to tell me how to sit like a lady (keep your legs crossed) but my parents never did tell me that I couldn't be involved in science if I wanted to.

It's important not to let others limit you because of their limited imagination. It's important that you

don't limit others because you have a limit to your imagination. It's important to make opportunities for yourself and make opportunities for others. Opportunities come in all forms. They don't have to be very large, grandiose programs, they can be rather small programs.

*"I know a lot of you had science projects; some were really goofy. I had this one science project that was on gold fish swimming through a maze. My cat liked the project."*

I'd like to share with you some opportunities I had in my life. When I was five years old I had an uncle who used to take me outside. We would look up at the stars, and he would tell me that stars were really suns. The only reason they were so small was because they were so far away, they were millions and millions of miles away. He'd also tell me about Einstein's Theory of Relativity and tell me that he had no doubt that I could understand it right then if I had an opportunity to talk to Einstein.

I remember special involvement programs. Some of you guys may remember SRA readers, I think they still have them. That's a real small, little thing, but it gives a child the opportunity to read at their own pace and learn information that is not necessarily covered in a text every day. I used to go to something called Hull House, an Ada S. McKinley Program in Chicago. Her whole house was like a social center/after school activity center, and I used to go there and take ceramic classes and dance classes and art classes. I grew up in Woodlawn in Chicago, and for those of you who know anything about Chicago and Woodlawn, you probably know that there are a lot of other things for a child to be doing after school besides going to ceramics classes at Hull House. But that opportunity was there and available.

Now sometimes you make opportunities for yourself even if you're still pretty young. I know a lot of you had science projects; some were really goofy. I had this one science project that was on gold fish swimming through a maze. My cat liked the project. There was one that I thought turned out to be pretty good, and it was one that was done on sickle cell anemia. The way I got involved in the project is I decided I wanted to do a project on sickle cell anemia. I knew sickle cell anemia was a blood disease. I knew that hematology was the study of blood diseases, and I knew that hematology laboratories existed in hospitals. So I called Cook County Hospital in Chicago and said, "Hello, my name is Mae Jemison and I want to do a science project on sickle cell anemia, may I speak to the head laboratory technician?" They put the supervisor of the laboratory on the phone, and I went through my spiel, and he said "Why don't you come down and I can show you what we do in the lab." So I used to go down after school, maybe twice a week, and we'd spend time together. He'd show me how to do electrophoresis and stuff like that, and identify the different types of hemoglobin. For maybe about two or three weeks, I was just going down all the time, doing research, helping to make solutions and things in the lab.

One day the Director of the lab, a M.D. kind of person, came in and saw me sitting next to the centrifuge. He sort of looked at me and said "Who are you?" I said, "Well, my name is Mae Jemison and I'm working on a science project on sickle cell anemia." Now there were a number of things that he could have done at that point in time. He could have told me, "Get out of my lab." But that's not what he said, instead he said "What's your hypothesis?" He asked me, "Well, what research have you done? What literature are you working with?" He said, "Well, if you're going to work in my lab on a science project, I want you to develop a hypothesis and I want you to get some literature." He sent me to the Illinois Institute of Technology to do research there, I had to write to the National Institute of Health to get information on the latest drugs that they were testing for sickle cell. I came up with a hypothesis and literature research and actually ended up working with the compound that people were thinking about using for sickle cell anemia. That was an opportunity that he could have not given me. It was not a specific program.

I have worked with programs also. I had a scholarship from Bell Laboratories when I was going to college, and every summer I used to work at a different Bell Laboratory facility on some project or another.

One summer I was working in Murrayhill, New Jersey on a project called Nuclear Magnetic Resonance Spectroscopy. There were two machines in the world like the one I was working on, and each one cost over a million dollars, which was a lot of money at that time for chemistry equipment. They used to let me go into the room and work on the equipment by myself and do the analysis of everything by myself. I was 19 years old. So for me now, being 33 years old, working with and being partially responsible for equipment that cost about two billion dollars with only four copies of it in the world feels about right.

*"When you leave here, I know a lot of people will be asking, "What does this space program have to do with any thing? You know, those guys brought back the moon rocks -- who cares, big deal --they just go up there joy riding. But, actually we all know that the space program has done much more than that"*

It's important for us to understand that when we talk about education, that education and literacy mean not just the discipline in which you're involved, but all disciplines. It's important not only to be able to read and be literate, but to understand history, to understand some science, to understand some technology. It's important that the people who are going to make decisions on technology and implement those decisions - that is politicians, program administrators - have some understanding of the science and the technology they're directing. It is equally important for all of us who are involved in science and who are engineers, to know that we interact with society everyday. We have to know how to communicate. Your idea is no good as a scientist if you cannot communicate it to someone else. It will sit there and die with you, and it won't win you a Nobel Prize either. It's important that every physicist, engineer, physician, chemist, biologist understand the implication of their discoveries. They must understand the responsibility they have to make sure it's used for beneficial purposes. It's important for everyone to understand that science and technology have something to do intimately with them.

When you leave here, I know a lot of people will be asking, "What does this space program have to do with any thing? You know, those guys brought back the moon rocks -- who cares, big deal --they just go up there joy riding." But actually we all know that the space program has done much more than that. I'd just like to talk about one thing, I'm not going to talk about NASA spinoffs or any of that kind of thing. I just want to tell you whenever someone asks you, "What does the space program do, what difference has it made in the world?" - just ask them about communication satellites. Would they have been able to watch the football game if not for the communication satellites? Would we know what was going on in the Gulf? Communication satellites have changed our perception of the world; they've shrunk the world.

Now we're meddling in everybody's business. So we're able to look at things like defense systems. We have the potential for evaluating crops and weather conditions before they occur or become problems. We have the ability to look for new mineral resources and scan millions of miles, square miles, at one point in time, over small periods of time. So whenever someone starts to talk to you and asks you, "What effect does science and technology have on my life, what effect does the space program have on my life?" - ask them, "Did you primp in the mirror this morning; did you put on any make-up; did you listen to Jazzy Jeff on their way to work or Henry Mancini?" It depends on whom they listen to.

I would just like to leave you with a couple of more ideas. One of the things I found that affects me tremendously, and has affected a lot of people, is images - things I've run into, problems with images. You know people have image problems. How many of you folks watch Star Trek? You know when I grew up I watched Star Trek and I must admit it was one of my most favorite programs, but I've always had some problems with Star Trek. My problem was the command structure. Now the way it was set up in the first Star Trek, there was Captain Kirk, Mr. Spock, Scotty, Sulu, Checkov, something like that. Lt. Uhura didn't figure into it, because they said that women couldn't command starships. Do you all remember that episode? I do. Well, we know that in The Next Generation, they've done a little better. They grew up; they knew better than to do that, right? So they have women commanding other starships, not the main one. I still have a problem, because now you look at Star Trek and the command structure goes, Picard,

Ryker, and then it's not Troy, it's not Worp, it's not Jordy. They had to go get Beta, an android who doesn't understand anything about people. All because of the images as to what would people who are watching the program accept. So you have to be careful about the images that you see.

*"I have seen some personal image problems. The first one I noticed, that I really remember, was when I was in kindergarten. You know how kindergarten teachers always ask you, "What do you want to be when you grow up?" Well, I said, "I want to be a scientist." She said, "Uh, don't you mean a nurse?" Because she had an idea in her mind what were women's roles in science at that time."*

I have seen some personal image problems. The first one I noticed, that I really remember, was when I was in kindergarten. You know how kindergarten teachers always ask you, "What do you want to be when you grow up?" Well, I said, "I want to be a scientist." She said, "Uh, don't you mean a nurse?" Because she had an idea in her mind what were women's roles in science at that time. You know, the problems don't always come because of disparate generations, or because someone is different from you. When I was in medical school my gross anatomy partner was a black female, my age. We were in gross anatomy, about two weeks into school, and we were standing there working on a cadaver. She said to me, "You know it's really funny, you don't look like a doctor, you look like you should have been a lawyer or something like that." She had an idea of what even she was supposed to look like.

When I did my internship I went to do it at the University of Southern California (USC)/LA County Medical Center. About two weeks into the program, again I had on my whites, you know jacket, stethoscope hanging out the pocket, looking really haggard, that intern look, blood on the lapel, and I ran into someone with whom I had gone to college. I'm not going to tell you his name, but he came up to me, and he was in whites, looking real haggard, and he said, "Mae, what are you doing here?" I looked at him and said, "The same thing you are," and he said, "You know, you were involved in all those student politics and all that other stuff, I thought you would have been going to law school or into dance or something." And I was thinking, "Well, Donnie, you know you were involved in football. I thought you were gonna to be a jock or something."

Another time this happened to me even after I got into the astronaut program; I'm not immune. I went to Indiana University of Pennsylvania. They were confused to begin with, I knew I had a problem. But I like to talk to schools whenever possible, so I went to talk to a grade school. The principal was so enthusiastic he said, "Oh, Dr. Jemison it's so great to have you here today because we're introducing this special program today. The state has said it's going to take essays from students in science and the best essays will get a trip to Space Camp. I am going to have all my male teachers introduce it today." He decided he'd better straighten it out; you know, I guess the look on my face said something. He said "Oh, the reason I'm having my male teachers introduce it is because I figure they're more interested in science." Well, I'll just let you all know that all the little girls won the badges that I had brought. You would have thought that maybe I'd leave Indiana, Pennsylvania at that point in time, but no, I stuck it out. There was a reception they were holding for me, and this really smooth, handsome, sophisticated, suave graduate student came up to me and said, "Oh, Dr. Jemison, it's wonderful having you here today and I'm really looking forward to your remarks. By the way what kind of a doctor are you?" I said, "I do general practice." "Oh, okay, I figured, because you don't look like a surgeon." When people have an idea of what you're supposed to be like, what kind of images they have in their mind, you have to let some of that just go on by. There are even some people who tell me, "You don't look like you're an astronaut." But the funny thing is, whether they think so or not, I am.

This will give us a little bit more time for you to ask questions, I just wanted to go ahead and end with saying: you know when we talk, as adults, and we sit down and talk about education and how to get more people involved in science and technology, we have to understand that we must continue to work, learn, grow, wonder, and seek solutions to the problems we have now, whether we created those problems or

whether we inherited them. For me, and I guess most of you, there are only like 86,400 seconds in a day and each one of those seconds is very, very precious. You can spend that second as you like, but you can never get any of them back. And I can guarantee you, that if you spend each one of your seconds to your best benefit, if you spend it learning, growing, seeking a better world today, the world that our children will inherit tomorrow will be alive and healthy, filled with amazing beauty, and all our daughters will know how to proceed.

# ADVANCEMENT OF WOMEN IN SCIENCE, ENGINEERING, AND TECHNOLOGICAL CAREERS[1]

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## INTRODUCTION

Within the National Research Council, the Office of Scientific and Engineering Personnel (OSEP) is one of two offices responsible for activities that cut across all disciplines of science and engineering. OSEP provides coordination, support, and expertise that can enrich examinations of disciplinary issues and serves as a monitor by identifying emerging issues, providing early warning signals on problems that may be developing with respect to the nurturing, development, and utilization of scientists and engineers, and making sure that these issues are acted on. In this role, OSEP collects data on the doctoral population in the United States; convenes workshops, symposia, and conferences; and conducts analytical studies that (1) illuminate the questions that need to be addressed in order to arrive at sound solutions to the problems, (2) lay out a possible research agenda to answer those questions, and (3) determine answers to the questions as well as missing data needed to answer them.

One such emerging issue is the potential shortage of scientific and engineering personnel in the next decade. The United States faces a critical period in the development of technical and scientific priorities to cope with numerous problems of this technological age. Particularly urgent is the need to maintain and to expand existing scientific and technical personnel pools in order for this country to maintain its economic competitiveness in world markets. Two years ago, the National Science Foundation (NSF) noted, "In order

[1] The views espoused in this paper are those of the author and do not necessarily reflect those either of the Office of Scientific and Engineering Personnel or of the National Academy of Sciences/National Research Council.

for the United States to maintain its leadership position in world markets, it must increase its investments in science and engineering education and research."[2] Luther Williams - assistant director of NSF's Education and Human Resources Directorate and a vice-chairman of the Committee on Education and Human Resources of the Federal Coordinating Council of Science, Engineering, and Technology - recently emphasized the importance of improving science and mathematics education at all levels of the education pipeline, focusing on:

> developing means for decreasing the science and mathematics avoidance rates of female, minority, and disabled students, increasing their interest in scientific and technical careers . . . [and] increasing the number of university faculty and researchers who give attention and effort to the improvement of science, mathematics, and engineering education . . . to ensure that the Nation will have the scientists and engineers it needs for the future and the technically literate workforce and educated public we require as we enter the 21st century . . .[3]

Similarly, in his address at the 125th annual meeting of the National Academy of Sciences, Dr. Frank Press emphasized the necessity for a cohesive program of science policy.[4] Among issues that he cited as top priorities was the need to preserve the nation's human-resource pool in science and engineering in order to stave off potential shortages.

This paper examines science education for girls and women, focusing on the following topics:

(1) Forces - for example, the changing demography of the United States and increasing retirement of scientists and engineers employed in academe and industry - necessitating a more concerted effort to recruit and retain females to scientific, engineering, and technological (SET) careers;

(2) Interventions to achieve that goal; and

(3) The roles of federal agencies, professional societies, and the National Research Council in maintaining a stable SET work force.

## FORCES NECESSITATING ACTION

The scientific community has long recognized barriers in the participation of women in Science, Engineering, and Technical (SET) careers. Interest in counteracting these barriers has arisen principally in connection with two developments: (1) the growing commitment within the private and government sectors to secure equal participation of all groups of our society and (2) the need for personnel to satisfy national requirements for the United States to maintain its competitive edge in the international marketplace.[5] To achieve the goals of adequate numbers of American scientists and engineers and parity representation of female scientist and engineers (including members of racial/ethnic minority groups traditionally underrepresented in these disciplines) so that national needs are met during the 1990's requires national leadership, for the decisions that we make about our scientific/engineering cadre today will have a significant effect on our ability to find solutions to future problems, and our ultimate success depends upon the degree to which we maximize use of all of the nation's human resources.

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[2] National Science Foundation, *The Role of Science and Technology in Economic Competitiveness*, Washington, D.C.: U.S. Government Printing Office, 1988.

[3] Luther Williams, NSF's *Science and Mathematics Education Agenda for the 21st Century*, speech to the Science and Engineering Education Review Group, Waste Policy Institute, Arlington, Virginia, July 25, 1990.

[4] Frank Press, untitled address to the members, annual meeting of the National Academy of Sciences, April 24, 1990.

[5] Several recent studies conducted by committees of the National Research Council have reached this conclusion, as noted in the following reports published by National Academy Press: *Engineering Personnel Data Needs for the 1990's; Foreign and Foreign-Born Engineers in the United States: Infusing Talent, Raising Issues; and Education and Employment of Engineers: A Research Agenda for the 1990,s.*

However, during the past decade, U.S. college enrollments in science and engineering have been dropping: currently, only 0.24 percent of high school sophomores are likely to pursue studies in the sciences and engineering that culminate in the receipt of doctorates in those disciplines.[6] In addition, the end of the baby-boom era has led to fewer college-aged white males, the demographic cohort that has traditionally supplied most of the country's scientists and engineers.[7] This, in turn, could reduce college enrollments by an additional 12-16 percent. The White House Task Force on Women, Minorities, and the Handicapped in Science and Technology estimated that, beginning next year, the United States will need 155,000 B.S. and 10,150 Ph.D. scientists and engineers from sources traditionally underrepresented in those fields (see Table 1).[8]

**TABLE 1**

**Employment of Scientists, Engineers, and Technicians (SET), by Field, 1986 and 2000**

| Field | Number Employed, 1986 | Projected % Increase in Employment, 2000 |
|---|---|---|
| **TOTAL, SET Fields** | 5,492,900 | 36 |
| **Total Scientists*** | 1,676,400 | 45 |
| Computer Specialists | 437,200 | 76 |
| Life | 340,500 | 21 |
| Mathematical | 103,900 | 29 |
| Physical | 264,900 | 13 |
| Social | 432,600 | 36 |
| **Total Engineers** | 2,243,500 | 32 |
| Aeronautical/astronautical | 104,200 | 11 |
| Chemical | 131,500 | 15 |
| Civil | 319,100 | 25 |
| Electrical/electronics | 540,800 | 48 |
| Industrial | 113,100 | 30 |
| Mechanical | 453,700 | 33 |
| Other | 581,100 | 24 |
| **Total Technicians** | 1,573,000 | 36 |
| Computer Programmers | 309,000 | 70 |
| Draftsmen | 348,000 | 2 |
| Electrical/electronics | 313,000 | 46 |
| Other engineering | 376,000 | 26 |
| Physical, mathematical, and life sciences | 227,000 | 15 |

* Includes 97,300 environmental scientists.

SOURCES: National Science Board, *Science & Engineering Indicators - 1987,* Washington, D.C.: U.S. Government Printing Office, 1987, from National Science Foundation, *U.S. Scientists and Engineers: 1986* (NSF 87-322), Washington D.C.: U.S. Government Printing Office, 1987; and U.S. Department of Labor, Bureau of Labor Statistics, *BLS Monthly Labor Review* (September 1987), pp. 51-52.

This is an increase from the approximately 56,250 bachelor's degrees and 2,130 Ph.D.'s that members of these groups - Blacks, Hispanics, American Indians, and White women - received in 1987 in scientific

[6] National Science Board (NSB), *Science & Engineering Indicators - 1989,* Washington, D.C.: U.S. Government Printing Office, 1989.

[7] *Ibid.*

[8] Task Force on Women, Minorities, and the Handicapped in Science and Technology (hereinafter, Task Force), *Changing America: The New Face of Science and Engineering* (Final Report), Washington D.C.: The Task Force, December 1989.

and engineering disciplines. Meanwhile, NSF predicts that the human-resource needs for science and engineering will increase, by 36 percent between 1986 and 2000, because of high-technology industrial growth and the increasing use of high-technology goods and services. Eileen Collins, NSF economist, has written:

> If present trends continue, there will be a shortage of trained engineers which cannot be filled by the natural increase in numbers of women and minority students obtaining degrees. Possible market adjustments include the injection of foreign talent, a policy decision to increase the numbers of women and minority students, and the recapture and retraining of those engineers no longer in the field.[9]

At the same time, there is much concern about a potential shortage of science and engineering faculty: the changing demographic picture of the United States also includes a higher number of retired persons than in the past.[10] In fact, some estimates show that 40 percent of tenured science and engineering faculty will retire by 1995.[11]

The declining number of college-aged students and increase in faculty retirements expected during the next decade do not necessarily mean that the United States will have a shortage of scientists and engineers, however, an important strategy to offset the potential adverse effects of these demographic factors would be to increase the representation of women, including members of racial/ethnic minority groups, in SET careers. The Office of Technology Assessment (OTA) has gone on record in support of

> raising women's interest in science and engineering . . . as a means of compensation for the projected decline in bachelor's recipients in these fields, [noting that] the research potential of women is great, though they still face pervasive social and economical barriers.[12]

In the midst of these several changes, many policymakers have reflected on mechanisms by which the United States might maintain its productivity and competitive edge in the global marketplace. As noted in the final report of the Task Force, however,

> There is little reason to assume this enormous underutilization of human resources will be reversed in the future without substantive changes in our approach to the problem.[13]

## INTERVENTIONS TO INCREASE PARTICIPATION

If research findings consistently report the need to increase the participation of females in mathematics, science, and engineering (MSE) education and employment, what has been done to achieve that goal? Actually, many interventions have been directed not only toward females themselves, but also toward educators at all levels of the MSE pipeline (see Table 2). At both the elementary school level and the crucial high school level, the origin point of potential college science and engineering majors, programs are being developed to improve the quality of science and mathematics instruction, and other initiatives have been undertaken to spur the interest of young women intellectually qualified to pursue high-level coursework in science and math. Girls considering careers in these fields are encouraged to gain strong

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[9] Eileen L. Collins, "Meeting the Scientific and Technical Staffing Requirements of the American Economy," *Science and Public Policy* **15**(5):335-342, October 1988.

[10] NSB, *op. cit.*

[11] U.S. Congress, Office of Technology Assessment, *Demographic Trends and the Scientific and Engineering Work Force - A Technical Memorandum,* Washington, D.C.: U.S. Government Printing Office, 1985.

[12] U.S. Congress, Office of Technology Assessment, *Educating Scientists and Engineers: Grade School to Grad School* (OTA-SET-377), Washington, D.C.: U.S. Government Printing Office, June 1988.

[13] Task Force, *op. cit.*

preparation in both required and elective courses in math and science and to participate in extracurricular science-related activities. They often have opportunities to discuss career options with counselors and mentors[14] in order to select the "right" courses in order to be admitted to a "good" undergraduate institution - one that has a national reputation in their fields of interest. In addition, some businesses offer summer employment so that students can develop their interests in math and science. Many of these local precollege programs have been in place for several years, partially because of their cooperative nature: local businesses, universities, and school systems work together to design and fund the programs. The more successful interventions have stressed, at the precollege level, commitment and active involvement of educators, parents, and practicing scientists and engineers who serve as role models and mentors.[15]

**TABLE 2**

**Some Interventions To Increase the Participation of Girls and Women in Mathematics, Science, and Engineering**

- **Programs developed by state boards of education and universities in 48 states**
  - University of Alabama, Huntsville, Early Start Program
  - George Washington University non-degree courses for secondary school students
  - Tri-State University (IN) Women in Science program for girls in grades 10-12
  - Maryland State Department of Education Summer Centers for Gifted and Talented Students
  - College of Saint Catherine (MN) Gifted and Growing Center
  - Development Program for Gifted/Talented High School Girls
  - New York State Education Department Summer Institute for Science and Mathematics
  - North Carolina School of Science and Mathematics
- **More local programs**
  - METRO Achievement Program (Chicago)
  - Programs offered by local boards of education, such as the Summer Math and Science Program funded by Anne Arundel County (MD) and held at the U.S. Naval Academy for middle-school students, and the New York City Board of Education's Mathematics and Science Academy for secondary school students
- **Other programs**
  - Science Talent Search, a scholarship program for high-ability high school seniors, conducted by Science Service and sponsored by Westinghouse
  - International Science and Engineering Fair, conducted by Science Service for secondary school students
  - Center for Excellence in Education's Research Science Institutes, held at Georgetown University and the University of California, San Diego
  - Earthwatch Research Expeditions, providing hands-on training in art and archaeology, geosciences, life science, marine studies, and social sciences

* * * * *

- **Programs for the federal government**
  - Presidential Awards for Teaching Excellence in Mathematics and Science
  - Department of Education's National Diffusion Network for the dissemination of curricular materials
  - Scientist in the Schools programs, such as those organized by the Department of Energy (DoE), NSF, and NASA
  - DoE's High School Science Student Honors Research Program and a similar program sponsored by the Department of Defense, whereby high-ability students are given summer employment in related laboratories
  - Research grants: NSF, NIH, ONR, Department of Education

Effective intervention programs to attract and retain members of groups underrepresented in science and engineering must be implemented throughout the pipeline, beginning at the precollege level and continuing through employment. However, at levels of the education pipeline other than the precollege

[14] A mentor is someone who assists a younger person in course selection, funding acquisition, and numerous other aspects of one's education. A mentoring relationship does not have to be formalized; it can develop from mutual interests and work. Thus, it is not unusual for young women today to decide to pursue scientific careers because of the influence of a high school teacher. One's mentor may be of the same or opposite sex. What matters is his/her interest in the same field as the student and willingness to assist the student in "breaking into" the scientific community.

[15] Marsh Lakes Matyas, *Intervention Programs in Mathematics and Science for Precollege Females: Program Types and Characteristics,* Washington, D.C.: American Association for the Advancement of Science, May 1988.

level, fewer focused activities to increase the participation of capable and interested female students are evident.[16] At every level, from high school through graduate study, women - particularly women who aremembers of ethnic minority groups traditionally underrepresented in science and engineering - are more likely to drop out of the science and engineering pipeline than are men. Nonetheless, increasing the participation of women may be achieved through a variety of mechanisms - including the appointment of faculty interested in encouraging women to pursue studies in science and engineering and in being role models and the development of counseling and retention programs that:

(1) Sensitize faculty to the needs of the nation and of women students.

(2) Follow the progress of women students throughout their enrollment period, and

(3) Promote mentoring between all undergraduate and graduate women science and engineering students and women science and engineering faculty.

In addition, after admitting women to their science and engineering programs, some universities have established effective retention programs (see Table 3). In addition, to retain undergraduate and graduate students in the sciences and engineering, universities are directing them to numerous sources of financial aid,[17] including the following:

Government: National Science Foundation, National Institutes of Health, Department of Energy, and U.S. Navy;

Professional Societies: American Women in Science, American Association of University Women's Eleanor Roosevelt Fund, American Institute of Architects, American Physical Society; and

Private corporations/foundations: Amoco Foundation, Inc., Ford Foundation, Howard Hughes Medical Institute, Hughes Aircraft Company, International Business Machines

**TABLE 3**

**Characteristics of Effective Undergraduate Retention Programs in the Sciences and Engineering**

- Orientation programs for freshmen,
- Remedial courses,
- Educational and career counseling,
- Peer tutoring,
- Research opportunities,
- Cooperative and summer job programs,
- Campus chapters of professional organizations such as the Society of Women Engineers,
- Recognition awards and events, and
- Exit interviews with graduating seniors.

[16] See, for instance, Elizabeth S. Ivey, "Recruiting More Women into Engineering and Science," *Engineering Education* **78**(8):762-765.

[17] Fellowship Office, National Research Council/National Academy of Sciences, *A Selected List of Fellowship Opportunities and Aids to Advanced Education for United States Citizens and Foreign Nationals*, Washington D.C.: National Science Foundation, 1988.

The employment picture directly reflects the education of women in the United States. Furthermore, analysis of the role that women scientists and engineers play shows that their abilities are commonly underutilized.[18] At the same time, in all types of employment, female scientists and engineers may be overly occupied with activities that serve to remove them from professional competition and yield no rewards in terms of career advancement: they are often expected to be token members of science and engineering departments, and their time and resources may be severely strained by burdensome committee and other assignments related to "women's issues."[19] These activities often constitute an obstacle to research publication and a handicap in the competition for prizes and awards and do not help the individual to advance in her profession. Only when their numbers have greatly increased will female scientists and engineers be freed of such hindrances. To meet national needs, female scientists and engineers must be utilized more effectively.

## THE ROLE OF KEY PLAYERS

In general, interventions supported by various entities - the federal government, professional societies, boards of education, industry, and others - have not been for nought: during the 15-year period beginning in the mid-70's, girls expressed increasing interest in math and science courses and careers requiring strong backgrounds in those areas.

Most federal programs aim to increase the participation of the general population within science and engineering careers; few have been directed specifically toward minorities, and even fewer are directed to females (see Table 2). Among the recommendations of the Task Force are the following:

- Federal intervention and funding in support of graduate education for women,
- Provision of federal agency funds to researchers who employ female scientists and engineers, and
- Federal monitoring of progress toward these goals.

Many federal agencies responded favorably to the Task Force recommendations, providing in their FY 90 budgets allocations for education and research specifically targeted to increasing the participation of women and minorities. In response to recommendations of the Task Force,[20] Allan Bromley, assistant to the President of Science and Technology and director of the Office of Science and Technology Policy, has established the Federal Coordinating Council on Science, Engineering, and Technology composed of representatives of federal agencies who will "develop a coherent federal approach to mathematics and science education to help insure development of a world-class work force of scientists, engineers, and technicians."[21] In addition, as shown in Table 4, several federal agencies have already planned activities to increase the number of women, minorities, and the handicapped participating in science and engineering.

### Professional Organizations

Professional organizations undertake a variety of activities to increase the participation of women and minorities in science and engineering. For instance, some professional societies have established student chapters - such as JETS and SWE. These interventions (see Table 5) cover most segments of the

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[18] Delores H. Thurgood and Joanne M. Weinman, *Summary Report 1988: Doctorate Recipients from United States Universities*, Washington, D.C.: National Academy Press. See also, National Science Foundation, *Women and Minorities in Science and Engineering*, Washington, D.C.: NSF, 1990.

[19] Office of Scientific and Engineering Personnel (OSEP), *Responding to the Changing Demography: Women in Science and Engineering*, an internal report by the Planning Group to Assess Possible Initiatives for Increasing the Participation of Women in Scientific and Engineering Careers, 1989.

[20] The Task Force was created by Public Law 99-383 in 1986 with four purposes: (1) to examine the current status of women, minorities, and the handicapped in science and technology, (2) to identify exemplary programs for increasing the participation of these groups, (3) to coordinate existing federal programs and to suggest cooperative interagency initiatives in this area, and (4) to develop a long-range plan for increasing the participation of members of these groups in science and engineering.

[21] Letter dated December 1989.

education/employment pipeline in science and engineering and range from inexpensive (but effective) mechanisms such as providing a speakers' bureau or sponsoring a program where scientists visit high school and college campuses to the larger programs that provide financial support (via fellowships, associateships, and research grants) directly to highly qualified students.

**TABLE 4**

**Some Federal Initiatives in Response to the Report of the Task Force on Women, Minorities, and the Handicapped in Science and Technology**

**Department of Commerce**
- Donations of satellite-receiving equipment to D.C. public schools
- Career awareness programs for secondary students

**Department of Defense**
- Expansion of science and engineering education programs
- Identification of recruitment and retention initiatives directed toward underrepresented groups

**Department of Energy**
- Increase outreach activities for underrepresented groups: Chicago Science Explorers Program, Oak Ridge National Laboratory

**Department of Health and Human Services**
- Establishment of an HHS Committee on Women, Minorities, and the Handicapped in Science and Technology, cochaired by Ruth L. Kirschstein and Eugene Kinlow

**Department of Transportation: Office of Commercial Space Transportation (OCST)**
- "Networking for Commercial Space Transportation"
- Commercial Space Simulation

**Environmental Protection Agency**
- Strengthening support of environmental education at all stages of the pipeline
- Developing effective recruitment and hiring strategies

**Federal Emergency Management Agency**
- Tutoring elementary school students in math and science
- Donations of excess computer equipment to elementary schools' science and mathematics departments

**NASA**
- Expanded outreach programs to teachers and students at the precollege level
- Increase direct student support at all levels of the education pipeline

**NSF**
- Continuation of current programs - e.g., summer institutes and other in service training for teachers as well as NSF Young Scholars Program, 71 summer institutes for students to participate in research in 35 states and the District of Columbia - and establishment of new ones

**Office of Personnel Management**
- Saturday Academy

**TABLE 5**

**Interventions Undertaken by Professional Societies* To Increase the Participation of Underrepresented Groups in Science and Engineering**

**Women**

1. **Financial support to undergraduates, including reentry women:** AAUW, BPW, SWE
2. **Undergraduate research grants:** CGS, NSF
3. **Graduate fellowships:** AAUW, NSF, SWE, AIP
4. **Postdoctoral fellowships:** AAAS, AAUW, AIP
5. **Graduate and postgraduate research grants:** AAUW, NSF
6. **Research and reports:** AAAS, ACE, AEA, AGI, AIP, AAC's Project on the Status and Education of Women, BPW, Center for Women Policy Studies (CWPS), NSF, SWE, Zonta International
7. **Publications to members/subscribers:** AAES, including an annual bulletin on the status of women in engineering, AEA, AGI, AIP, APA, ASEE, AAC, AWIS, BPW, CWPS, SWE
8. **Professional societies having committees on women:** AAES, ACE, AEA, AGI, AIP affiliates, APA, ASEE, CGS, Zonta International
9. **Organizations holding relevant sessions at their annual meetings:** AAUW, AAES, ACE, AEA, AGI, AIP affiliates, APA, ASEE, BPW
10. **Mentoring projects:** AGI, AIP APA, AWIS affiliates, BPW, CGS SWE
11. **Workshops for faculty:** AIP, CGS, SWE
12. **Assistance to institutions:** AIP, AAC, CWPS, NSF, SWE
13. **Speakers' bureau/visiting scientist program:** AAAS, AEA, AGI, AIP, APA, AWIS affiliates, BPW, CGS, SWE

**Minorities**

1. **Undergraduate scholarships:** AGI, Indian Health Services, National Hispanic Scholar Awards Program, National Action Council for Minorities in Engineering (NACME) Incentive Grants - awarded as block grants to institutions, earmarked specifically for financial aid
2. **Undergraduate counseling:** American Geological Institute's Minority Participation Program
3. **Undergraduate research training grants:** Minority Access to Research Careers Program (NIH)
4. **Undergraduate employment opportunities:** U.S. Geological Survey, National Consortium for Graduate Degrees for Minorities in Engineering (GEM)
5. **Graduate fellowships:** Bureau of Indian Affairs, American Indian Science and Engineering Society, APA, ASA, Committee for Institutional Cooperation, Ford Foundation, NIH, NSF, National Consortium for Graduate Degrees for Minorities in Engineering (GEM), University of California, National Institute of Mental Health
6. **Faculty fellowships:** NIH, NSF
7. **Faculty development:** Minority Biomedical Research Support Program (NIH)
8. **Visiting scientist fellowships:** NIH
9. **Support to institutions of higher education:** National Heart, Lung, and Blood Institute, Department of Education, NSF, Office of Naval Research, NIH
10. **Research:** ACE, ETS, Center for Education Statistics

* An explanation of acronyms is found in Appendix A

## THE NATIONAL RESEARCH COUNCIL/NATIONAL ACADEMY OF SCIENCES

### Previous Activities

The National Research Council (NRC) has a long and distinguished record of involvement in activities designed to increase the rate of participation of women in scientific and engineering careers. From 1973

until 1982, studies by its Committee on the Education and Employment of Women in Science and Engineering (CEEWISE) contributed significantly to an understanding of the issues involved.[22] Subsequently, when the National Research Council was reorganized in 1984 and the Commission's activities were transferred to the Office of Scientific and Engineering Personnel (OSEP), interest in this issue remained. OSEP was charged with the responsibility for

> activities of the National Research Council that contribute to the more effective development and utilization of the nation's human resources, giving emphasis to national education and manpower utilization programs and needs.

At an OSEP-convened workshop in 1986, participants explored what is known about the causes of the observed underrepresentation and differential participation of women in science and engineering at all educational levels and about the patterns and causes of their differential career development relative to that of men.[23] One consequence of that workshop was a call to OSEP for advice and information in setting priorities for research and action programs. In response, a planning group chaired by Mildred Dresselhaus recommended the establishment within OSEP of a continuing Committee on Women in Science and Engineering, which would undertake activities meeting three main objectives:

- Sensitize key decision makers about the seriousness of the demographic problem and the need to increase the participation of women in SET careers,
- Illuminate the multifaceted issues that must be addressed in reaching solutions to that problem, and
- Clarify and interpret the voluminous and complex research on the underrepresentation of women in science and engineering.[24]

This recommendation meshed with the Research Council's mandate for the Office of Scientific and Engineering Personnel to strive for

> enhanced strength as a resource and center of expertise . . . concerning the status of scientific and engineering manpower and the methodologies for assessing current and projected employment demand and personnel supply.

Future Activities

The National Research Council is uniquely suited to undertake a multifaceted program of these activities because of its prestige, influence, and special relationship with the government, the professions, educational institutions, and industry. It could set an example for others in the scientific and engineering community, playing an effective role in increasing the opportunities for women in science and engineering not only in its member organizations - National Academy of Science, National Academy of Engineering, and Institute of Medicine - but also in the larger society. Thus, OSEP is establishing a continuing Committee on Women in Science and Engineering. Its focus will be activities to achieve greater representation of women in science and engineering at the undergraduate, graduate, postdoctoral, and professional levels.

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[22] Among the CEEWISE reports are *Women Scientists in Industry and Government: How Much Progress in the 1970's?* (1980), *Career Outcomes in a Matched Sample of Men and Women Ph.D.s: An Analytical Report* (1981), and *Climbing the Ladder: An Update on the Status of Doctoral Women Scientists and Engineers* (1983).

[23] Linda S. Dix (ed.), *Women: Their Underrepresentation and Career Differentials in Science and Engineering,* proceedings of a workshop, Washington D.C.: National Academy Press, 1987.

[24] The Research Council's provision of funds in 1972 for a similar activity, the Conference on Women in Science and Engineering (June 11-12, 1973), had led to the establishment of CEEWISE.

The Research Council's Committee on Women in Science and Engineering will have several functions (Table 6). This committee will maintain established contacts with external groups as well as work cooperatively with other organizations striving to increase the participation of females in science and engineering at all levels of the education/employment pipeline. It is anticipated that the Committee will strive to inform and motivate industry, government, academe, and professional scientific and engineering societies to enhance the representation and utilization of women in science and engineering by conducting a program of diverse activities. This committee of OSEP is particularly suited to study issues dealing with women holding Ph.D.'s in the sciences and engineering, since OSEP conducts for NSF and other federal agencies two surveys of the doctoral population from which data on the participation and utilization of women scientists and engineers can be extracted: the Survey of Earned Doctorates and the Survey of Doctorate Recipients. However, the Committee may also examine issues that cross all segments of the education/employment pipeline.

## SUMMARY

In sum, the evidence shows the female scientist or engineer to be only a marginal participant in the scientific and engineering activities of the United States, and it reveals that the situation is not improving substantially. Not only do female scientists and engineers represent a small and decreasing proportion of the total technical and professional population, but also their abilities and training are often diverted from scientific activity. Longstanding concern about the underutilization of women, together with a new concern about the possibility of serious skill shortages in the future, has led the federal government, professional organizations, and the National Research Council to take steps toward ensuring an adequate supply of U.S. scientists and engineers. Whether viewed as an equity issue or a demographic one, increasing the participation of women in science and engineering is a viable objective of the scientific community. It is a goal that need not be left solely in the hands of science policy makers, however. Each of us can have a role in achieving this objective - by serving as role models and mentors both to individuals at different points of the education pipeline and to those younger women working beside us and by supporting programs targeted directly at members of these groups. As I mentioned earlier, many interventions have been successful in sparking the interest of girls and women in math, science, and engineering. However, they need to be implemented more widely in order to have a significant impact.

**TABLE 6**

## Functions and Possible Activities of the National Research Council's Committee on Women in Science and Engineering

### Functions

- Enunciate policy on the role of women in science and engineering;
- Serve as a resource to collect and disseminate data on the needs and opportunities of women in science and engineering;
- Exert its influence on the scientific/engineering community and the society as a whole to work toward the removal of barriers to the participation of women in the sciences and engineering;
- Encourage interaction between appropriate concerned groups; and
- Stimulate the development of innovative programs to increase the representation of women in scientific and engineering careers, such as mentoring programs pairing undergraduate women interested in scientific or engineering careers with tenured faculty committed to the advancement of women in the sciences and engineering.

* * * * *

### Possible Program of Activities

- Monitoring the progress of efforts to increase the participation of women in scientific and engineering careers;
- Conducting symposia, workshops, and other meetings to inform members of the broad scientific community of activities undertaken in various sectors and to stimulate and encourage initiatives in program development for women in science and engineering; identifying successful intervention programs; and evaluating their effectiveness on a regular basis;
- Proposing research and conducting studies on issues especially relevant to women scientists and engineers; and
- Collecting and disseminating current data about the participation of women in science and engineering to broad constituencies in academe, government, industry, and professional societies attempting to enhance the participation of females in science and engineering.

* * * * *

### Issues

- Status of postdoctorals, by sex, race, and academic discipline,
- Importance of mentors to the success of potential women scientists and engineers at all levels of education and during the early phases of their careers,
- Distribution and impact of financial support for women at all educational levels and by field, and
- Influence of foreign faculty and graduate students on the recruitment and retention of female students in science and engineering.

# APPENDIX A

## SOURCES OF INFORMATION CONCERNING WOMEN IN SET CAREERS

### FEDERAL GOVERNMENT

Provided at meeting

### PROFESSIONAL SOCIETIES

| | | |
|---|---|---|
| AAC | - | Association of American Colleges |
| AAUW | - | American Association of University Women |
| ACE | - | American Council on Education |
| AEA | - | American Engineering Association |
| AGI | - | American Geological Institute |
| AIP | - | American Institute of Physics |
| APA | - | American Physics Association |
| ASEE | - | American Society of Electrical Engineers |
| AWIS | - | Association of Women in Science |
| BPW | - | Business and Professional Women |
| CGS | - | Canadian Geotechnical Society |
| NFS | - | National Science Foundation |
| SWE | - | Society of Women Engineers |

# APPENDIX B

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# EQUITY IN SCIENCE, GRADE SCHOOL TO GRADUATE SCHOOL: A Women's Foundation Initiatives For Change

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I am very glad to be here this afternoon, to share in this conference and to spread the word about the American Association of University Women (AAUW), the AAUW Educational Foundation and its initiatives and funding support, particularly to women in science. I hope that everyone is fairly comfortable out there, these seats do get a little hard. I'm certainly feeling comfortable, sort of being home again. As indicated by Dr. Kay, I attended school here in Houston at the University of Houston. I am a native of Texas; Fort Worth is my home. As far as I'm concerned, today Houston seems to be the place where we ought to be - if we're talking about women taking the lead and being successful, whether in science or other professions.

AAUW with its long history of support for education and equity for women in all endeavors certainly would be proud to look upon this city; Houston, one of the top ten metropolitan centers, where the Mayor, the chief executive of the city is a woman and has been in her position for eight or nine years and the police chief is a woman who has advanced through the ranks in a nontraditional career. I believe, and someone may have to help me - I believe the school superintendent is also a woman, as is the new president of my alma mater, Dr. Margarete Ross-Barnet at the University of Houston, an emerging leader in public higher education in Texas. Also, I understand that the coordinator or chair of the esteemed Texas Medical Research Center is a woman. We heard from the wonderful Dr. Mae Jemison this afternoon, who is the first minority woman in the NASA astronaut program. Indeed, Houston is bursting at the seams with dynamic women leaders, many in science and technical spheres.

It's a little hard, in a short period of time, to really cover all that has brought AAUW and its Educational Foundation to this discussion because we have such a comprehensive organization with many levels of support to women in education. Recently more attention is focused on the needs and concerns of women and girls in science and technical areas. What is unique about us is that unlike science professional organizations, we are a voluntary association of women in various disciplines. I am going to reflect on some pioneering accomplishments in our history and quickly come up to speed with what's happening today and our role in preparing women for the future technical world.

***"Over the last three decades the AAUW Educational Foundation has been pioneering in its advocacy and funding to foster the ideal of equity and education for women and girls in American society, and globally."***

For more than 109 years the American Association of University Women has been making dramatic changes. Over the last three decades the AAUW Educational Foundation has been pioneering in its advocacy and funding to foster the ideal of equity and education for women and girls in American society, and globally. We've used an advertising slogan for our fellowships programs: "Whenever we award a $12,000 fellowship, we get plenty of change." Positive societal change has been the bedrock of the Educational Foundation's mission. It began with one graduate fellowship of $350 more than 100 years ago, awarded to a University of Michigan graduate student. More than 5,000 women have been funded since that time amounting to approximately $25 million in awards to help make change in the halls of academia, government, industry, the professions and in communities, nationally and internationally.

The Graduate Fellowships Programs, helping women to complete advanced studies, is the long standing jewel in the crown of our Foundation's program, having been built and strongly maintained by the 140,000 members of the AAUW, which is organized in 1800 local branches in all 50 states, the District of Columbia, Guam, Puerto Rico, and the Virgin Islands. This strong grassroots network not only extends the reach of the Foundation through direct action in local communities, but also reinforces women themselves as leaders and change agents and advocates of education. It is a venerable base of dedicated and innovative member fund raisers. This enables a solid undergirding of the Endowed Fellowships Funds and helps seed new ventures for the Educational Foundation. For 1990, 253 fellowships and grants have been awarded to women for over two million dollars. Since 1980 the fellowships award funding level has exceeded one million. The AAUW Educational Foundation is the oldest and largest women's foundation in the U.S. and has long been the largest nonuniversity source of funding for women's advanced studies. With this tradition firmly implanted as a part of our history and gaily celebrated two years ago and in the fellowships centennial observance, the Foundation has begun its second century with a blazing effort on behalf of tomorrow's women.

We recognize that we can't continue to look at higher education solely, only graduate education and beyond, but must start earlier if we're very serious about the continuing advancement of women in science and technical areas. Our board leaders, in the opening statement of our current bi-annual report, have chartered an ambitious agenda for the 1990's with particular implications and focus for women in science and technological education and careers. This agenda asserts:

1) To maintain and enhance our proud history of enabling women to move beyond gender defiant barriers toward the full development of their potential.

2) Expand our reach through the Eleanor Roosevelt Fund for women and girls with a bold, new focus on the elementary and secondary school education of girls, the young women who will be seeking their futures in the work place of tomorrow.

3) Address the disturbing decline of minority women's representation in graduate school.

4) Continue to sponsor community-based projects that promote the Foundation's mission and extend its national impact.

I would like to just review, briefly, some of the foundation's first attempts to initiate change for women in science through its early funding of pioneering scholars. Then I'll go into some of the contemporary fellowships programs which have been established, and highlight some of the really exciting and innovative projects going on around the country in which our AAUW branches are involved. The AAUW and its Educational Foundation has a long and constant thread of interest in women's advancement in the sciences weaved throughout the history. It may have started with a focus on numbers of women pursuing their fields. At the turn of the century sciences had been male dominated in the modern world. And there may not have been a strong positive link to societal change in the minds of our foremothers, but rather to support the individual achievement of outstanding women in scholarly pursuits. The way of operating in those days was very hands-off. We wanted to be supportive of women in academia, but we also felt that scholars were sort of "put on a pedestal" to be left alone to pursue their scholarship, and hopefully make a difference for women. Somehow, though, I think there was an instinctive and intuitive vision that these founding AAUW women believed, that the scholarship of women scientists would indeed infuse a different perspective on the conduct of science itself. This is quite evident from the caliber of young scientists supported by AAUW, many long before their accomplishments would be accepted and promoted within the scientific establishment.

***"Dr. Jenny Bramley, a 1936 Fellow, was the inventor of the cathode ray tube, and also was the first woman elected to the Institute of Electrical and Electronics Engineers."***

It is this examination of a fundamental question of the nature of scientific inquiry, the relationship between gender and science which is paramount in the work of this year's AAUW Achievement Award honoree, physicist and feminist critic, Evelyn Fox Keller. The AAUW Achievement Award is given annually. It is the organization's most prestigious recognition award for an accomplished woman. Keller examined many of her provocative questions on gender and science in her work on a biography of maverick Nobel Prize winning geneticist, Barbara McClintock. McClintock had won AAUW's 1947 Achievement Award long before the eventual recognition of her contribution. Keller examined the contentious response of the male dominated scientific community to McClintock's discovery of genetic transposition. Keller cited the destructive suppositions about the relationship between gender and science. She concluded that the exclusion of women and feminine insights from basic science research has resulted in immeasurable losses to science itself.

I'll just give a note: I'm not attempting to raise Keller's issues for discussion here. I want to weave the rich tapestry of AAUW support for women and science which started long ago with women like Barbara McClintock and sort of coming full circle to someone, such as Evelyn Fox Keller, as this year's Achievement Awards winner. Some of this early support went also to women like Madam Curie, who needed one final ounce of radium to complete her experiments and appealed to AAUW members who responded with the requisite dollars needed and more. Funds were raised throughout the membership and contributed to her effort. One of the Foundation's current post-doctoral science fellowships is named in her honor. The very first Achievement Award winner in 1946, Florence Seibert, revolutionized tuberculosis testing and has also been honored with a post-doctoral science fellowship in her name. Environmentalist and writer Rachel Carson was honored with the Achievement Award in 1956, utilizing the prize money to further work on her watershed, "Silent Spring".

Among the early Fellows is another impressive list of "firsts". Much of the earliest fellowship funding disproportionately supported women scientists who were not able to secure funding from universities, or from philanthropists. Dr. Jenny Bramley, a 1936 Fellow, was the inventor of the cathode ray tube, and also was the first woman elected to the Institute of Electrical and Electronics Engineers. Women like Sue Rossiter, who is an accomplished scientist and has the written much on history of women in science was a Fellow. Dr. Cecilia Payne Gaposchkin, physicist and astronomer, was also a former AAUW Fellow. She was the first Annie Jump Cannon Award winner, a recognition program for women in astronomy, which the Foundation administers. Cannon was the scholar who developed the system for classification of stars. More recently, and very appropriately being here at NASA/JSC, Judith Resnik, NASA Astronaut, received her AAUW Engineering Fellowship in 1971 and is honored with a doctoral fellowship in her name. In 1987 when AAUW had its convention in Houston, we had a very moving dedication in memory of Judith Resnik at NASA headquarters. There is a plaque hanging there which is an honor scroll of AAUW branches and members who raised money to establish and endow the fellowship. Those contributions were a nice tribute to "one of our own" as Judy Resnik was an active AAUW member.

*"Judith Resnik, NASA Astronaut, received her AAUW Engineering Fellowship in 1971 and is honored with a doctoral fellowship in her name. .... Those contributions were a nice tribute to "one of our own" as Judy Resnik was an active AAUW member."*

AAUW has a rich history of association with women in science, pioneers they were to be sure, who were making a way for their contemporary sisters. Many of these women are still, in many respects, pioneers in their respective fields today.

I want to talk a little bit now about the three major program components of the AAUW Foundation and how the structure of those programs has shifted and changed to really begin to address more coherently the issues of women in science and technical areas. The components are:

1) The discussion of our fellowship programs.

2) The research and project grants that are undertaken by AAUW branches or chapters across this country.

3) And, our newest initiative, the Eleanor Roosevelt Fund for Women and Girls.

I'd like to make just a slight point of departure. I hope these women won't kill me, but I think it might help just to diversify the lecture format. I'd like to introduce two women whom I've just met since being here, who embody all that AAUW is about in terms of our fellowship and grant support. Both of them are here as NASA scientists. One is a former fellow and I'd like to have her stand and just give a few comments about the role that her fellowship played. I know we ask our former fellows and current fellows to do this often, so I assume that she may have had some practice. I would like for Marilyn Lindstrom to informally relate the kind of role that the fellowship support gave to her at that critical time in her career. The other person that I wanted to introduce was Nadine Barlow, who is Vice President of the Clear Lake AAUW Branch. She was telling me about a wonderful project that they're going to start with teachers.

Comments by Marilyn Lindstrom, from the floor:

I had my dissertation fellowship from AAUW back in 1973-74, and it helped me out at a very difficult time. I had an NSF fellowship before that. But, the last year or so of school is when you really have to concentrate and not be working on other things, but focus on your thesis. I got a lot

of teasing from the guys - as a Geo-Chemist, competing for something they didn't have a chance for, was I cheating somehow and this sort of stuff. But I really appreciated the support that AAUW gave me. I hadn't really heard much about the organization before, though I found out when I got the fellowship that my mother-in-law was a member of the Wisconsin Chapter. I was in Oregon at the time and was quite an active participant in AAUW. I think that the moral support that we can provide each other is something that is of real importance.

Back in the mid 70's there weren't networking organizations, women were basically on their own. That didn't bother me, but knowing that there are people out there who you can talk to and who are willing to help you when you need it was really wonderful. Right now, the project that was mentioned that Nadine and I are trying to work on, (we happen to share an office at NASA; I'm on the Federal Women's Program Committee this year, she's with AAUW) is trying to organize workshops, starting with one in January, for teachers in our local area. We're not doing Houston proper, it's just a huge organization. We're taking the ones around Clear Lake and trying to get teachers in here to talk to women in science and in engineering from NASA, the contractors, or other technologically oriented organizations so that we can provide them with the resources to stimulate all students, particularly girls, in the fields of our interests. We think that they need some role models. I know that when I go talk to my kids' classes, they just go crazy about the fact that they've got a mother here and not just a father. There are lots of technologically oriented parents in this area, but fewer women than men. So we're going to try and share some of what AAUW has shared with us with the local schools. Thank you

I learned also that Linda Dix, our previous speaker, is an active member of our Maryland Branch of AAUW. I'm going to mention a little later a very innovative project in which the whole state of Maryland has been involved, in terms of supporting and encouraging girls in science, as well as to really affect on a policy level the needs in terms of funding and educational policy making in the state.

The Foundation began to think about two years ago about how we could more effectively become involved with increasing our support for women in science. We called together a small, but expert, cadre of science professionals and foundation experts, an IBM executive, a first of its kind, with our Foundation's Board leaders in a round table discussion. Betty Vetter was one of the persons who graciously agreed to be a part of that. Shirley Malcolm, who is another advocate in the field, Berniece Sandler, Barbara Scott Nelson from Ford Foundation, Dr. Ann Boyle from the National Science Foundation were included and they were very encouraging. They pointed out many of the gaps in terms of funding and programs for women and girls. It was heartening to us - the sense they gave that AAUW could make a difference and encouraged us to take an internal look at what we were doing.

One of the things that the Foundation, in terms of its graduate fellowships, may be more noted for is its support for women in the humanities or, perhaps social sciences. It's quite true that in terms of the way the funding was distributed, the allocation of money was done on the basis of the applicant pool, and the amount in the sciences was always smaller than other fields. We decided to initiate changes to shift the emphasis despite the standing policy that allocations are made on the basis of the applicant pool.In two years we've made significant strides to affect the shifts needed. In 1988, the Foundation's natural science fellowships at the dissertation level totaled ten awards, for about $100,000. The Foundation awards for 1990 are now at a level of fifteen awards just in the Natural Science areas, for $187,500. This is a fifty percent increase in the number of fellowships and almost doubles the total funding for science fellowships. This also includes increasing the amount of the dissertation award from $10,000 to $12,500 in an effort to remain somewhat competitive with other private sources for national fellowships. We are not quite on the level of the National Science Foundation (NSF) or some of the other larger university fellowships, but we are still in the ball park with many of the programs nationally.

There is further evidence of the commitment. For the first time this year, the number of fellowships awarded in physical sciences equaled, and really exceeded, the number in the biological sciences. The panel reviewers and our board have really been interested in bolstering support for women in physical science areas. For the current year there were eight awards in that category versus seven in the biological sciences.

This is in spite of the applicant pool in the biological sciences being double that of the physical sciences. There were 126 applicants in the biological sciences, the physical sciences had sixty-five and yet, in the final funding decisions eight women were funded for dissertation fellowships. As I mentioned briefly earlier, of our postdoctoral fellowships, three out of nine are designated in science areas and this is continuing. Fully a third of what we're doing in the postdoctoral area is geared toward women in science.

At another level of fellowships the program that I manage directly, Selected Professions Fellowships, the Foundation began to undertake transitions in 1987 which would address the emerging needs to encourage women's participation in technical disciplines, while at the same time continuing in other nontraditional areas. The Selected Professions Fellowships were established to promote the advancement of women in nontraditional careers. It's also designed to be flexible in meeting new graduate education needs. Engineering fellowships at the doctoral degree level have been awarded since the mid-1970's. By the Board's direction we instituted greater focus in this field with the addition of Master's level fellowships in the 1988-89 and also for the 1989-90 year, master's level fellowships in computer science, mathematics, and statistics were added.

Beginning in 1991 in Selected Professions there are going to be delineated categories of fellowships. There will be some focus on professional groups for minority women only in law, M.B.A., and medicine programs. Included in the science technology group will be engineering, computer science, mathematics, and architecture. In 1990, our engineering fellowships totaled fourteen, seven each at the Master's and Ph.D. levels. I anticipate that we'll be able to increase the engineering fellowships next year, particularly at the Ph.D. level, which continues as the area least represented by women in terms of doctoral degree attainment. I'm very proud to say that it is significant that AAUW has been focusing on engineering fellowships for the past fifteen years, long before NSF, which finally did implement a Women in Engineering Program this past year. I don't know how many awards they're going to make for that program but we were really ahead of the game on this kind of focused and sustained target group.

I want to talk a bit about our Research and Project Grants Programs. Before moving into R & P (our internal acronym) I would like to say that part of what we have really been interested in within the Foundation is the general status of minority women in graduate education. Just as we all are concerned about the status of women in science and technical areas it is equally important to pay close attention to what might be termed the "double bind" of sexism and racism for minority women in these scenarios, as students and as professionals. We have one bone of contention with reference to shedding light on the unique concerns and status of minority women, when one can rarely find consistent data collection by gender and race. Betty Vetter indicated earlier today, it's really hard to know what's going on with such gaps in information. Data that can pinpoint and quantify the numbers of minorities, particularly in the natural science disciplines, in universities across the country is difficult across various indices. In engineering, because the Engineering Professional Society has been interested in this question, there is a slightly better job of tracking by gender and race. But in the natural sciences this is not as easily done. We need to begin to identify what the standing is of minority women in order to address both issues of racism and sexism in setting any research agenda concerning minority women in science, and for designing intervention strategies. In the past few years, the Foundation has prioritized strategies to encourage and increase the participation of minority women as applicants, recipients, and panel reviewers.

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*"When you look at the honors roster of outstanding science students sponsored by the White House Initiative on Historically Black Colleges and Universities (HBCU's), you see in 1988 a little over half of the honorees are women, and for the next two years, closer to ninety percent are women."*

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There are pools of success and achievement among minority women to which we can point. You have Spelman College where one-third of their students are science majors, and they graduate near that number.

A majority of institutions don't approximate those numbers, those proportions, in the natural sciences. Xavier University of New Orleans is a top producer of Black medical and pharmacy school enrollees. When you look at the honors roster of outstanding science students sponsored by the White House Initiative on Historically Black Colleges and Universities (HBCU's), you see in 1988 a little over half of the honorees are women, and for the next two years, closer to ninety percent are women. Why can't we seek this number of talented women entering and completing graduate programs? Because of that, the AAUW Educational Foundation has embarked on a new initiative which is going to be a special "Outreach Program" to minority undergraduates in sciences and engineering. We're undertaking a planning study during this year and have been supported in the efforts with a planning grant from the Exxon Education Foundation. We want to identify a core of some 100 institutions to accelerate communications about our fellowships, select five or six target schools, and begin to develop a support and mentoring network program much akin to what CASET has been trying to do. I hope to learn much more about CASET's efforts as we're developing this piece.

My time is rapidly closing and I still need to highlight the local action through our Research and Projects Grants. We are very proud of the kinds of efforts that have been going on across the country without a lot of impetus from our national office in terms of grants and projects in which our local AAUW branches (chapters) are involved. We've done a brief survey of the kind of local action that AAUW members, largely voluntary efforts, but increasingly getting local corporate support, are targeting. The Foundation is in the developing stages of a new initiative, The Eleanor Roosevelt Fund for Women and Girls. We want it to zero in on the needs of girls in science, mathematics, and computer instruction in the very early years as one critical priority.

One of the more popular AAUW activities is involvement in "Expanding Your Horizons Conferences" nationally. A university like Washington State has really taken it on as a state-wide project. Twenty-two branches are collaborating on fourteen "Expanding Your Horizons Conferences". I mentioned earlier that the AAUW Maryland Division has taken on a statewide project at two levels of intervention. First, they started with a survey of mathematics and science instruction in districts concerning what the effect was for girls in terms of enrollment, course taking, testing, facilities, and equipment. They also had a lot to do with looking at funding patterns. Their research and advocacy were so strong that the Maryland State Legislature used their documentation as part of an effort to increase the level of mathematics and science curriculum improvements, particularly for teacher training. They didn't stop there. They also wanted to work on a local level with girls and have a very innovative project that takes mathematics and science to the mall....literally hands-on science and career exploration at major shopping centers. We all know young girls love to go to the mall and they decided to do something useful with that activity. This was a tremendous statewide effort. I believe something like 1200 girls were involved in this activity on one Saturday. They got a lot of local community and school district support, support from businesses, and made this a concept that they would like to take around the state. Those are just seeds of action of which we're very proud in terms of AAUW grants.

I wish I could talk longer about these local action programs but before ending, just some final comments about our newest initiative, the Eleanor Roosevelt Fund for Women and Girls and what it is going to be. The guiding principles of the Fund compel us to look at precollege issues affecting girls, particularly in science education. It is a program that has three components. One, for the first time we are going to commission research that is going to look very closely at the standing of girls in education nationally and for some particular insights into mathematics and science instruction, and explore the needs of girls which are unique and need addressing in the formal school environment. It is going to examine what happens in the school process that affects girls and keeps them ill-prepared or out of the pipeline, both for mathematics and science, and therefore generally in terms of higher aspirations. The second component of this leg of that initiative deals with a new area needing attention concerning gender equity issues and this is teacher training. We have begun to address this with a first action component by establishing a Teacher Fellowships program. We are awarding new fellowships for public school teachers who are interested in gender and equity issues. There is, here again, focus on science instruction and these fellowships have a wide range of use by teachers, either to do specialized course work for enrichment or retraining, or to get some benefit from different kinds of experiences as with science museums for example. The real beauty of the program is that there is a lot of flexibility - a teacher may take a form of a sabbatical or pursue

activities during the school year. We want those teachers to go back to their community, work with the AAUW branches, really make changes in the classroom, and eventually to affect the system. We think that teachers, hand-in-hand with our AAUW members as partners, can really begin to make things happen at the local levels. Eventually, we certainly hope to have something happen in the teacher training process, pre-service rather than in-service reflecting the need to address gender equity. The third component of the Eleanor Roosevelt Fund initiative is the community action projects. What will probably happen is that all of the sort of spotty activity that you see around the country in which AAUW branches and state collaborations are involved could somehow come together or be folded into a whole, make some new model projects taking place regionally that will have a substantive impact on education for girls across the country.

In closing, we're very excited about all that we have done and contributed in terms of the advancement of women in science and the many initiatives that are sure to come through our newer efforts. I've passed resource materials out, I hope that there are still more left. If you want more information, please feel free to contact us at the national AAUW office or any local AAUW chapter you're sure to hear about among your respective communities. Thank you for your attention and interest.

# WHAT IT TAKES TO PRODUCE A TALENT SEARCH WINNER

**Eunice Arnold**

**Science Teacher**
**Benjamin E. Mays High School and Academy**
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*Eunice Arnold has been teaching mathematics and science in the public high schools of Atlanta, Georgia since 1964. She received her B.S. in Science from Knoxville College and her M.A. in Chemistry from Atlanta University. During her 27 years in teaching, she has attended a number of science and education workshops throughout the U.S. She has received numerous honors and in 1990 was named Science Teacher of the Year by the Georgia Junior Academy of Science and Humanities Symposium-University of Georgia. Ms. Arnold currently teaches chemistry and physics and serves as Department Head at B.E. Mays High School and Academy in Atlanta.*

"What It Takes To Produce A Talent Search Winner" was supposed to be my topic for today. I want to change it just a little bit and ask this question, "What does it take to produce a winner?" Have you ever heard of a football, basketball, or tennis player entering a competition without practice? It sounds ludicrous, doesn't it? So it is when entering Westinghouse Science Talent Search. It takes more than a senior student saying, "I want to enter Westinghouse competition." It's not that simple. When a student enters high school in the eighth or ninth grade - in my school they enter on the ninth grade level - he or she should be forced to set goals, which would probably change from year to year, as you know. If the students can see themselves as a professional football player, a basketball star, or a movie star, we have to help them see themselves as a mathematician, a scientist, an astronaut, or an engineer. At Benjamin E. Mays Academy our major focus is mathematics and science and I represent Benjamin E. Mays High School and Academy. I teach both in the regular school and also I teach science in the Mathematics and Science Academy.

Students are required to do a science project. Let me tell you this, if you don't require it they won't do one. We usually tell them that the best project to do is one that you think of yourself, any project that comes out of your head. Many students would tell you, "You know I don't know what to do," and at that time, as a teacher, we have to give them suggestions.

If you have a copy of this book *Whiz Kid* - this is not my copy, I borrowed it from someone in the audience- you will find that my former student, Brian Hooker, is in this book. He is number nine, and I'm very proud of him. I was proud of him two years ago, and I'm still very proud of him. He is at Stanford

University. He won the Westinghouse Science Competition and it was not an accident. I taught him in the tenth grade and he came to me indicating that he did not have an idea about a project. But he said, "Mrs. Arnold, I would like to do a science project and I want to do a good science project, because I want to go somewhere with it." I said, "Okay, I'll help you." I gave him an idea and the kid ran with it. That is why I am so proud of him. He got help from Georgia Tech in Atlanta. He got on the telephone, he called six professors from area colleges. He finally got someone at Georgia Tech who could understand what he was talking about, and they decided to help him.

*"Students are required to do three hours of homework every night and we do not apologize for that."*

I would like for you to take a look at a profile of Brian Hooker, the student who won. I have his resume. As you can see, Brian Hooker participated in several activities. If you notice, this is his senior year and he had taken the SAT one time. Notice that he is a very active student, not a nerd, so to speak. Some students think that students who do science projects or do well in science are nerds. Brian was a very versatile student. Notice that he had a 4.13 average on a four point scale. The reason his average is above 4.00 was because he received extra credit for taking Advance Placement (AP) classes. That's because for taking AP classes you get extra credit.

Other than this award, he went to the International Science and Engineering Fair where he won third place, and he received other prizes and recognition. Look at his verbal SAT score. I am telling you to see that because we are going to come back to that later. You see that he had a 780 on the mathematics, a 670 on his verbal. Brian was not satisfied with that. As I said, this was around December and he had a chance to take the SAT again. Later on I am going to tell you how he improved his score. Many students would have been satisfied with that score. These are some other activities of Brian Hooker throughout his high school career. As you can see, he was a very active student, and he was academically talented.

Our school is an unique magnet school in Atlanta. It is very unique. We attract some of the best students who are interested in science and mathematics. Physics is taught in the ninth grade, followed by Biology and Chemistry. Then they take Human Biology, AP Chemistry and AP Calculus, which are a part of the program. We are trying to include AP Physics.

I talked to a professor over the summer, someone from the Southern Regional Education Board, about Advance Placement Physics. He related to me, "Mrs Arnold, why are you worried about AP Physics? We're worried about getting Plain Physics in some parts of Georgia. We don't even teach students that course in some of the remote parts of Georgia, so why are you worried about Advance Placement?" I said, "I want my students to have it. I am Department Head and I try to be very innovative. I figure by their senior year they should have a choice of AP Biology, AP Chemistry, and AP Physics." So I am still working on that and I have been working on that for about two years. My proposal is to get a college professor to come in and teach.

Students are required to do three hours of homework every night and we do not apologize for that. They have to do this to keep up with the program. At my school, science teachers in the academy realize that we have a responsibility to recognize and nurture scientific talent and potential. We feel that, in the academy, this is our responsibility.

When I learned last Thursday that I was coming to this Symposium, I talked to my colleagues and compiled this list of reasons why more minorities are not represented in Westinghouse Science Talent Search. We did this over lunch and I put it together quickly. I will discuss a few of these reasons that you see on the screen. I want you to see what we put our heads together and came up with the list as seen in table 1. (See Table 1) I am going back to that first one, the SAT component. This was the first topic that we put down, the first suggestion, and the many reasons for that is that students are not practiced enough. You can't study for the SAT.

**TABLE 1**

**WHY SOME MINORITIES ARE NOT REPRESENTED IN THE WESTINGHOUSE SCIENCE TALENT SEARCH**

| | |
|---|---|
| 1. | SAT COMPONENT |
| 2. | NOT MANY BLACK ROLE MODELS |
| 3. | LACK OF ACCESSIBILITY OF BLACK ROLE MODELS IN SCIENCES |
| 4. | SCHOOLS DO NOT STRESS SCIENCE FAIRS |
| 5. | MANY SCHOOL DO NOT ENCOURAGE STUDENTS TO TAKE MORE THAN THE MINIMUM 2 YEARS OF SCIENCE |
| 6. | MANY SCHOOLS ARE NOT AWARE OF VARIOUS COMPETITIONS |
| 7. | LACK OF INTEREST ON THE PART OF THE SCIENCE TEACHER |
| 8. | HOME RESPONSIBILITIES OF THE STUDENT |
| 9. | SOCIOECONOMIC FACTORS |
| 10. | LACK OF PEER GROUP THAT REINFORCES ACADEMIC ACHIEVEMENT IN SCIENCE |

I told you when we saw Brian's score that he said that he was going to raise that score. He did, he raised it to about 1520. You know that 1600 is a perfect score. He was about twenty points away from the 800 mathematics score, so he got that 20 points - he made a perfect mathematics score. But, he did not do quite as well on the verbal. I think that he raised it to about a 720. He did very well, but he asked me to talk to some of the other students. He said, "I practiced thirty minutes every night. I was determined to raise my score and I practiced." Do you know some of the students do not believe that? We were very proud of him. So this lets you know that you might not be able to study for the SAT, but you can practice. Perfect practice will make you better.

Next, the teachers were telling me that there are not many Black Role Models. They more or less meant the lack of acceptable Black Role Models in sciences. Now, let me tell you this. This is not a big problem at our school, because we are in a community where we have parents who are Role Models. We've put together a package for the city of Atlanta, because we were keeping in mind other students in other schools when we put these reasons together. Some schools do not stress Science Fairs. We stress Science Fairs at my school. At the academy we start at the ninth grade and say you have to do a project. We tell them that, "If you are going to be in the Academy, you just have to do it." But, in the regular school, where I have one class, there is a different attitude. Some say, "I don't want to do a project, why are you telling me this?"

I have seniors for the first time this year. I have taught tenth and eleventh grade chemistry previously. This year I have senior physics. I am telling them that they have to do a project and they say, "Why are you telling me that I have to do a project? I have never done one." I say, "You have to do it, it is simple. It doesn't have to be something complicated as long as you follow the scientific processes." Some of them know that I am serious and it may affect their grade, so they're going to do a project. Students who learn how to maneuver through the scientific method are usually very successful in solving other problems.

There is a two-year minimum requirement for Georgia. I don't know how that is all over the United States, but students are only required to take physical science and a biological science. That is all that they are required to take. So in the regular school you have many students who complete these requirements by the tenth grade in our schools, because we started in ninth grade. When they get the two years, they're through with it. That is one of the biggest problems, trying to get minorities to stay with the sciences.

I do not have problem number six. I have a very innovative principal, she feeds information down to me. Many schools are not aware of various competitions, because they don't get that information. Most organizations send mail to the principals. It just stays on a desk waiting to be opened. Sometimes it is too late. My principal doesn't open it any more. She puts my name on it and places it in my mailbox. That is how I get information. In turn, I inform all of the other teachers that we have these competitions. I ask,"Who are we going to get ready for this competition?" My school knows about the competitions, we don't have that problem. But, we do get calls from other schools, asking, "How do you get into the Georgia Junior Science and Humanities Symposium? How do you get into the Westinghouse? What did you do?" I say, "Didn't you get the information?" They say, "No, will you please send it to me in the school mail?" Then I send copies to the school.

Number seven is very important. Some teachers are not interested in a Science Fair. You know, it is a lot of work, let me tell you that. I stay at school late. Sometimes I have been there as late as eight o'clock. Sometimes I've had a few parents who have offered to help. Sometimes they offer to bring us dinner. But, it doesn't bother me. I enjoy teaching and I enjoy seeing students learn. Dedication to me doesn't have that much to do with it, I just enjoy it. There are about two of us in my department who feel the same way. We just enjoy teaching and we will stay with students to help them with their projects. When we don't have the specific equipment at school, we have to seek help from local universities for those projects that can not be done at school. Number eight and nine can be combined. My colleagues said, "You know, some students have to work." Yes, they do. Sometimes they have to babysit. Sometimes that will play a part in whether or not they will do a project. So I feel that economics is a factor.

Number ten, the lack of a peer group that reinforces academic achievement in science. We do not have that problem at Benjamin E. Mays High School, but we do have that problem in Atlanta. The Academy impacts the whole school. Other students see students doing projects, carrying boards, explaining, and winning. They have peer groups that are involved in academic competitions and science, but some schools do not have this.

This ends my presentation. I have enjoyed it and I would like to thank Dr. Kay for inviting me. Thank you, very much.

# STUDENT PANEL

**Yolanda D. Brooks**

**Prairie View A&M University**
**Mechanical Engineering Major**
**Prairie View, Texas**

*Originally from Edna, Texas, Yolanda Brooks first became interested in mathematics and science in elementary school. Her early success carried over from elementary school to high school, and has followed her through her college career. Although she was offered a scholarship to the University of Texas at Austin, Ms. Brooks chose Prairie View A&M University to pursue her dream of becoming a professional engineer. Ms. Brooks is currently a senior majoring in mechanical engineering at Prairie View A&M University, and has maintained one of the highest grade point averages in the School of Engineering.*

Hello, I am Yolanda Brooks. I'm originally from Edna, Texas. That's the small town going South on Highway 59, about 100 miles from Houston. I guess, you can say my knowledge and interest in the sciences and mathematics began in fifth grade. My mother was a teacher, so normally homework came first. You did your homework and you got your grades, that was just a given. Actually, in the fifth grade there was a program called GCAME and in my area it was called Golden Crest Alliance of Minorities in Engineering. This program was sponsored through Dupont, a chemical plant near Edna. Dupont chose students from various towns in the area. They all had to meet certain academic requirements, had to be leaders in the community at that age, in our activities, for instance, church choir or girl scouts. What they would do is set up a program where we could take different mathematics classes, different computer classes, and they would introduce us to the field of engineering, also. So during the fall and spring semesters, we would go once a month to a chosen high school in Victoria, Texas and there we would go to meetings. We would either have speakers or different role models from the plant - engineers, male, female. During the summer we would go to a six week program where we actually worked on little engineering type projects. We would be assigned a role model and they would work with us. There we would develop our mathematics classes, our sciences, and work on our technical writing.

I was first called into the principal's office - in fifth grade going to the principal's office is like, "Oh God, what did I do now." My principal sat me down and she said, "Yolanda, you've been chosen to participate in this program in Victoria. They chose you out of a number of students to participate in this program. We were wondering if you'd like to participate?" I said, " Well, what is it dealing with?" She said, "Engineering." I said, " Huh, what's engineering? I'm not going to be an engineer or anything." So she went into this big description of what engineering consisted of, what I would be required to do, and so on and so forth. I said, "Hey, that sounds interesting." So I went home and I talked to my parents. My mother, the teacher, said, "This is something different." My father said, "Well, whatever you want to do." So that's basically how I started. I got a chance to go to these programs.

At the end of your senior year if you stayed with the program and kept up your grades, you were allowed to work at one of the chemical plants in the area. So we got a chance to work on our skills, our interviewing skills, our technical writing skills. So basically, I didn't really choose engineering, engineering

sort of chose me. Towards the end we got a chance to go to different plant sites to get used to what the different fields of engineering consist of. About role models - we had some pretty good role models that worked with us and helped us with our projects. Some of the kids were from one parent homes, so they would take the kid out on Saturdays. If you just had a mother and your role model was a male, he would come to your house and spend some extra time with you. That's basically how I got started.

Why did I choose Prairie View A & M University? At the beginning I wasn't going to Prairie View, I was going to The University of Texas. My mother graduated from Prairie View, so she was saying, "UT, are you sure?" She was thinking, "If you don't get a scholarship or anything, we're gonna have to pay for this" I said, "Don't worry I'm going to get the scholarship."

My junior year I got an invitation to go to Minorities Introduction to Engineering (MITE), which is a Pre-Engineering Program at Prairie View. You get a chance to go on campus, find out what engineering's about, and just kind of hang out on the campus, for two weeks. My mother said, "Why don't you go to this, you know, you should really go to this and give Prairie View a chance." "No, Mama, I don't want to go, I don't want to go, I don't want to go." She said, "Go, go." At the end of the GCAME, during the summer I went for their six-week program. We were all assigned different projects at the end of the program. That summer I worked on an installation project with two other students and our project turned out very well. It attracted a lot of attention from people in the program and the Plant Manager, who was there, was very excited about our project.

A recruiter from Prairie View was there as well. She came over to me and said, "Your name sounds familiar." I said, "Oh really?" She said, "Didn't we send you a form for MITE?" I said, "Yes you sure did." She said, "Well, why don't you come?" I said, "Well, my mother's been kind of pushing the issue." She said, "Well, come, come, come." (The program I had been in ended on Saturday and the MITE Program stared the very next day on Sunday) I said, "Isn't it too late because I didn't even respond or anything?" She said, "No, come on, come on, I'm going to be there, and I'm in charge of the program."

I went to Prairie View and really enjoyed myself. I just don't know if it was a recruiting tactic or what, but they loved us to death - that was one of the things that I enjoyed there. Whatever we wanted, whatever we needed, they were there. We were just like newborn babies. They just treated us so great. I said, "Hey, you can't beat this!" I had also visited the University of Texas and Texas A & M University, and I got a chance to tour the campuses, and so on and so forth. When I was there, I toured the campus, but nobody really approached you and said, "Hey, we want you here, come on, the campus is yours." You were just kind of there as just another person walking around. So I said you can't beat Prairie View. If you can go to a place when you're not even a student yet and they treat you like this, I can imagine what it will be like to be an actual student. I got a chance to talk with some of the professors there, and they just seemed like they were so concerned about the students. These students were their main goal. So I went back and I told my recruiter, "You know that scholarship that you were going to get me for Texas that I signed up for and you said that I had." I said, "Well, you need to give it to someone else." She said, "Yolanda what do you mean?" I said, "Well,I didn't sign any papers or anything, you know, and Prairie View sounds great." She was kind of disappointed about that. But, I have to say that really and truly Prairie View is a great school. I wouldn't have done it any differently. With my being in engineering those classes and stuff get hard, but you can just go to an instructor personally - not his aide or his assistant. You can feel like he is just taking you aside as if he's your father or she's your mother. You can go into the dean's office with no problem, as well. We have a new dean and he's great, with an open door policy. You can go in and just sit down, drink soda, if you are thirsty or whatever.

Anyway, I feel like education is important, but if you don't feel comfortable, if you are not able to get over that adjustment barrier then how can you do your studies? That's basically why I chose Prairie View. As I said, I didn't choose engineering, engineering chose me. When I graduated from high school, and they gave me a job for the summer, and I got a chance to work at the plant - that was great. I worked for Dupont that summer and that was great - just having the responsibility and knowing that once I become an engineer I'm going to have a part in designing and constructing things. I just may patent something, change something, or invent something, and that just makes a person feel great. That's all I have to say.

# STUDENT PANEL

**Johnna Branch**

**Prairie View A&M University**
**Mathematics Major**
**Prairie View, Texas**

*Johnna Branch is currently a senior majoring in mathematics at Prairie View A&M University. Earlier this year she became a commissioned officer in the United States Army as a second lieutenant. She, however, took a very non-conventional route to end up in mathematics. A native Houstonian, Ms. Branch attended the magnet school called the High School for Law Enforcement and Criminal Justice. Ironically, as she jokingly admits, as a youngster, she was more interested in sports than in science or mathematics. It was during a high school ROTC field trip, where she was taken for a helicopter ride, that set her on the path to pursuing a Science, Engineering, and Technology (SET) career. Upon finding out that the only way to fly a helicopter was to get a college degree and preferably in a mathematics-based field such as engineering or mathematics, Ms. Branch focused her interests to realize her goal of becoming a pilot. Four years after her famous helicopter ride Johnna Branch is not only a graduate of mathematics, she is also an officer and soon-to-be pilot in the U.S. Army.*

I'm Johnna Branch and I'm from Prairie View, also. My story is not that glamorous. I went to a Magnet Elementary School and Magnet Junior High and Magnet High School, but I guess I really wasn't interested in all the technical aspects of what they were giving us when I was in elementary and junior high. I was more into sports. In elementary I was in gymnastics. I know that this is not really what you guys wanted to hear about. But, in elementary I was in gymnastics and in middle school I was in basketball. So my mom was saying, "We have to get you away from sports." So she sent me to a high school in Houston which is right next to St. Thomas High School and it's called The High School for Law Enforcement and Criminal Justice. This is far from the technical aspect, but this is where I got my background.

Well, I went to Law Enforcement and I basically hated it in my freshman year. They had no sports, all they had was ROTC. You had to take it so I had to channel all of my energies there. In ROTC there was a program that you went to during the summer. It's called summer camp. It's a full week, Sunday to Sunday. When I got there we got to ride on these helicopters. I thought, "Wow, this is really neat." So I asked one of the pilots who was an officer, "How do I get to fly one of these humdingers?" He said, "You go to and graduate from college, and become an officer. But, you probably shouldn't." I said, "Well, what should I major in." He said, "Well, the sciences would be the best - like engineering and mathematics." I thought, "Okay," and then from that point on, believe it or not, I was determined to be either an engineer or a mathematician. I didn't change schools, although we also had an engineering magnet school in Houston where you could also get your Pilots License when you graduated. However, I decided not to go there, because I liked law enforcement and because it was a real structured program.

You got to know computers; we had good chemistry teachers, we had good physics teachers, good mathematics teachers. But, I wasn't really good in mathematics. I never really was. So when I was telling my counselor that I wanted to be an engineer or mathematician, she said, "You would never make it, because, you are only getting D's and C's in mathematics." I said, "I don't care what you say. I don't care what the teachers are giving me in class, I'm going to be an engineer." I finally graduated.

Before that, I went to Prairie View A & M University where there is a Minority Introduction to Engineering (MITE) program. I was like Yolanda, I never wanted to go to Prairie View. You heard such horror stories about Prairie View. It wasn't what everybody said it was. My mom graduated from Prairie View and my three uncles graduated from Prairie View. One was an engineer and is in the military. I went my sophomore year during the summer. It was as if I had to go to camp! I went to camp every year until I graduated. Then after camp I went straight to Prairie View to the MITE program. It was really great; they had good instructors. If it weren't for Prairie View's MITE program I wouldn't be as structured as I am in mathematics and sciences now. Because, in the MITE program you have mathematics courses, you get the computer, you get the science, and all of that. It's just a two week program, but it really is geared toward engineering and mathematics. So they really get you going and stir it up so you feel that you really want to do this. After going to MITE for all those years, by the time I was a senior, Prairie View offered me a scholarship. So did the University of Texas in San Antonio. I wanted to go there because of the ROTC, not because of the engineering. But, I weighed the options and decided that Prairie View had the best engineering program for me. I really liked it, because the teachers were so concerned about each student. I really needed somebody to push me, because I'm not a person who studies; I don't have very good study habits. So if you come to class without your homework, this is what Dr. Frazier, one of our instructors says, "You have to get out, because you can't help me today. You can't participate. So you have to get out of my class." Not doing my homework wasn't working so I had to go home at night and do my homework. I accepted the scholarship to Prairie View.

To become a pilot, which is what started me in the sciences, I had to complete ROTC. So I entered ROTC. Initially engineering was going pretty good. I interned at General Motors for two summers in '88 and '89. But, I really didn't like engineering. It was okay; I got the practical experience and we did mechanical engineering, we did electrical engineering. But, we didn't do any chemical engineering. We did more mechanical engineering and electrical engineering. We did troubleshooting and all that type of thing so I got to see how to troubleshoot. But, I really didn't like it, because, after you do the troubleshooting and all of that, you have nothing to do. Just sit there, right? So I got pretty bored with that.

This summer I decided to just declare another major. I declared mathematics. This summer I took about eighteen hours and I'm currently taking sixteen hours. Now I'm able to graduate in May with a degree in mathematics. If the Army lets me, I might be able to finish my engineering degree in December or May of '92. You probably wouldn't even care, but I got my commission as a Second Lieutenant in the U. S. Army, on May 13. So I'm really trying to concentrate on the Army. The mathematics - I really like that, I've done really well in it since I've been at Prairie View. I just really like the Mathematics Department, because the instructors are also really good. The instructors for engineering are really good, but I just don't like engineering. Not because the instructors are not good, but I just don't think it's for me. Plus, my grades are so much better in mathematics. Not that it's easier, because it's really hard. If any of you know anything about Modern Algebra, it's killing me.

But, that's really how I got started in the sciences. It sounds kind of a round-about-way to get from ROTC to mathematics. Although, ROTC was my goal and directed me towards engineering, I ended up going into mathematics. I'm glad that I made that choice. I hope that I'm able to complete the Engineering Degree, if Uncle Sam doesn't call me. Thank You.

# STUDENT PANEL

**Tracie Hall**

**Rice University**
**Bio-Chemistry Major**
**Houston, Texas 77251**

*Tracie Hall's interest in mathematics and science began in elementary school. A native of Houston, Texas, Ms. Hall cites the opportunities that she was able to be a part of while growing up, as the basis for her becoming interested in mathematics and science. By the time she entered college at Rice University, where she is currently a senior majoring in bio-chemistry, she knew that mathematics and science were things that she wanted to pursue. A student and community leader Ms. Hall is presently organizing a program to help elementary school students in the Houston area.*

Good evening, I understand that we have been asked to discuss the reasons or influences that created an interest in science and engineering. The most important gift or character trait instilled in me is the love of learning, regardless of the subject matter. And I guess I became interested in science, because my parents - neither completed the ninth grade - instilled the confidence to ask questions, and the motivation to seek the better answers. Thanks to my parents, I was able to read at the age of three. And with this talent, soon questions such as "Why did the sun rise?" emerged. As a result, mother and I would spend hours in the bookstores looking for books that had the answers. I still have one of the books Answers to Everyday Scientific Questions or something like that. Anyway, the point is that with parents who were supportive, I developed a love for learning, and science was the object of that love.

I attended the Pleasantville Elementary Vanguard program. The teachers in the program, mostly minority, had great interest in their students. Often they strayed from the curriculum, and discussed interesting ideas. For example, if a student had a question regarding outer space, the teacher would arrange a trip to the planetarium. Or if someone wanted to understand how the eye functioned, the teacher would arrange a dissection of a cow's eye. In other words, the teachers, parents, students, and administration worked together to make sure that the students were in an environment that was conducive to learning.

During both middle and high school, I participated in privately funded summer programs that offered science and engineering courses. One such program was the Summer Enrichment Program for High School Students at Rice University. The Rice University program was by some standards extremely expensive. The program costs approximately $300.00. However, by my parents standards (my mother was a telephone operator and my father, at the time, was a retired delivery man) they felt the opportunity outweighed the cost of the program and they favored my attending the summer program. The program offered algebra, chemistry, biology, as well as literature and history courses. At the age of twelve, I enrolled in computer programming, chemistry, and algebra, and somehow managed to perform quite well in the courses. Another summer program I participated in was the Kinkaid Math Science Program, which is a joint effort between The Kinkaid School and the Houston Independent School District (HISD). The program, designed to introduce HISD students to engineering, offers such classes as drafting, electronics, binary electronics,

FORTRAN, PASCAL, physics, and chemistry. The entire program covers three summers, and each summer high achieving students are invited to participate in the next level.

With such a strong background in science, I just knew that in college I would major in engineering, and that the engineering department would be supportive of all of its students. Some engineering professors are not concerned about the B- or below students. In fact, when I attempted to discuss a C-, a professor told me, "It's probably not your fault you are here. Have you thought about economics because you really don't have what it takes to be in science and engineering?" Please note that the soliloquy began the moment I opened the door. These attitudes exist too often in our science and engineering departments. And too often, these statements deter students with potential, especially women, from continuing with their hopes and aspirations of majoring in science and engineering.

As a former president of National Society of Black Engineers (NSBE), we established a tutorial program for freshmen science and engineering, and encouraged professors and graduate students to tutor. Thus far, the program has helped, because I believe now that the professors are realizing that they need to modify their lectures to accommodate all students. Also, the NSBE chapter is establishing a program, or is trying to establish a program that tutors elementary students without dividing them into gifted, normal, and slow sections. Labelling has negative effects on students.

In addition, universities should examine their science and engineering departments. America is no longer the big technology powerhouse. If we are going to remain a major contender in the technology field, then universities must first educate their faculty to educate their new students. Classes no longer consist solely of white men. Now they are composed of minorities and women, and professors must learn to respect these individual's cultural differences and learning patterns.

In conclusion, my interest in science and engineering evolved from the support from my parents, early exposure to science during elementary school, and development programs (both private and government funded) during adolescence. However, the interest remained in science due to the support I received from my peers, and NSBE.

# STUDENT PANEL

**Yamile Cendales-Behaine**

**University of Houston**
**Industrial Engineering Major**
**Houston, Texas 77204**

*Yamile Cendales-Behaine is from the South American country of Columbia. Her interest in engineering started at a very early age as her father, her neighbors, as well as her high school teacher were all engineers. She completed three and one-half years of college in Columbia in an industrial engineering program before arriving in Houston. With the help of her uncle, who lives in Houston, she was able to transfer to the University of Houston last year and enroll in the industrial engineering program there. She is currently a senior majoring in industrial engineering at the University of Houston and plans to pursue her masters degree after she graduates next year.*

My name is Yamile Cendales-Behaine. I was born in Bogotá, Columbia where I lived for 21 years. My maternal grandfather was an immigrant from Lebanon and married my grandmother in Colombia while my father's family is Columbian. My mother has her Ph.D. in history and my late father was an army engineer. I began industrial engineering at the Xaveriana University, a private Catholic university, directed by Jesuits in Bogotá, Columbia.

After finishing high school at a private Catholic school in Bogotá, Colegio Santa Maria, directed by Benedictines, I started engineering in the Fall of 1985. All professional majors including engineering in Colombia take five years to complete, and when I finished my seventh semester, my uncle Jorge Behaine, who is a medical doctor in Houston, invited me to spend Christmas vacation with his family. Once here, he invited me to stay for six months and practice my english with the possibility of staying to finish my degree if the University of Houston accepted me and would transfer enough of my credits.

Even though I had to leave my family, my friends, my university, and my beautiful country, I knew it was a great opportunity for me because I always dreamed of pursuing the master and doctorate degrees in industrial engineering in the United States. If for any reason I had to go back to Colombia I would have spoken fluent English and had a degree that would have given me the opportunity to find an excellent job in Bogotá.

There are seventeen universities in Colombia that have industrial engineering departments and the Xaveriana is one of the biggest, with about 800 students in the undergraduate program, but they did not have a graduate program in engineering. In contrast, the University of Houston has about 80 undergraduate students and a bigger graduate program. In Bogotá I could have had somewhere between 5 and 20 female classmates, and here sometimes I am the only female in the class, even in classes that all engineering students are required to take. On the other hand, in Bogotá almost all my classmates were Colombians, and here I was the only Columbian! It was a great experience for me to have contact with so many cultures in one place!

In Columbia we don't have the minority issue, but I have never felt any kind of discrimination for being

a woman. I remember one priest telling me what my mom always tells me, "Men and women should do the best they can, they should not be mediocre." That is what I always try to do.

I was accepted at the University of Houston in the Industrial Engineering Department as a junior in the Summer of '89 after attending two classes during the Spring. Now I am a senior and am expecting to graduate next May, thanks to my uncle and my mom.

Question from the floor:

What are you going to do with it?

With Industrial Engineering? I want to specialize in Safety and Human Factors. In Colombia I didn't have any classes in safety because that was offered in the last semester of the program, and I was here. Now I am taking a Human Factors and Ergonomics' class and I really like it. I like the human side of engineering, and that is the reason I liked Industrial over any other of the branches of engineering. After doing my Ph.D. and working for several years I would like to become a professor at a university.

Question for the floor:

Can the eight hundred get employed? Do they have jobs in Columbia for that many Industrial Engineers?

The job opportunities are reduced, but since industrial engineering can be applied in so many fields, students can find jobs. The variety of jobs is great. From banks to multinational firms. The university really works hard helping the student find the best available job for him/her. Students start working in the seventh or eighth semester, so by the time they graduate they probably can get a job offer from that company.

Question for the floor:

Do you feel any pressures now being the only woman in your class as opposed to the other environment where you were in the majority?

No. I feel very comfortable with what I am doing. I guess it helped that I have a brother five years older than me and we were very close growing up. He and my mother helped my sister and I to grow up being as good as we could be no matter who we were with. I don't feel any different pressures being with males than being with females even though it was a real change coming from a school with all females to a major where almost all are guys.

# STUDENT PANEL

**Roberta Manuelito**

**Engineering Student**
**University of Colorado at Boulder**
**Boulder, Colorado 80309**

My story is way off in left field compared to the one you just heard. I guess I would call it "The Trials and Tribulations of Roberta Attending University of Colorado (CU) at Boulder." I've had a lot of ups and downs. But, I'm still here. I am a full-blooded Navajo. Just like my grandmother, who is a medicine woman. My grandmother a long time ago used to say, "You know, one day you're going to go back to school." Because right out of high school I never had the opportunity to even know what college was like. If you made it out of high school that was a major accomplishment coming off the reservation. If I look a little nervous, I am. I can usually handle this many people, but (I don't know for what reason) I am shaking.

Anyway, I speak full-blooded Navajo. Navajo is my first language. When I was going to school, and they were trying to teach me to speak English, it just did not make sense to me. I think a lot of the times when Native Americans or people who have a different language than English get into school, they're really confused, like I was. If I were to say in Navajo, "What are you doing," the word for word translation would be "Doing what are you?" Everything was so backwards to me. So when people had to go do problems it would be like, "Why?" My father had an eighth grade education and my mother had an eleventh grade education. They raised six kids. Somehow, they kept pushing education as somewhere to get out of the hole of always being considered, you know, quote "a dummy Indian." I think one of the hardest parts about - sometimes this gets real emotional - is that traditionally, as Indian people, you are really close to your Mom and Dad, you have your Mom and Dad as your apron strings. Even as old as I am, I still hang on to my Mom and Dad; because tradition to me was always number one. For me to lose that tradition has been really hard. To let go and go to a predominately White school, where no one knows what or why you do the things you do. I have ceremonies I go home to. To tell a professor, "Hey look, I've got a ceremony that I have to go home for," and they look at you like, "Excuse me?" So I have to go to the Chancellor. I've gotten really friendly with the Chancellor at the University of Colorado. So that's been a real big plus to try to explain to him, because he has been really supportive of me being there. Engineering wasn't a field that I was going to go into. Right out of high school I started working for AT&T with this Job Training Partnership Act (JTPA), a job training program, because my counselor in high school told me that I wasn't college material. He said, "You don't have a chance." I had always wanted to go to college because I thought, "This will be really neat. My parents would be really proud of me." When he told me I wasn't college material I said, "Well, all right - I'll try something else." I went to work for AT&T. I worked for them for seven years. During that time my supervisor, an older man, never sent me to school. There were guys hired years after I was, who got to go to Ohio and California for two and three week schools.

Finally, I took a voluntary layoff from AT&T and went to get my Electronic Engineering degree. I wanted to see what it was like to go to school. I did really well in my Associate Degree so I decided, "Let me try." I really liked school then, it was like great. Then I thought, "Well, I wonder what it would be like to go to the University of Colorado at Boulder?" So I got admitted there. They told me at the time there

were hundreds and hundreds of Indians there. I thought, "Wow, this is pretty good." Because by this time I'm really missing my family. So I had to always go home - we had the quarter system, so every quarter break I would be home for a week and a half. I'd have enough willpower, and put myself back into balance, to go, and get back into school again.

My parents were trying to save enough money to make it down to Denver to see me. As I told you, the only way that my parents have been really supportive is that sometimes they're coming to visit me, and I'm just busily trying to figure out problems in calculus and so forth. They're looking at me, "What is that stuff?" When I try to explain it to them or try to explain it to my grandparents who are pure Navajo, and don't know the concept of physics or what "nothing" is, to try to explain it in Navajo is a little bit tricky. But, the only thing that my parents and my grandparents tell me is that, "All we can do is to traditionally take Corn Pollen." Corn Pollen is one of our most traditional sacred medicines among Navajo people. They take that and offer it to Mother Earth every morning. Maybe it sounds kind of funny, but it seems like when I study hard and for long hours - I'll either call my mother or see her. I'll call the trading post to tell them to please have my mother call me. She'll call me and I'll tell her, "Mom, I have a heavy duty exam tomorrow morning. Would you put some Corn Pollen out for me?" That's all it takes to make me feel so much better. That's the support I get from my mom and dad. I think that when I shed tears it is because I really miss my mom and dad.

Some of the things that have happened in my life have caused my life to be like a roller coaster. For example first coming to Colorado University, and not being able to find Indian people around there to support me. I felt as if I was in a place where I was not really wanted. That's how the Chancellor came in. I was going to quit school. My grandmother said, "Don't quit, because for some reason you are at CU-Boulder. You are going to make an impact there that no one has ever really made. If you leave there, then none of your younger brothers or sisters are going to be able to follow your footsteps." I thought, "I'd rather be hit or beaten than to have to take this emotional abuse here," but I stuck it out. She said, "Somewhere along the line you're going to start seeing little changes. Little things that will indicate to you why you should really be there."

The start of my third semester, I was given the Minority Equity and Excellence Award, for undergraduates there. I don't even know to this day what I did to get it. At that time I was really going through a hard time because we had lost a student to a murder, because he had hitchhiked home. It was one of my Navajo friends, who hitchhiked to Albuquerque, and he got murdered on the way down. He only hitchhiked because CU wouldn't front him money for a Student Emergency Loan for two hundred and fifty dollars, because he didn't have any finances to actually pay the money back. So at that awards banquet I gave back the money. I shed a few tears, but it made me realize that they need to do something with the schools. So instead of taking the money I said, "I'm honored to take the award, but at the same time I want to give you this money back so that this won't happen to another Native American, let alone a minority student - that at least there is money here." The Chancellor gave me back that money with his personal check, and then actually started a fund for students with problems like that. But, from there I keep having roller coasters.

Before that, I could never get into engineering. They told me I had to take all these classes and go through all this rigmarole - "Until you take four semesters of calculus we won't let you in." Plus, you need to take three semesters of physics, three semesters of chemistry, and all these prerequisites to get into the engineering. But it so happened that after I got this award, the Dean of the College of Engineering came up to me and said, "Roberta, I just want you to know you are in engineering now." I said, "I haven't taken all these classes yet." I almost got to the point to where they said, "I don't know if you are engineering material." I thought, "Well, you may not think so, but I think I am." You just had to keep going out there, and just showing them. They didn't know that I had all this experience behind me, plus an Associate Degree. It was like a role reversal when I started in classes for engineering, because it was the guys coming up to me for help, instead of me going up to the guys. That's the only thing I can say: there are a lot of trials, but - see - I still end up smiling at the end of my stories.

But, it's just something that is hard to be - I know as a Native American - walking down two roads. I have to straddle both sides, because I can never let go of my tradition. To be able to get into engineering, realistically, a long time ago even my grandparents said, "You know you are really not supposed to be in engineering, because that's something that you need to have a ceremony done for before you actually go

in, because you are working with something that is part of nature and that's electricity. So someday you may get sick from this." I'm, like, "Oh, great!" I have had my share of ceremonies for this kind of stuff.

I think that the next turning point would have been when I was chosen as the National Student Representative to the Board of Directors for AISES which is The American Indian Science and Engineering Society. Being able to be a role model for Indian students among 68 chapters has been an honor for me. I'll be stepping down next November, in Albuquerque at our national conference up there. To me, I hope that just being a role model for other Indian students will give their kids incentive to go on. Right now I actually do some volunteer work, some of it paid, to help Indian students in their urban areas to try and reach first graders, even kindergartners, to tell them that mathematics and science aren't so hard. Even Dr. King was talking about how one should not tell them that it's hard, and I try to make it just as easy as it is. Most of these kids are failing the sciences, and to get them to do *A* and *B* work in junior high is really quite something. It is something to just being a role model and to tell them, "This isn't really as hard as it's supposed to be." It has really made a difference in a lot of Indian kids' lives in Colorado.

I don't know what else I'm supposed to say, but I hope that's enough for you guys to hear about. Thank you.

# EXPANDING YOUR HORIZONS IN SCIENCE AND MATHEMATICS

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One of the things that I would like to do this morning before we get started is to let you know a little about what Expanding Your Horizons Conferences are all about. The best way that I feel to do that is to show you some video tape that was shot at last year's Tri-Valley Conference in the Livermore Valley in California. Now this tape is totally unedited, it is not polished, it is just raw footage, but it is gut-level reactions from some of the young ladies who attended the conference. What you will be seeing this morning, at the beginning of the tape, is young women interviewing various adult role models. Basically what they're trying to do is figure out what these role models do for a living. They've been given a game to play called Mystery Women, and so by asking questions of the role models, which will be answered either yes or no, or with very simple answers, they're trying to figure out what the occupations of the role models are. So that's what you'll see this morning. I'm not going to show the whole tape, because it gets a little redundant after a while. One of the things that I would like for you to pay particular attention to are some of the comments that the young ladies make. No matter what we say, it's still very dependent upon how they feel, and where they're coming from, the way we should approach things.

Video Runs

The video up to this point shows a pretty good idea of what Expanding Your Horizons Conferences are

like. You've got a fairly good overview of hands-on workshop sessions, career sessions, where they were having discussions about the differences and discrepancies in magazine articles, and hands-on workshop sessions with the young ladies dealing with the materials. You saw a little bit of the career fair, where they were scurrying around in different areas, talking to different people about their jobs. The beginning of the movie was young girls trying to take care of their game playing contest in Mystery Women. So basically that is what Expanding Your Horizons and Math and Science Conferences are about.

***"I know the premise seems far fetched when young women are first presented the idea; however, when given the choices of attending workshops with names like "Designer Genes, Zap-it-to-me, and Who Done It?" it sparks their curiosity."***

Now I'd like to give you a little bit more of an in-depth view of it. Basically I'm here as a representative of the Mathematics Science Network. You will hear me use the term EYH. The reason I use EYH is because saying Expanding Your Horizons in Science and Mathematics is a mouthful, and EYH is much easier to say. I'm here as a representative of EYH and as a representative of Sandia National Laboratories. Now you may not know it, but the Mathematics Science Network which is the parent organization of EYH, is recognized as an, and I quote "exemplary program" in Changing America, the New Face of Science and Engineering, from the report of the U.S. Task Force on Women, Minorities and Handicapped in Science and Technology. Every EYH program is a major part of that recognition, because the Mathematics Science Network is the parent of EYH, and like all good children, EYH is now growing and spreading out to spawn new growth and more conferences throughout the United States.

The first conference was held in March of 1976 at Mills College in Oakland, California. It came about as a result of an observation by sociologist Lucy Sells[1]. Her study concluded that mathematics education early in life was clearly a critical filter in keeping young women from pursuing science and math related careers. A group of teachers came together and decided the best way to present mathematics to young women from a different perspective was to allow them to meet with women who were working in the fields of science and mathematics. Hopefully this experience would leave the young women with the feeling that, "If I take enough science and mathematics now, I will be able to do that too." A student conference was presented in order that young women could see how much fun and excitement could be theirs as a result of taking science and mathematics classes.

I know the premise seems far fetched when young women are first presented the idea; however, when given the choices of attending workshops with names like "Designer Genes, Zap-it-to-me, and Who Done It?" it sparks their curiosity. Would you know that Designer Genes was about the study of genetics, or that Zap-it-to-me was about communicating with VAX Computers, or that Who Done It? was the study of forensics, using DNA to solve crimes? Sometimes in order to stimulate attention and spark interest, it is necessary to package the product in an attractive manner, that's what we try to achieve with the Expanding Your Horizons Conferences. It must be working, because ever since the first conference in March of '76, interest has continued to grow.

In 1977, two conferences were held, one at Mills College and one in San Francisco. The following year there were five conferences and they were all in the California Bay Area. In 1980 there were 20 conferences being held throughout the country, and by 1990 there were 80 conferences held throughout the country. Some of the statistics that go along with those numbers include: from September '89 -June '90, 83 sites requested and paid for EYH planning materials. Of the 83 requesting materials, 67 actually held

[1] Editor's Note: Sells has written extensively on this subject. See paper presented at the 1973 Conference on Minority Graduate Education, University of California - Berkeley; "The Mathematics Filter and the Education of Minorities and Women," a paper presented at the 1976 annual meeting of the American Association for the Advancement of Science; "Mathematics - A Critical Filter." 1978 *Science Teacher* ***45 (2)****: 28-29.*

conferences, six rescheduled for Fall of 1990, three cancelled, six sites were unable to hold a conference for various reasons, and one organization requested planning information to provide it to the public. By the way, if anybody has any questions while I'm talking, please feel free to interrupt me, Thank you.

***"Our children are our biggest resource and if we don't care about them, we can save the planet from now until doomsday, but it's not going to do any good, because there is not going to be anyone here to appreciate it. If they don't care and we don't help them start to care, then we have failed miserably as human beings."***

Of the 67 conferences that were held, we received 41 completed evaluation forms giving us a 61 percent return on our evaluations. The results from those were as follows: Nationwide student participation at EYH conferences was estimated to be 18,425 students. This number was based on the average number of student participants, 275, for 41 sites. However, it has come to our attention that there have been EYH conferences held about which we knew nothing. These sites did not request the materials but followed the model and used the name Expanding Your Horizons, which is absolutely fine with us. As long as the concept is being used, as long as young women are being reached, that's all we care about. We're there to help as a National Organization. If you need help, we're there for support if you need the support. We're there to offer materials that we have if you need them as well as the experience of our people. But if you want to use the name of the concept, please feel free to do it. Last year we reached approximately 20-22,000 girls. If you know of a group that is a prospective EYH site please let us know. We'll be more than happy to them get started.

Here are just a few statistics: Washington State, as Avis Davis said yesterday, has the most conferences being held. They have 16, and of those 16, 14 are sponsored by the American Association of University Women. California is next with 14, I believe. Texas, at this time, has only two conferences listed. With Texas as large as it is we need to get more Texas conferences going, ladies. The intent at the present time is to have as many conferences as possible in order to convey the message that mathematics and science can be fun and women don't have to limit their horizons. We'd also like to increase the participation across the United States, and the ultimate goal is to reach a point where it's no longer necessary to have these conferences. The reason that it will no longer be necessary is that all young women and minorities will know that it's the norm rather than the exception for women and minorities to be working in the scientific, engineering, and technical fields. So it is our hope that one day we no longer need to have the conferences. In order to achieve this goal it's necessary to begin with the young women and minorities of today and have them change their perceptions of these fields of endeavor.

It's obvious that this country is suffering from the shortage of qualified people to work in scientific, technological, and engineering fields. According to the Aerospace Education Foundation 1989 Report, I quote, "The United States faces a crisis situation that's as hazardous to its future as if several enemies attacked simultaneously." It would seem that the way to change this pattern is to change the way that young people think about mathematics and science, which is the goal of EYH. It's important also, I feel, to change the way that society at large perceives mathematics and science. Apparently people across the land are willing to accept that we have a problem. However, they're not willing to accept responsibilities for doing something about it. Of course if everything worked ideally, we wouldn't have the high drop-out rates from high school, that we have. We wouldn't be facing teenage parenthood in alarming numbers. We wouldn't have the drug crisis that we have now. Unfortunately, the society in which we live has these problems

One of the messages we send our children is that if you don't perform according to certain expectations and meet certain criteria, you're not going to make it. It's a shame because there are an awful lot of children out there who don't have caring and nurturing teachers like we have in our midst today. They don't

have caring and nurturing parents who are willing to guide them or help them along their way. So there needs to be someone out there who is willing to help, who's willing to spend time and who's willing to be committed. Hopefully, EYH would like to play a small role in that part, to be able to be there for them. We have to let them know that they can make it. Also, we have to reach the students who have "attitude problems", the ones who say "I'm never going to graduate from high school anyway, so why are you talking to me, why do you care about me?" We have to let them know that they're important. Our children are our biggest resource and if we don't care about them, we can save the planet from now until doomsday, but it's not going to do any good, because there is not going to be anyone here to appreciate it. If they don't care and we don't help them start to care, then we have failed miserably as human beings.

All the wonderful programs that we have heard about up to today are of no use if we cannot get our young people interested in them. One of the reasons that I particularly like working on EYH conferences in the Tri-Valley area at Livermore is we have a very large pool of women working at Lawrence Livermore National Laboratory and Sandia National Laboratory. These women are committed to making the lives of young women and minorities in the area much, much better by exposing them to these kinds of programs. And that commitment is something that is not really easy to be realized from everyone. Money is easy to obtain, in some instances. Time and commitment and dedicated people are not always easy to obtain. I mean, people have their own lives and their own children to take care of, and it's sort of like "Why should we worry about someone else's child?" Because that someone else may not care about their child, I think if we really care the way we say we do, then we have to take an interest in those less fortunate youngsters and let them know that someone out there really cares.

My personal experiences with EYH go back to 1979 when I was asked to be a role model presenter at a workshop. One of my personal success stories is from my very, very first career presentation. I was very disappointed, I was very disheartened, because I asked if there was anyone there to hear me, there were three of us speaking together. One was a veterinarian, one was a agriculturist, and then there was myself. At the time I was doing precision sheetmetal fabrication. So I asked if anybody had signed up for this workshop because they wanted to hear what I had to say. They all just kind of looked at one another and started to laugh. And I said, "Okay, you don't want to hear what I have to say, but I'm going to tell you anyway." So I did. There was a sixth grade young lady in the classroom who listened to what I had to say, and as a result of it she is now employed by Lawrence Livermore National Laboratory as a Journeyman Sheet Metal worker. As I said, that is one of my personal success stories.

There is a young lady who, as a high school student, attended an EYH conference in the Tri-Valley area. She has gone on to become a computer scientist at Lawrence Livermore Laboratory, and she has also chaired one of the EYH conferences that's been held in the Tri-Valley area. So you can see from some of the stories I have told you that there are successes, that the program works, and it's not something that's very difficult to do. All it takes is a little bit of commitment on our part. One of the things that I think happens a great deal is that people have a tendency to burn out. You get the same people working on the same projects, over, over, and over again.

One of the things that we try to foster with EYH is bringing in new people, bringing in new blood, bringing in new ideas. There are always young people graduating from colleges who are going out into industry and getting started. If they had the chance to experience an EYH conference for themselves, one of the things that they have come back and said was, "Well, gee, I got to take advantage of this, now I want to do this for someone else." And hopefully, that's going to continue to happen. We're going to continue to get new ideas and people are going to come into the program to help pass on positive experiences.

Now Dr. Kay asked me to relate some of my personal experiences. I was a young parent; I was a high school drop-out, but I believe in these kinds of programs. Now that my children are grown and gone, it's time for grandma to go back to school, so I'm returning to school and hopefully I will be getting my degree shortly.

Thank you.

If there are any questions I'll be happy to answer them.

**Question from Mildred Dresselhaus:**

You were giving us a bunch of anecdotal success stories. That's very valuable, but has anybody done a more quantitative study of how many kids were channeled into starting college and studying engineering?

That is one of the programs that we're working on now. We are trying to get an additional grant. We're working on getting an additional grant right now for a national office so that we can take some of the data that has come in, some of the minuscule amounts of data that has come in, and do just that. One of the things that we're trying to do at the national level right now is get more coordination, get more solid data collection so that we can actually track those students.

**Comment from Rebecca Lubetkin:**

I just want to respond to that, that's of course what's needed. The problem is very difficult, and it becomes almost speculative to look at the fields that people go into and try to connect them to a one-day experience, perhaps at the age of 13. But, there is a way in which we try to get at that, and I think our establishing some data are going to be very useful. Using the Expanding Your Horizons model, we at Rutgers modified it for the Future is Unlimited Conference, and we've done about 60 different places. We did some pre-surveys of people who came, and some posts several years later. Now we weren't looking at career entry, we were looking at a more modest objective which was to increase the percentage of young women enrolled in advanced mathematics. So we were looking at what were their expectations, in terms of algebra, geometry, advanced algebra, trigonometry and so on, and then what actually happened. Our conferences have another component which is in-service training for the teachers who accompany the students. Every student must be accompanied by a teacher or guidance counselor. And we have the teachers attend parallel sessions. And then we do follow-ups with the teachers, and we have found that we have been able to increase the number of students to elect more mathematics than they may have expected to elect before they came to us.

**Comment from Betty Vetter:**

I only want to add another piece of anecdotal information to something that Millie was saying. I was in one of these conferences in California, in about '78, I think, except this one was for returning women. It was one of the first conferences, and it was for returning women. And one of the women who came that day brought her daughter, who must have been in junior high at approximately that time, I don't know exactly. But a couple of years ago, I was on Millie's campus at MIT making a speech about something else, and walking across the campus, and this young woman came up to me and she said, "Are you Betty Vetter?" And I said I was. She had been at that conference and heard what was going on, and is now a graduate student at MIT. And she said it was the whole thing that changed her life. Her mother never did anything, because she got too discouraged. But the daughter was there, simply because there was no babysitter available.

As a result of anecdotal information you can determine the effect of these conferences as positive. At this point we are still in the process of forming a national database quantifying the effects of EYH Conferences and being able to provide statistical data in a concrete manner we hope to continue to foster a better outlook for young women of the future.

# GENDER EQUITY ISSUES IN MATHEMATICS AND COMPUTER SCIENCE

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I need to give you a little background on why I'm talking about *gender* issues. When I got my doctorate in 1973 we talked about sex differences, and in dealing with sex differences, we talked about sex differences in mathematics which implied a biological link. My dissertation was the first one that talked about sex-related differences. These were differences related to the sex of the individual, but not caused by their biological nature. Recently we have been seeing in the literature the use of the word "Gender". Gender is that whole constellation of factors that makes us what we are and it is related to biological sex, but it's much more than that. You will see on the transparencies that I mix-up sex-related and gender-related because I haven't redone all of the old transparencies.

Gender issues in mathematics deal with lots of things and I'm going to start with adult things. First, something which you have all heard about, I know, is the "Mommy Track." It is the absolute belief that if you are going to be a mommy, you are automatically not a true member of the corporation. Therefore you should be put into this track that says, "Listen, you can go so far but not too far, and I'm not going to put too much energy in you." Some of you may have faced the "Mommy Track" in another way, and that is when you were in high school or college and you wanted to be doctors. You were told that they weren't going to waste the space on a girl in medical school because she was going to have babies and not continue to doctor. This is "Mommy Track" talk. Nobody ever raised the issue in all these articles that there's something wrong with a society that expects you to work ninety hours a week and put work above anything else. It may be that the "Mommy Track" is the civilized track for living because it talked about balance in one's life. Nobody ever talks about that. We talked about disloyalty to the corporation.

A little while back on the cover of *Newsweek Magazine (July 16, 1990)* "The Daughter Track" was mentioned. The statistics included stated that American women spend seventeen years raising children and

eighteen years helping aging parents. In addition to that folks, what are we supposed to do? Parents have to deal with seventeen years of raising children, and children having to deal with eighteen years of dealing with their aging parent. We again have this absolute narrow focus of "This is the woman's responsibility." Lastly, there was an article in the Los Angeles Times in August, 1990. It stated that 80 percent of mothers and 20 percent of fathers would quit their jobs to spend more time with their children. All of these issues serve as background for discussing gender and mathematics.

***"Some of you may have faced the "Mommy Track" in another way, and that is when you were in high school or college and you wanted to be doctors."***

I think that mathematics, its mastery, becomes one way of dealing with these gender issues. When you look at the problem of females and mathematics, there are two issues involved. One is the sex-related differences in achievement that get reported. The other is sex-related differences in enrollment. This is the chicken and the egg problem, the attitude vs. the achievement problem - which came first. I do know that you saw a headline in the Washington Post, which announced that girls did much poorer than boys on the SAT in mathematics. This is absolutely true! But, then you looked at who took the SAT. You looked at a breakdown. You found that boys tend to take three and one-half to four years of mathematics in high school and girls tend to take two and one-half to three years in high school.

Can you imagine this headline, "People who study more mathematics do better in mathematics?" There is a bias in reporting the data and it must be dealt with. All right, what is the story? The story is that there is still a difference in enrollment. When you look at the advanced placement calculus courses for high school level, if you look at computer courses, you still find this two to one ratio, male to female. There is that difference. Things have gotten much better than the early 70's. Then it was two years of high school mathematics for girls, because that's all the colleges required, and three years for boys.

About the sex-related differences in achievement, they are now doing meta-analysis of all the old studies. They are finding, as they control for more and more variables, there really is no significant difference in achievement in most areas of mathematics. So we have that issue with which to deal. This is what the research says, and I say, "What does this mean for me as a teacher?" Well it means that the newspapers in the world are telling us that there's this big difference in achievement between men and women.

The SAT difference between males and females is caused by two questions. You're going to tell me your whole life track is determined on the fact that you missed two questions and the guys got two more right? You know the old saying you hear, "Statistics don't lie, but liars use statistics." Anyway, there was this image being presented to girls, in high school, on the seven o'clock news, on the front page of the paper, in the educational supplement of the New York Times, which talked about this difference. I see a responsibility that we have today, because we need to tell them, "This difference isn't real."

The next thing I want to look at are the possible causes for these differences. Having reviewed the research, these are the things that get listed. Now **the first possible cause is genetic**, and I put it first because it's the one that always comes up. In the 70's and 80's we used to get the study that came out with, "If you are allergic, nearsighted, blond, male, and left-handed, you do better in mathematics than if you are not." What does that mean for the classroom teacher? Should we only try to teach students like that? Now I can give explanations as to why the individuals listed above do better in mathematics. First of all, if you're left-handed, you didn't get as involved in sports because who had baseball gloves for them in the olden days. If you are allergic, were you outside playing most of the time in the warm weather? Do you have fair skin too? I can think of a lot of reasons why those characteristics would give one more of an intellectual bent in life than other things kids might do.

Next, we got more sophisticated, and we had the study of the mathematically precocious by the Johns Hopkins Group. They gave the SAT in the seventh grade, and if you got 600 or better, you were invited to go to this special accelerated program. Now I agree that 600 or better in the seventh grade makes you precocious in mathematics. There's no doubt about that. Then there was the article by Benbow and

Stanley[1], which stated that since seventh graders have always been in the same classrooms, and have not been separated out, haven't studied more mathematics than the others, and if we find far more boys getting 600 or better on the SAT than girls, then it has to be genetic.

> ***"Research has shown that if somebody believes that mathematics will be useful to them when they grow up, they take more mathematics courses, even if they don't get A's in it."***

There are two problems with their conclusion, which you need to know about so that you can refute these statements. The first is, we know that even twins don't grow up in the same environment, because they have to interact with each other. Anybody who's looked at classroom research, and I will talk about that, knows that no two children in the same classroom have the same environment. Another issue, I don't care how smart you are, if you see a radical sign with a two underneath it, there is no way you can intuit what that means. Somebody had to tell you that was called the square root of two and what it means.

Think of the SAT test. This is not an aptitude test. This is a test of mastery of knowledge. You had to be taught that, so don't tell me they had the same mathematics background. The other thing is they have had several girls get 800's. Are you telling me they're "Genetic Mutants?" How dare you come up with a good publicity release that basically says, "This is genetic," and not mention that the highest scoring students this year were girls. It doesn't make any sense. We are now dealing with "Testosterone Revolution." Research has found that it is male hormones that make you do well in mathematics. This is out there and you will keep hearing these studies. If you read the dissertation topics abstract listings you will find there are always the genetic or biological studies.

We have two alternatives. We can start shooting ourselves up now with testosterone to get our students better in mathematics - put it in the milk supply. Or you simply recognize, which is really the basis of this whole biological area, that individual differences are far greater than any group differences. That's number one. And number two. You know something, I really don't care about the kids at this top-end of the normal curve, the top .5 percent, because that's not what you need to be an engineer. Let's talk about the bulk of the students with whom we are dealing. I have addressed biological issues because it's always going to come up. It's going to come up at parent conferences. It's going to come up all over the place. It is raised with regard to racial groups. It just needs to be refuted, and you can't just say, "That's not true." So I've given you some ways of refuting it.

**The second possible cause for this difference in SAT scores is perceived usefulness of mathematics**. Now here's where we get into issues related to the child, the young student. Research has shown that if somebody believes that mathematics will be useful to them when they grow up, they take more mathematics courses, even if they don't get A's in it. And, boys believe mathematics will be important and girls don't. The critical grade is eighth grade, which is exactly when you are deciding to take algebra or not to accelerate. What does that say to me as a teacher? It says to me that what I need to do is make sure that all my students believe that mathematics will be useful to them when they grow up.

There are real differences in the value structures of boys and girls and the things in which they believe. I know that when I started this work in the 70's you didn't dare say that. I mean, our statement back then was, "We're just like the men." We proved it. We got heart attacks and ulcers, and took up smoking, and took on all the damage that came with that. I remembered, "Oh, no no no, we're exactly alike, same, no difference." Well, that's not true. The research shows that there are differences. When I think of engineering, and I apologize to our host, I think of war, I think of space, I don't think of robotics engineering which gives a child who's born without an arm or a hand the ability to pick up a toy. If you're going to address some of the concerns of twelve, thirteen, fourteen, fifteen-year olds, young women who

[1] Editor's Note: See for example: C.P. Benbow and J.C. Stanley 1983 "Sex Differences in Mathematical Reasoning Ability More Facts" *Science*, 222, 1029-1031

think of children and nurturing as part of their lives, maybe we need to think about how engineering does other kinds of things, rather than the stuff that gets the big money. Think of how long it took them to make a child's seat for a car that was truly safe. Remember we're still working on designing a crib so that no child will ever die because of the way cribs are made. And one of the things with which I think we need to deal is showing the usefulness of mathematics in a way that relates to the interest and values of our target group.

## *"Math is perceived as something that boys do."*

Those of you who work in mathematics know that when we do our trigonometry we are shooting projectiles because they make parabolas. That's fine except I don't intend to shoot projectiles. But, I am interested in art, I am interested in drawing things and designing things, and filling the inside of a parabola with gold leaf strips because this is a work of art. It becomes the exact same problem and that can take off into calculus if you want. So perceiving usefulness has two aspects. One, all of our students must come to know that mathematics is not something that just some folks do. Everybody uses mathematics and boys and girls need to know that. I also think we need to be sure that it's shown to be useful in ways to which our students can relate!

**The third possible cause of girls not going on in mathematics, and therefore not doing well, is that mathematics is perceived as a male domain**. Math is perceived as something that boys do. Now the research on this is fascinating. Girls do not perceive mathematics as something that boys should do. But seventeen year old boys perceive mathematics as something that boys should do and girls shouldn't do. And what is more important to fifteen and sixteen year old girls? Seventeen year old boys! One of the things we need to do in dealing with mathematics as a male domain, and what it teaches us, is that any intervention program we do to encourage girls to go on in mathematics also has to address boys.

Now I'm going to switch a little and go out of gender issues and talk just for a minute about racial issues as they relate to this. That is, "Are mathematics and science something that Blacks and Hispanics can't do?" We need to look at the whole concept of role models. I teach at a Polytechnic University. I'm the Director of the Center for Science and Mathematics Education, so I have a bulletin board. Being basically a political activist I use my bulletin board for political ends.

February came and I said, "It's Black History month, and we're going to put up a bulletin board about Black Mathematicians and Scientists." And a colleague of mine, who's a Black science educator, didn't have anything to put on that bulletin board. He didn't think it was really important, but said, "If you want to do it, it's okay." So I put up this bulletin. It was fascinating to watch. Faculty would walk by, they'd never stop, but they would walk very slowly and would look and walk by. One day I was sitting in my office and a young man came in, a Black man, and he said, "Are you Dr. Jacobs?" and I said, "Yes," and he said, "Thank you," and he had tears in his eyes. I thought, "What do I do now?" And he said, "This is a large university with many students. I have never seen a positive image of a Black man on this campus." That was the up-end of the bulletin board. We have a club of Black scientists, and that month they were able to just stand there and look at different people they had not heard about, but who were Black Scientists.

Also, it gives a message to the White students that minorities can do mathematics and science. The perception is that mathematics is a male domain or White male domain and we can't ignore that perception. Some people don't like talking about this; it makes them uncomfortable. But we need to address these issues. Again, it was not done as anything other than, "There it is, look at it if you want." I wasn't hitting people over the head with the issue, but it had its impact.

**The next possible factor is teachers' differential treatment of males and females in the classroom**. First of all, the evidence is clear from observational studies where people go into classrooms over time and check off what goes on. Teachers, both male and female, old and young, Black and White and Hispanic and Native American simply spend more time interacting with male students than they do female students and the nature of the interaction is different. When they are dealing with girls in mathematics, the teachers tend to show them how to solve the problems, and they give the boys a hint on how to do it.

On the positive light in the differential treatment in males and females, there was a study done by Pat Cassaley of Educational Testing Service (ETS) which I think is a very telling study[2]. She looked at those high schools that produce the most females in advanced placement calculus, biology, chemistry, physics, and found that the high schools that produced the most females in AP classes were high schools that were fed by junior high schools that tracked students. Tracking is a bad word, it's fallen into disrepute. Heterogeneous grouping is now the thing in schools. What the research found was this: If you identify in the fourth, fifth, sixth grades people who are interested in mathematics and good at it, you have formed a cohort peer group. So when the time comes to decide whether to take algebra in the eighth grade, it's not, "I'm going to be the only girl in the class," or "I don't know anybody in that class." because connection and relationship are important to girls. If you have given them a peer group, all it takes is one teacher to say, "Okay, everybody's signing up for algebra in eighth grade." You don't even give them a choice. That's what I did when I taught junior high school. You don't give them a choice, this is it, and it's done. When you don't have a cohort group or peer group, they feel isolated, and girls are less likely to accelerate their mathematical studies.

Another approach to forming a peer group is through a mathematics club. Then go out of your way and make sure that the girls get invited to join the mathematics club. This is a way of mentoring. Treat the girls differently - get them involved in doing mathematics.

Now I will make my confession. A friend of mine did her doctorate at the University of Maryland. She looked at geometry classes and found that same thing, that males got more attention than females in the classroom. I taught elementary Mathematics Method Classes at George Mason University in those days. I had a class with twenty-three females and two males. I read that dissertation and I go in the next day and there I am standing, talking to the two men in the class. I have spent my life doing feminist research, I mean this is my passion, as well as my research area. As Gloria Steinem says, "Click". I watch myself in class now. I don't intentionally refrain from talking to the men in my classes, but I make sure that I have personal interactions with the females to let them know, "This is a mathematics class and we can talk about mathematics." I am still working on this issue. One thing you can do if you're in the classroom, or if you're working with people: use an audio tape. Listen to yourself. Look at the nature of their interactions with different students. It's truly important.

**The next possible cause is perception of self as a learner of mathematics**. Again we see gender differences. There is lots of different research in this area, but I'm just going to talk about one kind and that is "Causal Attribution Theory." This research looks to what you ascribe your success and your failure in mathematics. There are different kinds of causes, internal and external causes. Internal ones are virtually impossible to change. External ones are not under your control, they can usually be blamed on somebody else. There are also stable and unstable causes. If you ask a young man who is successful in mathematics why he is successful, he will tell you he was smart. That is stable and internal. If you ask a young woman why she is successful in mathematics, she will say she's lucky, or, and this one's the toughest one to deal with, "You're the best teacher in world, I couldn't have learned this from anybody else but you." These reasons are external and unstable. Putting your ego aside for a moment, you can say, "No, no, that's not true." You're supposed to say at that moment, "You had the ability. I helped a little. It's okay, I accept your gratitude." But you're really supposed to step out of that and say, "You did it, I didn't."

Looking at the attributes for failure we see the opposite. When you look at a male's response to why he failed, he will say, "The test was unfair, the teacher picked the worst questions in the world." They're all external. The girls will say, "I am dumb," That is internal and stable. Now, what do we as teachers do about that? Well I told you how you'd handle the compliment, but also you must never let a student get away with saying that they were successful because they were lucky. We were taught in our education courses that if a student says they're dumb you should tell them, "You can do this work and I will help you and we'll work that out." But no one ever said that it's just as damaging to say, "I was lucky." Luck changes rather quickly, as we all know. Because you're not lucky, you're capable. That's the important thing. We

[2] Editor's Note: See the ETS study by P.L. Cassaley and D. Rork 1980. "Factor's related to young women's persistence and achievement in advanced placement mathematics."

really need to look at their perceptions of themselves, which means we need to help them get in touch with those feelings. We have to the address reasons they give for succeeding or not succeeding.

**The last possible cause is "Mathematics Anxiety."** It's one on the list over which I have the most conflict. "Mathematics Anxiety" is a phrase which became very popular in September, 1976 when Sheila Tobias wrote an article in *Ms. Magazine*[3]. Those of us who were mathematics educators didn't like this outsider - I can say this because Nina knows that Sheila and I are old friends - this outsider telling us what was wrong with our field. There is "Math Anxiety" and teachers spread it, which is one of the issues with which we deal.

> ***"There is 'Math Anxiety' and teachers spread it, which is one of the issues with which we deal."***

A lot of us in mathematics education got very offended and started talking about "Mathematics Avoidance" rather than mathematics anxious people. But the truth of the matter is, whether we like to believe it or not, there are students who walk into the mathematics classroom with knots in their stomachs. I have my own theories about the cause of Math Anxiety, but whatever the cause people can usually tell you what the cause of their Math Anxiety is, such as: "When I was in the third grade, the teacher was wearing a striped top and black skirt, and she made me go to the blackboard and do a multiplication problem. I had to stand up there until I got it right. I was mortified, because I couldn't do it." Or, "I was out with the measles when they introduced fractions and I never caught up again." This goes beyond, "I don't want to study mathematics, it's too much work." This is anxiety! It needs to be addressed. The traditional way of working on math anxiety is through workshops that have both a counselor-type and a mathematics-type, and it really can't be the same person. People do mathematics and talk about how they feel while doing it. You can't just talk about it, it's not group therapy. You need to do some mathematics so when they leave these Mathematics Anxiety Reduction Programs, they come away with a sense of power that, "I can solve problems."

One of the things we never show kids, those of us who do mathematics, are our waste paper baskets. We come into class with our books and we start with the first homework problem and just zip it off. Then they have a question and we zip it off and they don't know that we spent four hours trying to figure out how to do problem seventeen. I think there are lots of things that we do as teachers that perpetuate myths about mathematics. Students need to see our struggle. They need to know that doing mathematics is not instantaneous.

So these are some of the possible causes for females underachievement and underenrollment in mathematics. I now want to take another approach to looking at this problem. In 1980 Carol Gilligan wrote a book called *In a Different Voice* and for many women, that book legitimatized the conflict with which they had been dealing for years. Carol Gilligan is a psychologist who worked with Coleberg on moral development in adults. They studied adults and found all the stages through which people go. They found that women never reach the highest stage of moral development. Now the first thing you have to realize is that the study was done at Harvard and a long time ago. All the data was normed on undergraduates at Harvard, which was before women went to Harvard. So you have this whole set of stages of moral development through which you go, and women never made the top stage, but the stages were based on a male sample. Gilligan did research to look at the nature of moral judgments in males and females and found out they were very different.

If you want to know how males view morality, the symbol is very clear, it's the "Lady Justice" who's blind. That's the legal system, it's very hierarchical. Women are much more concerned with connections and relationships. Now for many of us this book started a revolution, it was a vindication and it freed us.

[3] Editor's Note: Tobias, S., September 1976. Math Anxiety. *Ms. Magazine* 5(1), 56-59.

For me, it was an eye opener. It explained why I didn't feel comfortable in this university. They were telling me that if I co-author an article, they can't be sure which words I wrote, and therefore it can't count towards tenure. I know I teach mathematics, but the sum is often greater than its parts. I was more comfortable in this collaborative mode. I thought I wasn't good enough to be a college professor. I felt that there was really something lacking in me, rather than feeling that this is a system that's not my style. So Gilligan's work freed me.

Following up Gilligan's work, a book came out called *Women's Ways of Knowing*, written by four women from the Massachusetts area, which did for cognitive psychology what Gilligan did for moral development. They looked at how women learned things, or come to know things. They found out that it was very different from the model that had been developed on male college students. I want to share that model with you, and then tell you about some dual action research that I've done.

Now, there are stages in knowing, according to *Women's Ways of Knowing*, and the first stage is the **"Silence Stage"**. This is the stage where the individual simply accepts the authority's verdict as to what is true. And what I did on these is worked with the stages in terms of the theorem of "base angles of an isosceles triangle are equal." Well, in this silence stage, something inside expresses awareness that the teachers think that base angles of an isosceles triangle are equal. There's no verbalization, it's intuitive that they think that they are equal - not me, they.

In **"Received Knowing"**, which is the next level, you learn by listening, you prove you've learned something by returning the words of the person who said them. So in this area of development it's, "I know the base angles of an isosceles triangle are equal because the teacher said so." Now, let me tell you a story about this stage. When I was teaching high school mathematics, I was teaching a regular old Algebra I Class, and Belinda White came in the first day of class and said she had to sit in the front of the room, because she had failed Algebra I last year and she was going to pass this year. I said, "Fine." You know how you realize at the beginning of the year this is somebody you're going to work with. So she sat there and we were doing integers. One of the stories I do with integers, it used to be called the "Postman Story", but now it is the "Letter Carrier Story". It dealt with the letter carrier bringing checks and bills. And are you richer or poorer after the visit? So, if you bring a check for two dollars and a check for seven dollars, are you richer or poorer? Well, if I just got two checks, I'm richer by how much? Two and seven - nine. Then you get a check for five dollars and a bill for two dollars. Am I richer or poorer? Well I'm still richer but only by three dollars. Then the story goes, I bring you a bill for five dollars and a bill for eight dollars. Are you richer or poorer? Poorer. How much? Thirteen dollars. Belinda did that, she said, "Poorer, by thirteen dollars." The follow-up, because you have to make the transition to the abstract was "Negative five plus negative eight equals?" and Belinda said, "Positive thirteen." Well I told another letter carrier story, and Belinda could do it. A bill plus a bill and you're poorer, she did the arithmetic. Then I'd put it into terms of negative numbers. I said, "Well then, what's negative seven plus negative five?" And she would say, "Positive 12." Now after about four or five of these I finally learned to shut up and listen, and I said "Belinda, why?" She said, "Because two negatives make a positive." The fact that it only works in multiplication or division was irrelevant. She had received some knowledge from an authority, and only retained part of it. Nothing, no reality in the world, like the fact she just told me she was poorer by twelve dollars, would in anyway change her view. This is the "Received Knowing".

The next level in *Women's Ways of Knowing*, is called **"Subjective Knowing"**. This level represents the student who says, "I only know what I feel in my gut." The male version is, "I have a right to my opinion," and the female version of this is, "It's just my opinion." But it basically comes from how you feel, and it's the student who looks at you and says, "Why are you bothering to make the fuss? Look at the picture, the base angles are equal. Anybody can see that." They don't need to go any further. This is "Subjective Knowing", it is very much related to you as a person.

The next stage of knowing, from *Women's Ways of Knowing*, is called **"Procedural"**. Before I describe it, let me document that there is no way for you get from "Subjective" to "Procedural Knowing" by yourself. These are not stages like Piaget's developmental stages, where maturation will bring you forth. There's no way of getting from "Subjective" to "Procedural" unless there's some Intervention. It doesn't have to be a teacher, but someone has to raise the issue of "why" and that there is a reason to present. There are two kinds of "Procedural Knowing" The first is called "Separate Knowing". You look to propositional logic, you look outside to prove something. I know these angles are equal, but maybe all base angles are not. I need

to prove this. Some of you probably remember the two column proof of why base angles of an isosceles triangle are equal. I taught in New York City for five years, and we had a Regents Examination. About every four years this was the theorem on the exam. There's another kind of "Procedural Knowing", and this is called **"Connected Knowing"**. These words, by the way, are very powerful. Language is very powerful when we talk about the impact on individuals. The "Connected Knowing" looks to circumstances and leads to perception. I want access to what you think. Those base angles are equal. What about the triangles you looked at? Is it the same?

***"Are our institutions so structured that women don't feel comfortable?"***

Here's a set of words that go with "Separate Knowing" and "Connected Knowing". Now remember, let's go back to "Moral Development", remember the male idea of "Moral Development" is the blind justice. Separate has logic, rigor, and abstraction. Rationality, of course, has to be there, if you're not rational it makes you irrational. Axiomatic, certainty, deductive, completeness, these are all the words that we use. It's structured, those of you who do computer programming know about structured programming, which means if you don't do it that way you must be unstructured. This is "Separate Knowing" which is the way mathematicians know things. They are the people who prove things. Yet everybody knows that before you can do "Separate Knowing", what you have to do is have some creativity and intuition, you have to make hypotheses - this is what was on all the slips of papers that went into the waste paper basket. It's coming up with the conjecture that's real mathematics. For me proving is the boring part. The creative part of mathematics is figuring out, "Hey, you know what? Quadrilaterals always have 360 degrees in them when you measure all those angles." That's the power! The proving is nice and it makes it true forever. The real power is in looking at situations and coming up with a conclusion, particularly when we're dealing with students who are not going to be mathematicians - which means they're not going to be earning their living by proving things. They need to be connected knowers.

Gilligan talked about connections as the way women related to people. "Separate Knowing" is blind justice. Look at our institutions of higher education. Which are valued? Are our institutions so structured that women don't feel comfortable? Well, if you look at history it would make sense. Who created the institutions? There were created by White men for White men. They were designed for separate knowing, not connected knowing.

The last stage **"Constructed Knowing"** is where you try to integrate what you know intuitively. "Those base angles are equal." Every time I look at an isosceles triangle, I notice that. I did an acute isosceles triangle, and somebody else did a right isosceles triangle. You know when you teach, you have to make every kind of example, every kind of triangle. It's still a triangle when you tilt it. This is a big thing for a lot of people. But I look at what you know and I start looking for connection. This is "Constructed Knowing". Constructivism is an important part of learning something. That if you don't create it yourself, it always belongs to the person who told it to you. Now the question is, how do you deal with *Women's Ways of Knowing* in teaching mathematics? What you need to do is look at how you perform in the classrooms. Do the students have time to just sit and talk about what you're teaching? Now, I know that there are many university mathematics classrooms where the basic mode is lecture. If the students happen to form study groups on the outside, they may get a chance to talk about it. Well, I have some innovative colleagues who are teaching calculus courses where students work in groups. In this way they get to talk about the problem, explore it, see what's going on rather than just listen to the professor's discussion of how you do this problem. They get to construct their own knowledge.

The metaphor that *Women's Ways of Knowing* uses, which I think is so beautiful, is the teacher as midwife whose job is to help nurture, to bring into this world new ideas. She nurtures them, and helps get students to the point where they can stand on their own. The teacher is not a male voice in a commercial, which is the authority who tells you that if you want to find the area between two curves, you can find the integral in that range, and take the integral and subtract. The teacher helps you see why this makes sense.

I really think that we need to look at how we go about teaching and at what kind of an environment we are setting up. We need to make sure that students don't feel they were lucky and that's why they did well in mathematics. To enable them to realize that they can use their math and science in ways that fit in with their value structure. Help them make connections with other individuals as they're learning mathematics. Who ever heard of committee group work in a mathematics class? That is not how you worked. You worked alone, or it was called cheating. In fact, if you think about it, you had mathematics teams that never worked together. This is a real distortion. So we need to change those environments and say, "I'll be here till five o'clock today, so over lunch, whatever, we can talk about that."

I do want to talk a little bit more about language because I think it is really important. In mathematics we have adopted as our mode of discussion exactly those words that are male. We talk about the **MASTERING** of the subject. We **ATTACK** problems. We **DRILL**. Wouldn't it be nice, these things I got from the Dameron article, if we used other language. Instead of **MASTERING** the problem, which means beating it down and subjugating it, we can talk about **INTERNALIZING** it so it becomes part of us and we know how to deal with it. Instead of **ATTACKING** the problem, why don't we **INTERACT** with them. **CHANGE IT**. Figure out what happens if we do change it. Instead of, **MASTERING**, why not **RESOLVE** the conflicts that exist within a problem. Why not start using a language that is not adversarial, that does not promote competition, but might look at some other ways of interacting so that we have a sense of mathematics as something that people other than White males can do.

Thank you.

# RECRUITMENT OF MINORITY WOMEN INTO MATHEMATICS

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I would like to thank Dr. Nina Kay and the Center for the Advancement of Science, Engineering, and Technology (CASET) of Huston-Tilliotson College for inviting me here to speak with you this morning. I am the director of an exciting new project, Strengthening Underrepresented Minority Mathematics Achievement (SUMMA), of the Mathematical Association of America (MAA), the professional association devoted to undergraduate mathematics and college teaching. My topic is the "Recruitment of Minority Women into Mathematics."

The first Ph.D. degrees in mathematics to U.S. Black women were awarded in 1949 to Marjorie Lee Browne at the University of Michigan and Evelyn Boyd Granville at Yale University. The magnitude of their accomplishment is revealed by the fact that only nine Ph.D.'s were awarded to women of all races in 1950. I am still researching the corresponding information for the Hispanic and Native American women. I mention this date to point out how few years have elapsed since the mathematical profession first showed some willingness to accept minority women into its upper echelons. By contrast, the first majority woman to receive a Ph.D. was Winifred Edgerton Merrill in 1886 from Columbia University.

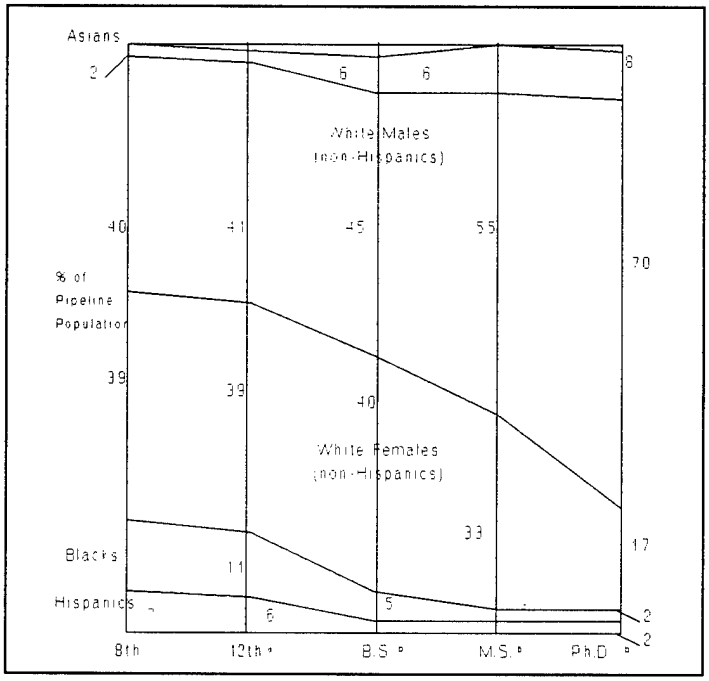
A major thesis I would like to suggest is that there are two aspects of recruiting minority women into mathematics. First, more young minority women must enter the pipeline, by which I mean they must take more mathematics and science as early as possible. This is the responsibility of minority families and communities, the teachers, and the schools. Second, more must succeed in leaving the pipeline at its top end, i.e. earn doctorates. This is the responsibility of universities and the mathematics profession. Of course, individual responsibility is the factor also.

We all know that nothing flows through a blocked pipe. It must be open at both ends and in the middle as well. It does no good to encourage large numbers of young minority women to take more courses and major in mathematics and science if the professions do not get their houses in order. The number of

minority women (and men) currently completing doctoral programs is so low that only a few hardy souls even dare to try. One U.S. Black woman in 1988 received a degree. In 1989, four Hispanics out of 904 were awarded degrees. Let me note that none of these constitutes even 1 percent of the total per year. Native American women earned eight doctorates in the mathematics science from July 1973 to June 1989; unfortunately none have been awarded since June 1983! The statistics for minority males were eight degrees in 1988 with one going to a Native American and six in 1989 with none to a Native American.

I would like to give you my analysis of where the clogs occur in the mathematics pipeline. A simple standard to use in judging the smoothness of the flow is **parity**, namely how closely does the percentage in the pipeline approximate the corresponding population percentage. Of the U.S. population, Blacks constitute 12 percent, Hispanics form 9 percent, and Native American only 0.6 percent. Parity is achieved when the given minority group constitutes **at a minimum** the same percentage of the students at a given point in the pipeline. (This is not the only standard, nor necessarily the most appropriate. Another measure would be to use percentage of school age population at a given point in the pipeline.)

**FIGURE 1**




According to our definition, the situation for eighth grade students is close to parity, although Hispanics have lost 2 percent (Native Americans are not shown in the graph) and White males (non-Hispanic) are 3 percent over parity. The statistics for twelfth grade show Blacks and Hispanics each down 1 percent and White males up 1 percent. The first large drop-off in parity is during college where only 5 percent of Blacks complete a B.S. in mathematics and only 3 percent of Hispanics. The final blow is a drop of Blacks to 1.5 percent and Hispanics to 0.8 percent of doctorates. While I do not have long-term statistics on Native American participation at all levels of mathematics, I do know that they received 0.4 percent of all bachelor's degrees and 0.3 percent of all master's degrees in mathematics in the year 1985. For the period July 1973 - June 1989 (the entire period for which statistics on race and ethnicity have been collected by the American Mathematical Society), Native Americans received 0.4 percent of all doctorates in mathematical sciences.

**FIGURE 2**

**MATHEMATICAL SCIENCE DOCTORAL DEGREES AWARDED BY SEX AND ETHNIC GROUP TO U.S. CITIZENS**

**(July 1973- June 1989) Source:AMS**

| | MEN | WOMEN | TOTAL | % |
|---|---|---|---|---|
| **BLACKS** | 93 | 34 | 127 | 1.49 |
| **HISPANICS** | 50 | 16 | 66 | 0.77 |
| **NATIVE AMERICANS** | 22 | 8 | 30 | 0.35 |
| **TOTAL** | 7169 | 1358 | 8527 | 100 |

It seems that Blacks receive considerable discouragement relative to mathematics as undergraduates. Hispanics lose prior to eighth grade and again as undergraduates. Native Americans lose out as undergraduates and at all other points of the pipeline. This may be a good place to comment that the Historically Black colleges and universities enroll only 20 percent of Black undergraduates but produce 50 percent of the Blacks earning bachelor's degrees. Even more striking is the statistic that 36 percent of Ph.D.'s earned by Blacks in mathematics went to HBCU graduates. (It is indeed unfortunate that Hispanics and Native Americans have no historical analogue of the HBCUs). Until the majority institutions stop clogging the undergraduate pipeline in all fields, including mathematics, the need for colleges with a special mission to serve minorities is obvious.

Thus, while graduate mathematics programs are even more inhospitable to minorities than undergraduate programs, we see that Hispanics that complete a bachelor's degree have less than one chance out of three of completing a doctorate. Unfortunately, Blacks have only one chance in five. These facts show clearly that the mathematics profession needs to change considerably if minorities are going to enter the pipeline in larger numbers and not fail in even greater numbers.

So far I have assumed it is clear why it is important to recruit minority women into mathematics and science. It goes without saying that the best mathematicians and scientists are produced when all segments of society are encouraged to achieve to the limits of their abilities in these fields. Common sense and mathematics tell us that these abilities are randomly distributed among the population. As a result, exclusionary policies are bound to miss "diamonds in the rough." Current demographic trends preclude the country continuing with these failed policies if it is to prosper and compete in the 21st century, since minorities and women will constitute 85 percent of all new entrants into the workforce by the year 2000.

As I said at the beginning, I am the director of the SUMMA Project. It has five components designed to address the underrepresentation of minority women (and men) at each stage of the pipeline in ways appropriate to a professional organization. The components are Mentoring, Intervention, Collegiate Mainstreaming, Development Assistance, and Minority Teacher Recruitment.

## MENTORING

SUMMA will seek funding to launch a nationwide mentoring program patterned on the successful MAA programs, Blacks & Mathematics (BAM), and Women & Mathematics (WAM). BAM was funded by the Department of Education from 1977 through 1987, when funding expired. WAM is ongoing. The new program, "Mentoring Minorities into Mathematics," will involve minority professionals visiting K-12 classrooms to speak to minority and other students about mathematics and careers in mathematics and also serve as mentors and role models. Certainly, the participation of minority women mathematicians in this program would be especially meaningful to young minority women. It seems to me that although mentoring

is beneficial at all stages of the pipeline it has great potential as a mechanism to stimulate the young to start studying mathematics.

*"The fundamental goal is to increase the number of minority students taking and completing mathematics and science courses in high school and college."*

At the undergraduate level, one aspect of mentoring will involve faculty on campuses with large minority populations. SUMMA encourages the 29 regional MAA organizations (Sections) to hold their meetings (which should include minority speakers) at such institutions so that students there will get more involved in mathematics. New MAA Student Chapters can be started on the campuses also. They will provide an excellent vehicle for inspiring minority students. I will discuss undergraduate minority students on majority campuses later when I examine Mainstreaming.

The graduate level poses special problems. We have already seen the statistics on doctoral completion for minority students. The small number of minority graduate students and their wide geographic distribution lead naturally to the idea of networking these students with minority mathematicians. Each student would receive a list of minority mathematicians in their local area or elsewhere who would be willing to serve as support persons while the student traverses the rocky path to a graduate degree. The student would initiate the contact and the professional would provide whatever assistance he or she could. For persons who are situated near each other, the contact could extend to personal meetings. Others might correspond or converse by phone, FAX or E-Mail. The mentor might advise about course selection, subject concentration, and useful references. This assistance might prove invaluable to students lost in some of these graduate wildernesses. The generations of minority mathematicians who have cleared the hurdles can now reach back to help their progeny succeed as well.

## PRE-COLLEGE INTERVENTION

SUMMA will encourage the replication of successful middle/high school mathematically-based intervention programs for minorities. The fundamental goal is to increase the number of minority students taking and completing mathematics and science courses in high school and college. We recognize that such programs can supplement and encourage change in the schools, but are no substitute for necessary educational reform.

SUMMA is not advocating remedial programs but programs with a strong mathematics component. As a professional organization of mathematicians, the MAA will encourage its members to establish or participate in such programs. These programs are not only for minority students; all students can and do benefit from summer work in mathematics/science or year-round Saturday Academies. Programs can be targeted for specific minority groups according to locale or have an emphasis on women students including minorities.

While there are many intervention programs, there are very few mathematically-based programs directed by mathematicians. I would like to single out two such programs Since I am in Texas, I would like to mention the Texas Prefreshman Engineering Program (TexPREP), started by Professor Manuel Berriozabal of the University of Texas at San Antonio and run at 18 locations throughout the state including Huston-Tillotson College. It serves a largely Hispanic clientele and 49 percent of the students have been women. The other program is the Spelman Women In Science and Engineering (WISE) Scholars Program headed by Professor Etta Falconer who is the Director of the Natural Science Division at Spelman College. It features a 6-week summer session, research at NASA installations for returnees and opportunities to meet many minority women in the field of mathematics, science, and engineering. This program contributes to the success of Spelman in graduating an average of 20 Black women with a B.S. in mathematics each year. Overall, some 25 percent of each graduating class have majored in mathematics and science.

To encourage mathematicians in such endeavors, the MAA through SUMMA will serve as a catalyst to facilitate the establishment of large numbers of mathematically-based projects by building on its existing internal structure, its publications and communication network, and by working in collaboration with other organizations within and without the mathematical community. The SUMMA office will sponsor national and regional conferences and workshops to enable current and potential project directors to share information and results. The office intends to provide small planning grants to help prospective directors with the creation of linkages, writing of competitive proposals, and recruitment of staff. Finally, SUMMA will assist in the development of the critical linkages between directors of new projects and local and state colleges and universities, private industry, the armed services, and other government agencies.

*"The sad state of the mathematics education of minorities today is reflective largely of the lack of resources minority educators have had available for education, for themselves, and for their students."*

## COLLEGIATE MAINSTREAMING

SUMMA will work to make majority institutions more successful in encouraging minority students to pursue degrees in mathematics. These institutions now enroll large percentages of Black, Hispanic, and Native American undergraduates. Without passing judgement on the efficacy of the educational process at these institutions for majority students, it is easy to say that they do a poor job of educating minority students. Specifically, minority students graduate from these institutions in far lower percentages than the general student body. I gave the statistics for mathematics majors earlier.

A program that has been successful in improving this situation is the Professional Development Program of the Dana Center at the University of California at Berkeley. The program is characterized by faculty involvement in curriculum review and development of challenging problem sets, innovative teaching that includes group interaction among students, and strong counseling and advising. The accomplishments of the program at Berkeley have led to the spread of similar department-based efforts at other schools such as the University of Texas at Austin, the City College of New York, and the University of Illinois at Chicago. Students in the program at UT Austin had an average calculus grade of 3.4 versus 1.66 for all students. AT CCNY the results were 3.2 versus 1.8.

The legitimization of this kind of program, as well as other non-traditional approaches such as teaching calculus by research projects at the University of New Mexico and the flexible mathematics curriculum developed under the leadership of Professor Clarence Stephens at the State University of New York at Potsdam, is one of the goals of this particular SUMMA program. To this end, SUMMA will publicize these innovative programs and encourage their replication on college and university campuses by forming alliances with mathematics departments to help them re-examine their programs, set goals for minority participation and achievement at both the undergraduate and graduate levels, and establish mechanisms to achieve these goals.

## DEVELOPMENT ASSISTANCE

Any effort to increase the participation of minority women (and men) in mathematics should make full use of the already existing pool of minority mathematicians. The minority mathematical community has the most experience in the education of minority students, both in terms of history and numbers (at least in the case of Black students). Whether located in predominately minority institutions, other colleges and universities, government or industry, they will have an important role to play in any successful program. Many minority mathematics students are taught by minority mathematicians, who can thus be instrumental as role models and in the identification of minority mathematical talent.

Minority mathematicians have made and continue to make great strides in producing and nurturing minority mathematical talent. One problem that many face is lack of information about sources of funding

for projects by minority mathematicians and for minority students. Another is that few minority mathematicians have experience with proposal writing or other fund-raising efforts. The sad state of the mathematics education of minorities today is reflective largely of the lack of resources minority educators have had available for education, for themselves, and for their students.

Through this component of SUMMA, the MAA will provide information to minority mathematicians or those interested in projects for minority students on sources of funds and how to apply for them, and technical assistance with proposal development through workshops, minicourses, and individual consultations. Special emphasis will be placed on working with faculty at the 117 historically and predominantly Black college and university members of the National Association for Equal Opportunity in Higher Education (NAFEO), the 24 tribal college members of the American Indian Higher Education Consortium (AIHEC), and the 78 colleges and universities served by the Hispanic Association of Colleges and Universities (HACU).

SUMMA will encourage all appropriate federal agencies and private foundations to utilize planning grants so interested mathematicians can forego summer employment and concentrate on generating viable proposals. Faculty at schools with high course loads, typical of minority faculty and schools with large minority populations, would be better able to compete under such conditions against those from larger schools with low course loads. Finally, SUMMA will work to get the appropriate agencies to replicate in the mathematical sciences, the program, Minority Access to Research Careers (MARC), which has been so successful in increasing the numbers of minority researchers in the life sciences.

## MINORITY TEACHER RECRUITMENT

Every program that proposes to address the underrepresentation of minorities in mathematics-based fields must consider the mathematics teachers who will train, direct, and encourage the students. Many adults can point to a teacher with whom they identified and who provided inspiration and encouragement. In the primary grades, teachers are needed who are confident of their knowledge of mathematics, who enjoy exploring mathematical ideas with their students, and who let minority students know that mathematics is rewarding, that each student can succeed, and that the teacher truly cares about the success of each. Secondary teachers need to act as role models and to encourage and direct minority students to accept the challenge of mathematics. On the postsecondary level, it is imperative that teachers be sensitive to the many factors in and out of the classroom that affect the performance of minority students.

It is vitally important that the nation seek to inspire more minorities to enter mathematics teaching at all levels as part of the effort to expand the pool of mathematically trained minorities. The shortage of mathematics teachers is increasing and the percentage of minority students at different grade levels is also growing. Various means must be used to address these problems.

Through SUMMA, the MAA proposes to launch a six-point program to attract minorities into teaching at all levels. The program will build on the other components of SUMMA as well as the programs and publications of the MAA. SUMMA has already started discussing collaboration with the National Council of Teachers of Mathematics (NCTM) on ways to implement the program. The program will feature: (1) opportunities for students to explore mathematics teaching as a career, (2) multi-media career information focusing on the attractions of a career in teaching mathematics, (3) activities at national and sectional MAA meetings where interested faculty can build a network of mathematicians actively encouraging students to consider teaching mathematics, (4) consultants to visit institutions and advise faculty and administrators on their programs for prospective teachers, (5) national conferences for faculty from minority institutions focused on the needs of future mathematics teachers, and (6) advocacy of expansion of scholarship programs for prospective teachers.

In closing, allow me to quote from the almanac for 1795 of Benjamin Banneker, who taught himself the mathematics of astronomy with only a few years of education: "The most sensible of those who make scientific researches, is he who believes himself the farthest from the goal, and who, whatever advances he has made in his road, studies as if he yet knew nothing and marches as if he were only yet beginning to make his first advance." If we can convey this determination to learn mathematics to our minority and majority students, female and male, and get those who historically erected barriers to minority education to finally help us tear them down, the problem of the underrepresentation of human beings in the pursuit of mathematical knowledge and its transmittal to succeeding generations will be solved.

# MAKING EVERYBODY COUNT

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The title of my presentation is "Making Everybody Count." It is a spinoff from the book entitled *Everybody Counts*[1]. In beginning this presentation, I will make several quotations from that book and other recent documents. The following four quotations are from *Everybody Counts*.

> *"Apart from economics, the social and political consequences of mathematical illiteracy provide alarming signals for the survival of democracy in America. Because mathematics holds the key to leadership in our information-based society, the widening gap between those who are mathematically literate and those who are not coincides to a frightening degree with racial and economic categories. We are at risk of becoming a divided nation in which knowledge of mathematics supports a productive, technologically powerful elite while a dependent, semiliterate majority disproportionately Hispanic and Black, find economic and political power beyond reach. Unless corrected, innumeracy and illiteracy will drive America apart."*

We have already heard earlier at this symposium one of the key demographic projections, "that women, and immigrants will make up 85 percent of the growth in the workplace over the years 1985-2000." (Workforce 2000, the Hudson Institute). Thus, our pool of talent for new scientists and engineers is predominantly female or minority or disabled - the very groups that we have not attracted to science and engineering.

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[1] National Research Council. (1989) *Everybody Counts: A Report to the Nation on the Future of Mathematics Education*. Washington, D.C: National Academy Press.

In this respect, **EVERYONE IS NOT COUNTING.** The underrepresentation of women and minorities in scientific and technical fields is well documented and has been the subject of several conferences, symposia, commissions and working groups, reports and publications. Several statistics have already been given concerning this underrepresentation, therefore, I will mention only a few. According to the Engineering Manpower Commission figures, last year, out of 5,017 engineering doctorates awarded, 31 went to African Americans, 37 to Hispanics, two to Native Americans, and 440 to women. There are several hundred Afro-Americans who have bachelor's and master's degrees in mathematics. There are numerous Black women who hold doctorate degrees in mathematics education and who are very active in the profession. There are less than 50 Black women who hold Doctorate Degrees in pure or applied mathematics.

*"The factor which has most often been attributed to the lack of minorities in scientific and technical fields is the quality of their pre-college science and mathematics courses."*

The role that inadequate high school mathematics plays in this underrepresentation is also highlighted. Recent publications dealing with this theme include: *Everybody Counts*, 1989; *Women and Minorities in Science and Engineering*, 1989; *Changing America, the New Face of Science and Engineering*, 1989; *Education that Works, an Action Plan for the Education of Minorities*, 1990.

Over the past year, several regional conferences and a national convocation were convened around the theme "Making Mathematics Work for Minorities." Various factors have been listed as attributing to the underrepresentation of minorities and women in mathematics-dependent fields. Those differences most often related to women include differential course taking, lack of encouragement from significant others, women's perception of the usefulness of mathematics in later life, attitudes toward mathematics, and differential teacher attitudes and beliefs. Some researchers have also found that females were less confident of their ability to do mathematics. The factor which has most often been attributed to the lack of minorities in scientific and technical fields is the quality of their pre-college science and mathematics courses.

A recently released study by the Rand Corporation, (a think tank) entitled Multiplying Inequities identified two key factors thwarting the education of minorities and low income students in the areas of mathematics and science. These factors were: 1) Their relegation by the education system to low-ability courses and low-ability teaching (tracking) and 2) Facilities in the schools which these students attend. This study was based on an 1986 survey of 1200 public and private schools and more than 6,000 teachers. They found that minorities were less likely to have well qualified teachers in mathematics and science, and they had less access to science equipment, laboratories, computers, and materials which could make their learning more stimulating. They also found that many of the teachers in the slow tracks were less experienced, less qualified, and placed less emphasis on problem-solving skills and developing interests in mathematics and science. Low expectation on the part of parents, teachers, and significant others as well as the lack of role models are also listed as factors. While not all minority students have interests or aptitudes to become scientists, engineers, or mathematicians, considerable talent is lost.

What is being done to help Make Everybody Count? You have heard and read of many intervention programs. Many of us are involved in intervention programs. Intervention programs take time, cost money, should be begun early, they should be broad based, and sustained over a period of time.

At this point, I would like to mention two intervention programs in which I have been involved.

## THE BLACKS AND MATHEMATICS (BAM) PROGRAM

You heard Dr. Hawkins mention earlier The Blacks and Mathematics (BAM) Program. I would now like to speak briefly about BAM. The Blacks and Mathematics Program was a secondary school lectureship program sponsored by the Mathematical Association of America. The goal of BAM was to increase in

Black students an awareness of the need for mathematics courses in high school which would prepare them for careers in many different areas. In order to achieve the goals, the program had the following objectives:

1. To provide role models to encourage more Black students to consider mathematics-based courses.

2. To influence counselors, teachers, and parents to direct more Black students into mathematics-based careers in which Blacks are underrepresented.

3. To inform students, teachers, guidance personnel, and parents of the large number and variety of careers for which mathematics is a prerequisite.

The program was patterned after the Women and Mathematics (WAM) Program and operated initially in Houston, Atlanta, and Washington D.C. The program later spread to other cities including Hartford, Connecticut, Detroit, Michigan, Gramblin, Louisiana, and Newark, New Jersey. I coordinated the program in the Houston Region. BAM was sponsored initially by the Exxon Corporation and later by the Minority Institutions Science Improvement Program (MISIP) the Connecticut Mutual Foundation. Speakers for BAM were local Black persons in mathematics-related careers such as engineering, physics, chemistry, accounting, and computer programming. They worked in government, private industry, and educational institutions. Several of our speakers were employed at NASA.

## TEXAS SOUTHERN UNIVERSITY - NORTH FOREST I.S.D. PARTNERSHIP FOR IMPROVING MATHEMATICS ACHIEVEMENT

Another intervention program in which I am currently involved is a University-School District Partnership. One approach to improving the mathematics achievement of students is to focus upon improvement in mathematics instruction at all levels, and increased parental involvement. Such an approach is the focus of a University-School District Partnership between Texas Southern University (TSU), and the North Forest Independent School District (NFISD).

Texas Southern University is a historically black university located near downtown Houston. The Fall 1990 enrollment is 9,300 students with 76 percent Black, 3.6 percent Hispanic, 3.6 percent White, 1 percent Asian, and 15.39 percent other. North Forest Independent School District is approximately seventeen miles from the Texas Southern University campus. The student population consists of 12,900 students with 89.4 percent Black; the racial make-up of NFISD personnel is 90 percent Black.

The TSU-NFISD cooperative effort to improve mathematics achievement began five years ago and has continued up to this time. The underlying objectives of the cooperative effort are: (1) to improve significantly students' scores in mathematics on state and national, and norm and criterion-referenced exams; (2) to increase significantly the number of students who have adequate high school mathematics preparation to enter math-related fields or math-dependent fields; and, (3) to improve minority involvement in mathematics and other quantitative fields.

The primary activities for accomplishing these objectives have been a series of workshops conducted yearly for elementary, middle, and high school mathematics teachers, and mathematics courses for college credit. A support activity is parent seminars. The workshops are conducted by faculty members from Texas Southern University and other consultants and are held in various schools in the district. Workshop topics and courses offered are determined by a needs assessment of teachers, district priorities, and an evaluation of past projects. Some topics of past workshops are: (1) developing higher level thinking skills through problem solving; (2) the use of manipulative devices in the teaching of mathematics; and (3) improving achievement on norm-referenced and criterion-referenced tests.

The courses offered for college credit are usually held on the Texas Southern University campus and are taught by TSU faculty. Teachers may enroll in courses that are part of the college mathematics curriculum or specifically designed courses such as "The Use of the Calculator and Computer in the Teaching of Mathematics." The workshops and courses focus on content knowledge acquisition and improving methodology.

The parent seminars focus upon how parents can help their child learn mathematics. These seminars are held in the district and conducted jointly by NFISD faculty and administration and TSU faculty. During the parent seminars, efforts are made to keep parents abreast of the many jobs and careers that require a knowledge of mathematics, math course requirements for graduation, the mathematics component of state-mandated tests, activities and resources that promote mathematics achievement, the effect of parents' expectations on mathematics achievement, and the need to encourage their child to persist in taking mathematics throughout her or his high school career.

Teachers participate in the workshops and courses on a voluntary basis, and the participation has been very good. Teachers receive college credit for their courses and Advanced Academic Training (AAT) credit for the workshops. Program accomplishments over the past few years are (1) test scores have improved and in fact, last week five of the schools in the district were selected for the Governor's Educational Excellence Award. This award is based upon exemplary performance on a statewide test; (2) subject matter competence of teachers has been enhanced; (3) number and utilization of manipulative devices and other instructional materials has increased; (4) teachers from the various schools have been provided the opportunity to talk with each other about mathematics and to share ideas in working toward the solution of common problems; (5) teachers have been exposed to the effect of technology on the mathematics curriculum and have had an opportunity to have hands-on experience with computers and calculators; (6) parents have been provided with materials and information that they might use in assisting the mathematical development of their child; (7) the project director and consultants have had the opportunity to serve as resource persons to other activities; and (8) there has been an increased awareness among administrators, teachers, parents, and students concerning the role and importance of mathematics.

The activities of the TSU-NFISD partnership for improving mathematics achievement have been supported through grants received by TSU funded by the Education for Economic Security Act (EESA), the Dwight D. Eisenhower funds provided by the Texas Higher Education Coordinating Board, and the EESA funds provided North Forest Independent School District by the Texas Education Agency.

In addition to intervention programs (or along with intervention programs) several other things can be done to help Make Everybody Count, this includes:

1. Strengthening and increasing the numbers of teachers, particularly minority teachers, in science and mathematics.

2. Teacher training and retraining in methods to address the different learning needs of students.

3. Increasing the pay of these teachers in order to compete with industry.

4. More involvement of minority parents in school reforms.

5. Address the misuse or abuse of the "tracking system."

6. Reforms in the teaching of mathematics.

7. Reforms in the mathematics curriculum.

8. An improved precollege experience for minorities and women.

9. Research on issues related to the participation and performance of minorities and women in mathematics, and applying applicable research findings to teaching.

10. A national will and commitment in terms of time, money, and effort on the part of all individuals and institutions involved.

Every American will ultimately benefit from increasing the participation of women, minorities, and the disabled in the science and engineering work force.

Thank you very much.

# THE BIRTH OF AISES - American Indians Against The Odds

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The American Indian Science and Engineering Society (AISES) is a unique organization. Founded 13 years ago in 1977 by a small group of professionals in these fields in the Southwest, it has mushroomed into a national group with several thousand members and several dozen student chapters at colleges and universities. A miracle, it seems.

Exactly how did this unprecedented success take place? In the early 1970's only a handful of Indian people with degrees in science and engineering could be located, sprinkled around the country. The previous generation of Indian people -- the first ones to go into higher education -- had mostly elected for the field of education and had become teachers. The 1960's saw the beginning of a small wave of Indian lawyers, to be followed some years later by a few doctors (M.D.'s). (Even today there is no national or regional group devoted to Indian education in Business Administration and Management, a critical field that has lagged far behind.) The idea of becoming scientists and engineers had not taken hold in the Indian world, although the need was certainly recognized. Tribes in the 1970's were constantly fighting battles to protect their land and their culture, and to receive their fair share from contracts with mining companies, power plants, water developers, timber companies, and other industry. And the tribal officials did not have Indian professionals in those fields available to advise them. Here is the story, rarely told, of how that situation changed.

In 1974, in the heart of Indian country, in Albuquerque, New Mexico - the unofficial Indian Capital -- a significant event took place, the **birth** of a new program, the first of its kind. The Dean of Engineering at the University of New Mexico (UNM) helped secure a grant for $1.3 million from the Sloane Foundation, working with the National Academy of Engineering, National Research Council (NRC). Dr. Percy Pierre, Chairman of the Minority Committee, was the key supporter. The purpose of the grant was to recruit and graduate engineers. The dean was new to the campus and ambitious. He had looked around

the campus and seen only three or four Indians in his College, which was not enough in that ethnically conscious decade. A small group of Indian and Chicano professionals in New Mexico worked with him to devise a program; they were educators, scientists, and engineers. There were no models to use. Most people never had gone into technical fields and they never would. Even Indian people were not certain that potential students could be found.

*"These Founders like to refer to the "dark and stormy night" when AISES was born; even the airport closed and transport ceased."*

But the small group of believers prevailed. The new education model developed in the proposal for the grant proved to be successful. Young people and some not so young came forward to enroll in this difficult field, and with transitional help in mathematics they began to graduate several years later. The Native American Program - College of Engineering (NAPCOE) was founded on unconventional concepts. The program staff was working on an unknown frontier -- how to teach mathematics and other technical subjects to about 40 recruits who were not even well qualified by conventional standards of selection. Fortunately, morale was high and determination was great.

As the well-funded three-year education program gathered steam in New Mexico, a parallel but smaller program continued at the University of Oklahoma. Staff for the two programs soon were in touch with each other. Almost any new Indian program will soon be known to all the tribes and most of the urban professionals. (I should mention that the Indian world is relatively small in numbers --only about 1.5 million or fewer in the whole USA.) Both the Oklahoma group and the New Mexico group discovered that they could work better together than separately. Each had formed a small regional Society to function as a voice for engineers and to support and advise campus programs: the National Society of American Indian Engineers in Oklahoma, and the American Indian Engineering Council in New Mexico, which also doubled as the Advisory Board for NAPCOE, the program at UNM. All were professionals and Indians, working in their field. These two campus engineering programs were the forerunners of AISES.

It was decided that a merger of the two groups would take place. A unique event in itself. Historically, minority (and some other) organizations are far more likely to split than to merge. Funded with seed money from the National Research Council, seven people -- six men and one woman -- met at Winthrop Rockefeller's ranch on a mountain top in Arkansas in the spring of 1977. (These Founders like to refer to the "dark and stormy night" when AISES was born; even the airport closed and transport ceased.) Officers were elected and plans made to increase membership. Later on, articles of confederation were written, and tax-exempt status was secured.

In the beginning, we had no money even to travel and hold meetings, let alone recruit others, except for the NRC grant. This money was soon supplemented by grants from General Electric and RCA on the private side, and National Aeronautic and Space Administration (NASA) and the Department of Energy in the Federal government. The National Action Council for Minorities in Engineering, Inc. (NACME) and others in Washington, D.C., especially the Black engineers, were extremely supportive. The Black science and engineering programs had started and begun to grow several years before; they were first. The Hispanic programs and Societies began in the middle of the 1970's about the same time as AISES. The 1970's was the decade that saw the growth of a whole network of minority involvement in science and engineering, all across the country -- beginning on the East Coast, leap-frogging to California, picking up strength in Texas, and the South, later in the Mid-West and Great Lakes states, finally reaching the Southwest, Rocky Mountains, and Northwest. It was in this later "Western stage" that the American Indians and Mexican Americans began to take their place in minority science and engineering education. And AISES from the beginning has been the dominant group in American Indian technical education.

Anyone might ask, why is the founding of AISES, a professional society, of any importance to engineering education? Because the first thing the AISES Board realized was that we could "meet in a

telephone booth" indefinitely unless something was done to recruit more Indian students to campuses, who would graduate and become future AISES members. AISES had only about two dozen full, professional members in 1977. Available records in the Bureau of Indian Affairs and the Office of Indian Education (U.S, Department of Health, Education, and Welfare) indicated that only about 50 or 60 engineers and scientists with degrees were known to exist in the whole United States, and they were scattered all over. The first major decision of the Board was to dedicate almost our entire resources and effort to recruiting Indian students, both men and women, onto college campuses and simultaneously to develop strategies so that they could succeed in graduating.

It was decided that Student Chapters of the parent society would create the needed tie between professionals and undergraduates and also help retention in classes. In retrospect, this was a major element in later success. After the first few Chapters were set up, the idea caught hold across the country. The dropout rate was known to be high at that point. We felt that strong groups of students would support each other, and that idea proved to be true. The students themselves took the lead in organizing and perpetuating the Chapters.

If we had known the difficulties of plunging into Indian education we might have been discouraged. But we were amateurs in education, working with Indian and non-Indian staff first on the campuses and later in the high schools. Novel mathematics strategies (curriculum and tutoring) were worked out in the program at the University of New Mexico, which became our model and laboratory. Technical English was the other subject that required intensive efforts, in effect, teaching a new language. Unorthodox testing methods showed the SAT and other standard scores alone did not necessarily predict student success in engineering; other factors might be more significant. A whole mosaic of interlocking recruitment and selection methods was developed, followed by a comprehensive program of student counseling, tutoring, summer sessions, bridge courses, individual and group support, scholarships, family stipends, group cultural activities, tribal involvement. Students needed five or six years to graduate, instead of four, mostly because of time taken to make up earlier serious deficiencies in preparation, and sometimes because of family responsibilities, including young children (many students were married). After about two and a half years, the retention rate at the University of New Mexico, in the program, was approximately 35-40 percent, which was very good, in fact unprecedented.

Some people may be thinking of the parallels to the film "Stand and Deliver" with Edward James Olmos playing the lead role, teaching calculus to barrio students in Los Angeles. So much that is described in that amazing true story was also discovered by the AISES programs. Apparently some of the same teaching strategies will bring success in Chicano or American Indian mathematics programs, perhaps in Afro-American programs, too. An intervention can succeed if it is properly matched to the students' environment and cultural background, and to their interests, abilities, and motivation. AISES worked with the practical "ground truth", the situation as it existed. We were nearly ignorant of education theories, but fortune was with us and we had good advice.

A few words need to be said about the mathematics problem. Reference is to the Native American Program (NAPCOE) at the University of New Mexico, which was the experimental arena for AISES in the middle 1970's. That program was conceived with the idea that mathematics in general and calculus in particular was likely to be the single greatest obstacle to graduation of Indian engineers, aside from scholarships. So, a transitional year of mathematics (and technical English) was built into the curriculum as a bridge for the majority of students who had not gone beyond geometry or trigonometry in high school. The program hired a mathematics instructor and the tutors conducted their teaching in parallel with campus classes but from a different concept: that math is practical, related to the real world, is not an abstract exercise; that it is a series of related strategies that can be learned step by step, a higher skill that can be de-mystified and mastered.

This approach had some success. A number of students survived the first two or three years on campus, including calculus, and received the newly created Associate of Engineering degree at the end of the critical sophomore year. They qualified for employment as technicians if they left the campus at that point. (The world needs more good technicians, also.) The retention rate then was over 30 percent, which is quite good. Some students were so encouraged that they went on to receive the Bachelor's degree, mostly in

electrical or computer fields, some in civil engineering. They made many sacrifices along the way. We are very proud of those minority pioneers, both men and women.

Going back to the national AISES recruitment program -- the first annual Student Conference was held in Phoenix, Arizona, at the State University in 1979. Several hundred high school students attended. Interest was high. The Salt River Project (SRP) (the major Arizona water utility) backed this successful event; they also provided the first AISES headquarters with support services for the next several years while the organization was small and struggling. (A Board member of AISES was a senior management officer at SRP.) The Board itself did most of the work until enough grants were brought in to hire a small staff. Various universities in the West hosted the annual student conferences, which grew larger each year. The most senior Board member, Andy Anderson (a Mohawk Indian from New York), retired from upper management of Union Carbide in New York, and became the first Executive Director. With the help of NACME and the National Research Council (Minority Committee), a whole group of significant corporate funders began to back AISES. As several Board members were also Federal employees, they approached their various Federal agencies such as U.S. Geological Survey, National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of Education, the U.S. Department of Energy, NASA, and others; they secured a number of special grants from the government and continued funding. For example, in 1978 AISES sponsored a telecommunications satellite demonstration with NASA and RCA, connecting Washington, D.C., with several tribes in the West and Alaska; this was a first. In 1979, AISES held a conference on solar energy in cooperation with NASA, U.S. Department of Energy, and Southwestern tribes, in Arizona.

**"Money and organization would count for nothing unless the Indian young people had come forward into the front lines of battle to educate themselves in the mainstream of science and technology."**

A permanent headquarters was established at Boulder, Colorado, in 1983, and several full-time staff members hired. Summer science programs were launched for students with the cooperation of the University of Colorado, which also loaned computers, and gave various support services. Norbert Hill, an Oneida Indian, became Executive Director that year and began a whole new era of growth, greatly increasing the student numbers, funding, and national recognition. The AISES Scholarship Fund began to reach significant proportions. The Board continued to play an active role. It is elected by members; all of them were and are Indian people with degrees in science or engineering. The officers continue to work closely with the Director in policy development and the direction of AISES.

The Student Chapters had proved to be amazingly popular. One Board member was the key person in establishing one of the most significant elements in this story. Of course, the students themselves were and are the key factor in starting and maintaining the Chapters. Campus support groups composed of students and their peers have been perhaps the biggest surprise to us all. Of course, they were set up at first by Indian professionals living nearby or sent out from AISES headquarters, working with campus staff. Now the Chapters are so well organized that their own elected officers keep up contact with Boulder headquarters and with other Chapters in the national network; members help recruit high school students and help each other in their studies to prevent dropouts. Recent graduates assist Student Chapters near their new places of employment or keep up as AISES alumni. Hundreds of students attend the annual AISES Conferences and hold their own elections for officers and for representatives to the national Board.

If I had to summarize the reasons for the unexpected existence of AISES and its continuing great success against all the odds, I would have to mention the unique combination at first of the National Research Council, plus NACME, and their access to major corporate funders interested in minority engineering; and to Federal agencies' support and funding; the University of New Mexico and its Sloane-

funded experimental program (which continues today in a smaller State-funded version); and the AISES Board members' access to the tribal governments, Indian education professionals, Indian high schools, and college staff. Not to be forgotten is the active support of Indian tribes and organizations, especially the Navajo Nation and the All Indian Pueblo Council in New Mexico, and many tribes in Oklahoma, later the other Western, and some Eastern tribes. If they had been opposed, I might not be telling this story.

Last, but most important of all -- the Indian students themselves. Money and organization would count for nothing unless the Indian young people had come forward into the front lines of battle to educate themselves in the mainstream of science and technology. Some of these graduates are working now with the tribes to preserve the Indian land and culture, to co-exist with the dominant culture; others have careers in the large corporations, the Federal government, sometimes State government. I'm happy to say that perhaps 15 percent or more of the graduates were women, but they have done very well. And now, 50 percent of the students and graduates are women.

Anyone might ask, why is the American Indian Science and Engineering Society significant in the development of an Indian presence in those fields? A professional society would not ordinarily be heavily involved in recruitment and education. But that is exactly what this particular fledgling society did. Because there were so few candidates for Society membership, our paramount concern was to increase the numbers. AISES Board members' earliest connections were fortunately made at the highest levels of the national science and engineering establishments in this country, and the upper levels of some key corporations. The rest is history, as they say. Thousands of Indian high school and college students have been exposed to the possibilities of technical careers at the AISES conferences, and hundreds have actually enrolled on college campuses, and in AISES Student Chapters. But only dozens have graduated in science and engineering, primarily engineering. Some other students have enrolled in or transferred to health professions or business administration, and so became professionals in other fields. Still, the numbers are not high enough and too many are lost.

Here are a few brief statements on statistics: AISES in 1990 has more than 1,000 college student members, most of them in 62 college chapters, plus 60 affiliated high school chapters. There are several hundred graduate members of AISES, professionals. More than 50,000 Indian students have been introduced to AISES at conferences, summer science fairs, or enriched curriculums in school. About 2,000 science teachers have received training through AISES. Some of these teachers work in all-Indian schools, others in public schools. Several dozen students have graduated with degrees in science or engineering in the past eight or nine years. These graduate numbers are not large, but they do represent a very noticeable increase over the pre-AISES days.

The budget is over $2 million, but it is still not enough because qualified students are being turned away because of lack of funds; this is in spite of the fact that AISES has one of the lowest overheads of any organization. About $200,000 is available for scholarships this year. Also worth mentioning is the quarterly magazine published by AISES headquarters in Boulder, Colorado, since 1986, called "Winds of Change" or just "Winds". It has been successful from the beginning, even paying for itself with appropriate advertising. Issues of the magazine reach a far wider audience than the members and supporters of AISES. They are passed around on college campuses and on tribal reservations, for example. They come to rest in high school libraries. Besides the focus on engineering and science and education, the magazine has articles on Indian history, culture, events, sports, biographies of Indian professionals and notable people. It is the only full-color, glossy magazine being published regularly in the Indian world.

It is a fact that AISES is the central moving force in American Indian technical education, and has been for the past 13 years - probably a unique situation. An interesting question is: would Indian students have gone into those fields by themselves in the 1970's? Minority progress on new frontiers was in the air in those days. I believe the Indian young men and women would have enrolled, but almost certainly in lesser numbers, with fewer graduates, because of lack of the AISES support system, including student chapters. There would have been no central organization coordinating the entire national effort and documenting it.

In closing, I should like to say that the technical education frontier is far from closed. So much remains to be done. Some principles are known that apply specifically to women and minorities, some successful strategies. But all too often these methods have not received much formal attention and have not been translated into action. Perhaps there hasn't been enough input yet from the people most affected by lack

of numbers in science and engineering -- those same women and minority people. Another possible reason -- there may be some dichotomy between the rational straight-line methods of technology itself and the teaching of science, engineering, technology which must rely on methods that apply to human beings and their behavior. We all know that the underrepresented groups can do engineering. That is no longer in question as it was 15 years ago.

But do they want to enter the world of science? How can careers in science and technology be made appealing to young people? To those who have potential but would not ordinarily consider such a life for themselves, without intervention from outside their normal environment? Peer pressure is certainly a serious problem, but there are ways to counteract it. The Indian students, for example, did not cease to be Indian when they entered college programs or when they graduated. Neither did they turn into technology obsessed "nerds". They remained themselves, but added another whole dimension to their lives -- the study of the natural world and its man-made derivative structures. In effect, these students learned another language, and they function in two worlds.

Do lessons learned by AISES apply to other minorities or to women? Perhaps we need a fresh look at the whole situation, more studies by groups such as CASET to examine and compare across cultures and gender, to make the most of the talent that is available. Our country needs the best of its young people to keep the nation moving. We dare not fall behind.

# CAREER OPPORTUNITIES FOR WOMEN IN SCIENCE AND ENGINEERING

**Mildred S. Dresselhaus, Ph.D.**

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*Mildred S. Dresselhaus is currently one of twelve active Institute Professors at the Massachusetts Institute of Technology (MIT); she is a professor of physics and electrical engineering. She was formerly the permanent holder of the Abby Rockefeller Mauze Chair in Electrical Engineering and in Physics at MIT. She is affiliated with the Center for Materials and Engineering at MIT, which she formerly directed, and with the Francis Bitter National Magnet Laboratory. In addition to her work at MIT, Dr. Dresselhaus has traveled to universities and technical institutes in Brazil, Israel, Japan, Venezuela, and California as a Visiting Professor. Her extensive list of honors, awards, and memberships includes honorary doctorate degrees from a number of colleges and universities, positions on several scientific and technical governing and advisory boards, fellowships, and achievement awards. In November 1990, Dr. Dresselhaus was awarded the National Medal of Science. She has been active in the study of a wide range of problems in the physics of solids. Her recent interests have been directed toward the modification of the properties of electronic materials by intercalation and implantation, the structure and properties of carbon fibers, and of high Tc superconductors.*

When I was asked to present this luncheon talk, Nina Kay asked that I address women's scientific, engineering, and technical careers in an international context as well as convey my own perspective on education and career issues here in the United States. It is interesting to address these topics, because, as you well know, in America women are much less well represented in science than men. Additionally, studies tell us that women have lower salaries by substantial amounts, and they have less recognition at almost any level about which you might inquire.

Yet amongst the sub-sets we've heard about, American Indian women and other ethnic groups, or in other countries, the same is not true. In fact, we heard in one of the talks this morning that many girls think that they can't do mathematics. That may be true in America, but there are other countries where girls can manage to do math just as well as the boys do.

In some of the statistics that I'm going to show, you'll see that there are some fields in science and engineering in which women do extraordinary well. The interesting thing is they are not the same fields in every country. So we know that there is nothing innate about a particular field; it just happens as it does in the U.S. A lot of this is due to circumstance and if we put our minds to it, we could probably overcome their prejudices and succeed much better than we are doing now. One of the points that I would like to make, whether it is in a university, or industry, or even national laboratories, the success of women varies

a great deal from one place to another. In one sense, if we could look at the places that women do well,understand why it is that they do well, and emulate some of these good places, then we would have our job partly done for us in trying to make the less good places better.

You have to have some realistic goals in this world, otherwise you don't do very much. If our goal might be that in the next decade we want to double the representation of women in the underrepresented fields of science and engineering, I think that is certainly a reachable goal. Then we just have to figure out a strategy, and I think that we can then do it. There are a lot of examples where women are doing rather well. So if we can just emulate the good places and reproduce the good aspects that are reproducible, then we can make some real progress. Every institution has its own folklore and history. We can't reproduce everything in another setting, but if we can take certain aspects they can be reproduced over time, then we can make progress.

**GRAPHIC #1**

**Employment of Scientist, Engineers, and Technicians (SET), by Field, 1986 and 2000**

| FIELD | NUMBER EMPLOYED 1986 | PROJECTED % INCREASE IN EMPLOYMENT, 2000 |
|---|---|---|
| **TOTAL, SET Fields** | 5,492,900 | 36 |
| **Total Scientists*** | 1,676,400 | 45 |
| Computer Specialists | 437,200 | 76 |
| Life | 340,500 | 21 |
| Mathematical | 103,900 | 29 |
| Physical | 264,900 | 13 |
| Social | 432,600 | 36 |
| **Total Engineers** | 2,243,500 | 32 |
| Aero/astronautical | 104,200 | 11 |
| Chemical | 131,500 | 15 |
| Civil | 319,100 | 25 |
| Electrical/electronics | 540,800 | 48 |
| Industrial | 113,100 | 30 |
| Mechanical | 453,700 | 33 |
| Other | 581,100 | |
| **Total Technicians** | 1,573,000 | 36 |
| Computer Programmers | 309,000 | 70 |
| Draftsmen | 348,000 | 2 |
| Electrical/electronics | 313,000 | 46 |
| Other engineering | 376,000 | 26 |
| Physical, mathematical, and life sciences | 227,000 | 15 |

* Includes 97,300 environmental scientists.

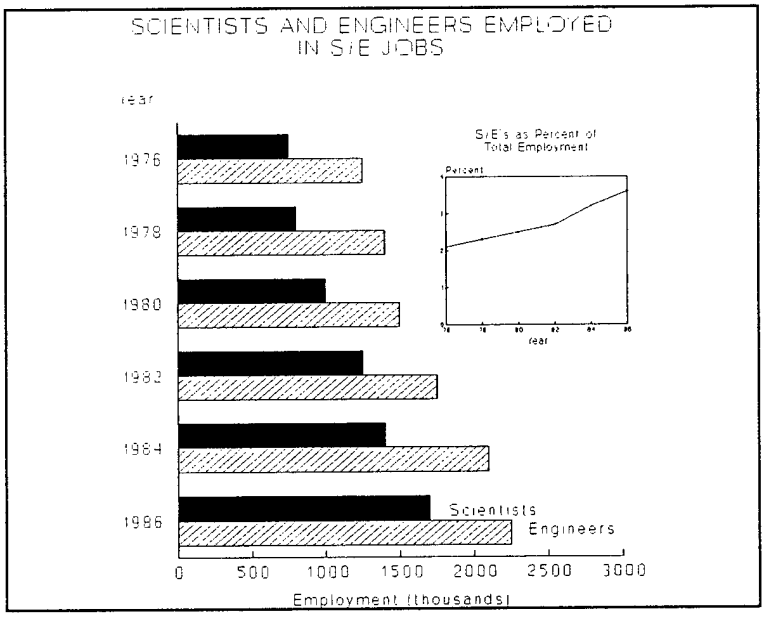
SOURCES: National Science Board, Science & Engineering Indicators - 1987, Washington, D.C.: U.S. Government Printing Office, 1987, from National Science Foundation, U.S. Scientists and Engineers: 1986 (NSF 87-322), Washington D.C.: U.S. Government Printing Office, 1987; and U.S. Department of Labor, Bureau of Labor Statistics, BLS Monthly Labor Review (September 1987), pp. 51-52

I'll start out with some statistics that will be a review of what we've been hearing in the lectures this morning. Now you must understand that I am a rank amateur at statistics. Our Dean of Statistics is sitting right there, Betty Vetter, and it is very embarrassing for me to present these statistics in front of her. She tells me that she likes to hear what I have to say about these statistics, because I am there in the trenches with the students. It is a little different when you are dealing with students in contrast to gathering data. I don't gather any statistics, I just steal them from people like Betty Vetter. After presenting the statistics, I was asked to give a little bit of a personal perspective on how I got into science and doing all the different things that I am now doing. Those of you who don't know me will be very surprised to hear how I got to where I am now. Then, I thought, I would give some ideas on what I think it takes to be successful in this field. I think that it is necessary for you to hear that, because of its importance. You can disagree with me and maybe I left out a lot of things, but I will present my viewpoint, at least for discussion. Then I'll talk about the fact that in the various institutions there is really a large distribution of successful outcomes. Most of the research institutions in the U.S. are very poor with regard

to their record in support of women in science, but there are a few that are excellent. So we'll talk a little bit about the good ones and why they are so good. I'll then talk about our Massachusetts Institute of Technology (MIT) experience where we're well above the average with regard to women in science. If we could make so much progress in women in science at a place like MIT, which I think is a really tough place for anyone to succeed, then there is hope that one can succeed in other places. So this is my agenda. I hope, Nina, that these are the topics that you wanted me to address.

The very first thing I would like to establish with the first set of view graphs is something that you all know. I consider the audience to be knowledgeable about women in science and engineering; I consider the audience to be a group of professionals. What I'm talking about first is science and engineering and these are National Science Foundation (NSF) figures. (Graphic #1) If you would look at this view graph you see (Linda Dix showed this in her talk) that by the year 2000 we'll need a third again as many scientists and engineers as we now have. Now the numbers in Fig.1 are obviously very soft. We may have the cold war coming to an end, and we have a recession, perhaps, underway. There are lots of factors out there that can totally change the numbers and change the data regarding the distribution in these fields. I think the sign regarding the increased need of technical manpower is probably right. If it isn't a third as many jobs that need to filled, then maybe, it's only 10 percent as many that will be needed, but I do believe there will be a need.

**GRAPHIC #2**



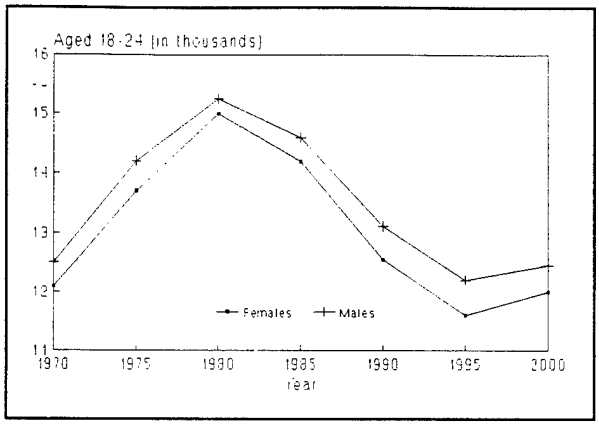

The next view graph (Graphic #2) seems to me to be more significant, at least from a scientific stand point. What this shows is the growth in the need for scientists and engineers over the last ten year period, a decade. Basically what we see on graphic #1 is that the projected increase in manpower needs is roughly 70 percent overall. But even more important is that the number of opportunities in science and engineering increases more than the average for other kinds of jobs that are available, as seen in graphic #2. The need for science and engineering personnel increases by about a factor of two when averaged over this decade. So it is not only a greater increase, but as the inset in graphic #2 shows it's an increase at an increasing rate.

What does that tell us? It tells us that as a nation we are going more into the high tech areas. If we wish to compete with the rest of the world for the environment, important for energy production. For almost anything that you can think about, we need science and technology. These two graphics establish in some sense the demand aspect, although the numbers themselves are probably not quantitatively accurate.

The next part of my presentation deals with the supply aspect and that's less soft, because the youngsters who will contribute to the pool of scientists and engineers are already here, I guess that has been covered amply in the previous talks. In graphic #3 we see the numbers in the cohort age, eighteen to twenty-four vs. time. What this shows is that the peak of the baby boom and the number of youngsters in this particular age bracket peaks at about 1980, when we had 25 percent more people than in this age group as compared

to the present. The minimum numbers are coming up in the next years in 1995. A 25 percent decrease in manpower is significant. These are hard numbers because the statistics have already been recorded.

**GRAPHIC #3**

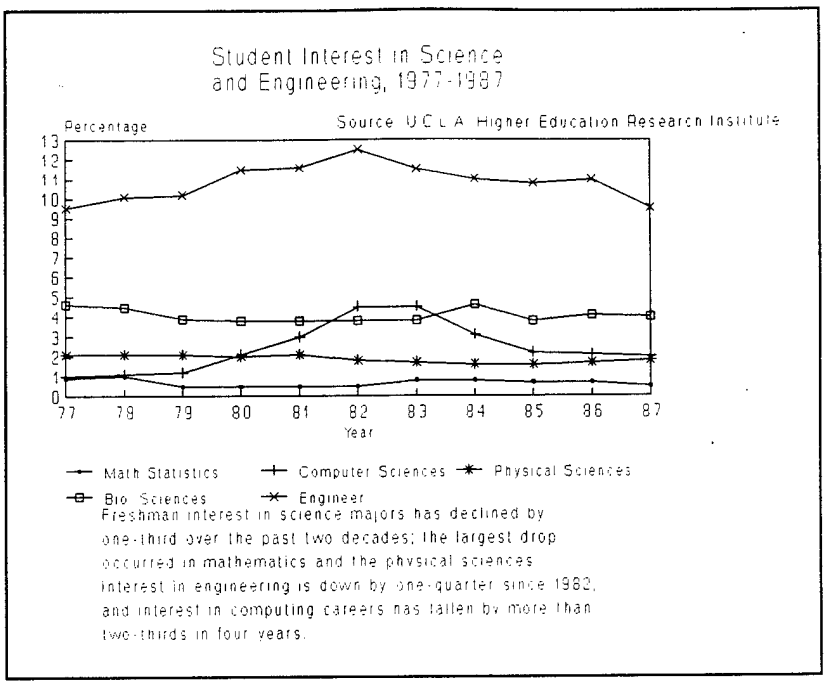



- SOURCE: U.S. Bureau of the Census, Statistical Abstract of the United States: 1987 (107th edition), Washington, D.C.: U.S. Government Printing Office, 1986.
- Figure 2. *U.S. population, aged 18-24, 1970-1985, and projected, 1990-2000* (in thousands).
- TABLE 2: Bachelor's Degrees in Science and Engineering as Percentage of All Baccalaureates Awarded, Selected Years, 1972-1986

| Field | 1972 | 1974 | 1976 | 1978 | 1980 | 1982 | 1984 | 1986 |
|---|---|---|---|---|---|---|---|---|
| Computer/Info Science | | | | .78 | 1.20 | 2.13 | 3.30 | 4.24 |
| Engineering | 4.91 | 4.28 | 3.88 | 4.77 | 5.88 | 6.96 | 7.86 | 7.67 |
| Health Sciences | 3.00 | 5.29 | 6.42 | 6.71 | 6.84 | 6.77 | 6.65 | 6.66 |
| Life Sciences | 5.71 | 6.71 | 7.67 | 7.67 | 7.11 | 6.64 | 5.79 | 5.35 |
| Mathematics | 2.91 | 2.61 | 2.16 | 1.36 | 1.22 | 1.22 | 1.36 | 1.65 |
| Physical Sciences | 2.23 | 2.09 | 2.14 | 2.33 | 2.35 | 2.50 | 2.44 | 2.17 |
| Psychology | 4.63 | 5.14 | 5.00 | 4.53 | 4.22 | 4.26 | 4.14 | 4.07 |
| Social Sciences | 9.62 | 9.16 | 8.15 | 7.59 | 7.18 | 7.33 | 7.07 | 6.90 |

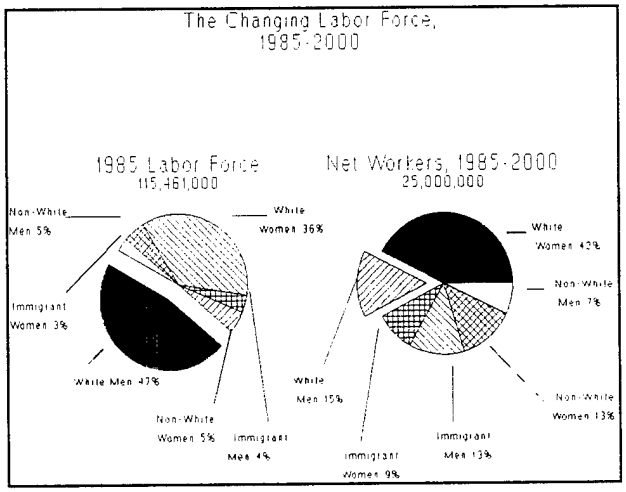
SOURCE: Betty M. Vetter and Eleanor L. Babco, *Professional Women and Minorities (7th ed.)*, Washington, D.C.: Commission on Professionals in Science and Technology, 1987.

**GRAPHIC #4**




The next view graph (Graphic #4) is important because it shows the probability that youngsters will go into science and engineering careers. The main point is that unfortunately when we were peaked in our college age-population availability, which was in 1980, the probability of the youngsters going into science and engineering also peaked. So the product of those two quantities determines the actual numbers. In physics we call this product the "Transition Probability" which is found from Fermi's Golden Rule. Fermi's Golden Rule gives the transition probability as a product of density of states times the matrix element squared. The density of states is analogous to the manpower that is available in the pertinent age group. Then we multiply that by the probability factor, which is the matrix element squared and this has been leveling off. Here on the view graph is engineering, that goes up and down by 25 percent over the time period of the view graph. So if you have a 25 percent decrease multiplied by another 25 percent decrease, then the product of these two factors yields a probability of 9/16 or approximately half. This product is quite a hard number and I think that it is not refutable. One more thing that we should say is that some fields have been affected more than others. Computer science has decreased by more than a factor of two during this period. Perhaps computer science increased too rapidly ten years ago and the expectations for jobs in this field exceeded the actual demand. But, I think it is probably true in a few years we will likely face a shortage of computer scientists once more.

**GRAPHIC #5**

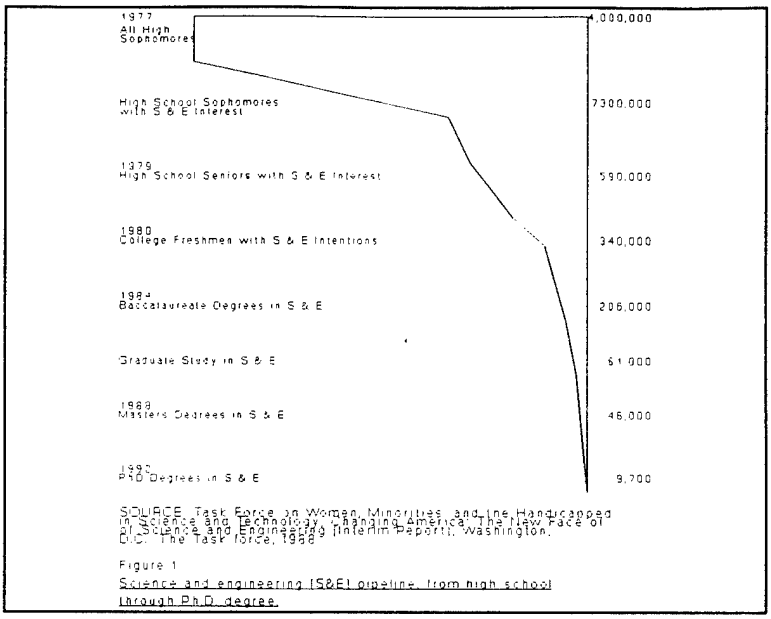



This morning many people were talking about this view graph, but nobody showed it, so here are the numbers (Graphic #5). Here we see the 15 percent of white males who are available to meet the increase in manpower needs for the period of 1985 to 2000. During this period it is expected that there will be twenty-five million new jobs in the United States. The traditional people who now fill these jobs have been approximately half white males, but until the end of this century we will not have enough white males entering the job market, so we're going to need other people. Here on graphic #5 are the women. Here you see that more than half of the available people are

women, when you add up all the different women's groups. Then the jobs that won't be taken up by the women or the minority populations will have to be taken up by immigrants. They are the people who always take what is left over. We import them, and eventually most of them become citizens and contribute positively to our economy.

**GRAPHIC #6**

The famous pipeline is shown in the next view graph (Graphic #6). I guess that this view graph has probably been shown many times during this conference. Here we have the four million sophomores in high school and you see, progressively, as the students get older they finish high school, then they enter college. Finally, at the baccalaureate degree you have 15 percent of the cohorts remaining in the science and engineering pipeline. This tells you that there are not too many people getting Bachelor's Degrees in science and engineering. Then as we go down the pipeline it constricts very rapidly, and finally as we get to the Ph.D. level we are left with about ten thousand. We can continue with this pipeline story if we want. U.S. science is as good as it is, not so much because of the actual Ph.D. production, but rather it has to do with a small fraction of the Ph.D.'s who do most of the creative work. You can say that science is a highly nonlinear process. More than half of the people with the Ph.D. degree never publish another paper in their lives. That is part of the whole story, and maybe only 10 percent do something approaching world class research.




SOURCE: Task Force on Women, Minorities, and the Handicapped in Science and Technology, Changing America: The New Face of Science and Engineering, Interim Reports, Washington, D.C.: The Task Force, 1988

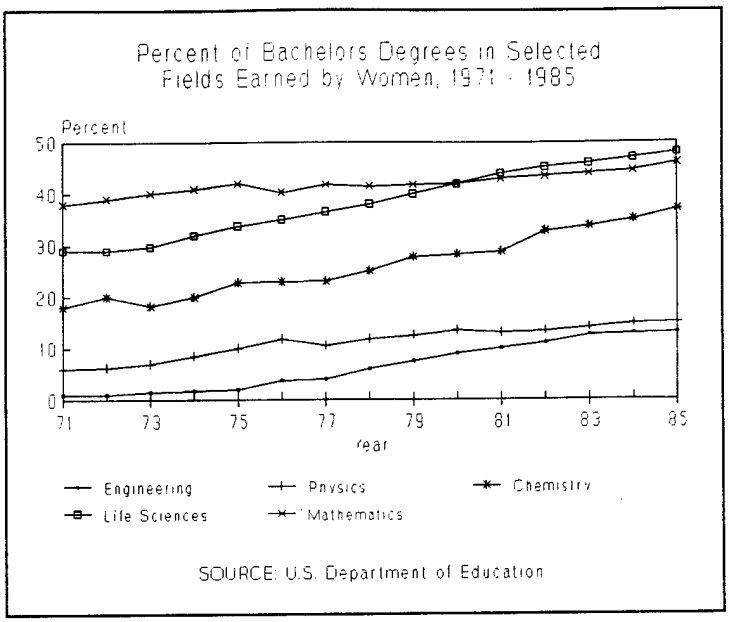
Figure 1
Science and engineering (S&E) pipeline, from high school through Ph.D. degree.

Another thing that this picture doesn't show is the importance of science and technology to students who don't become professionals. If you want to be in the business world, or you want to be in law, or you want to be almost anything that matters today, you have to know some mathematics. You have to have some exposure to quantitative reasoning and logic, and these issues are not contained in these statistics. Somebody was saying, I think Betty Vetter, that in the U.S., students are not studying math and science in the same proportion that they are in other countries, and that this difference is a very serious problem for the U.S. economy. I don't have a view graph to demonstrate this point, but I wish I did have one that would show this point more clearly. Well, because of the impending increased demands and the decreased manpower supply, what I want to say is that this is an opportunity situation for women, and it's an opportunity also for minority groups. If we can't make it under these circumstances we are not going to have a better chance for awhile. So we have to muster our forces and try to do better than we have been. In fact this is happening.

Here in the next view graph are baccalaureate degrees for a fifteen year period, and you can see the increase participation of women (Graphic #7). In most of the fields the increase in B.S. degrees to women corresponds to something like a factor of two. In the life sciences women are close to 50 percent of the B.S. production and that's pretty impressive. In mathematics women are close to 50 percent of the baccalaureate production. In chemistry women are approaching about 40 percent, and also in graduate school. What is amazing is the showing in my field of physics. There is not a great deal of difference between chemistry and physics so far as what the researchers actually do, but the percentage of women participants is very different. To me, this is a question of sociology and not of science.

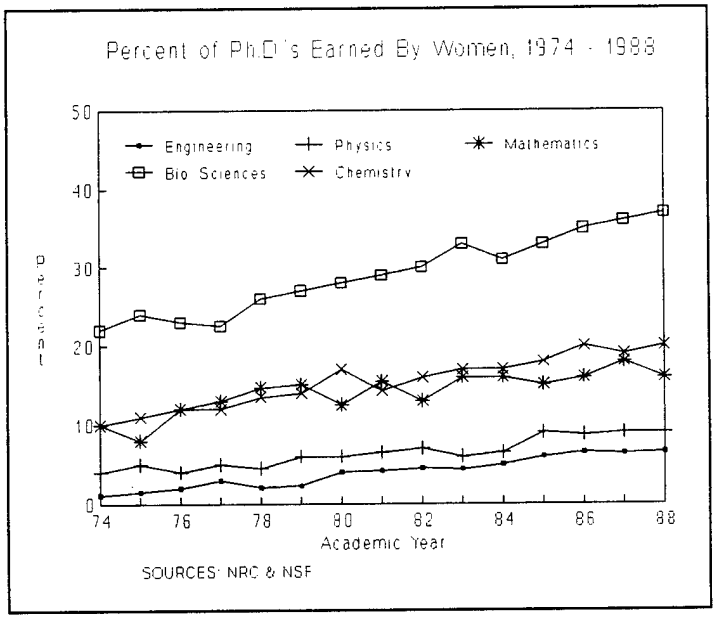
**GRAPHIC #7**

Well, here in graphic #7 is the physics B.S. degree production and you see that physics starts out at about 6 or 7 percent in 1971, and it gets up about 13 or 14 percent in 1985. Engineering has improved impressively and is catching up to physics.

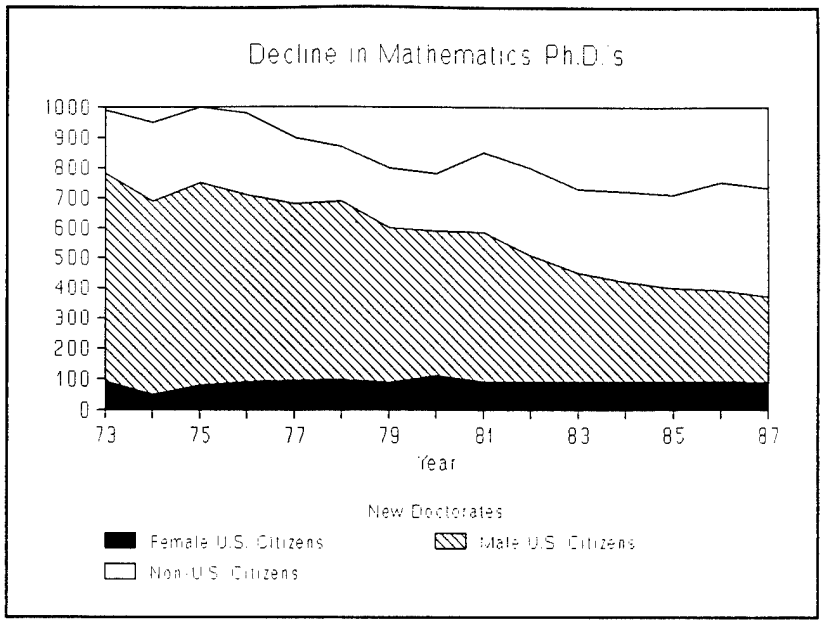



**GRAPHIC #8**

I guess that engineering will soon pass physics or maybe equal out. Let us now look at the Ph.D. levels, where we see the same increases (Graphic #8). Women have doubled over this fifteen year period in the biological sciences. If women can get a Ph.D. in biological science which includes a lot of chemistry nowadays, I don't see why they can't do better in some of the other areas. In areas such as physics and engineering, women are below critical mass and I will have more to say about that later, because being below critical mass makes it tough for women to succeed.

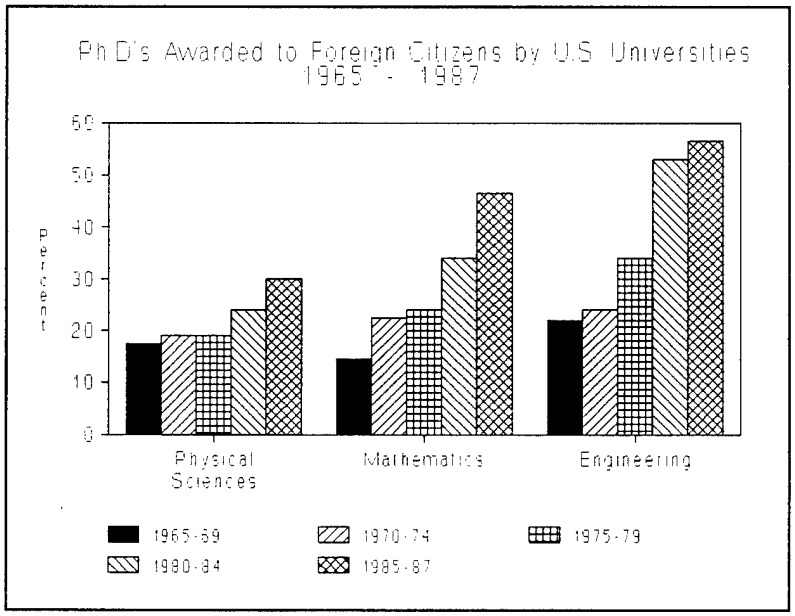


**GRAPHIC #9**



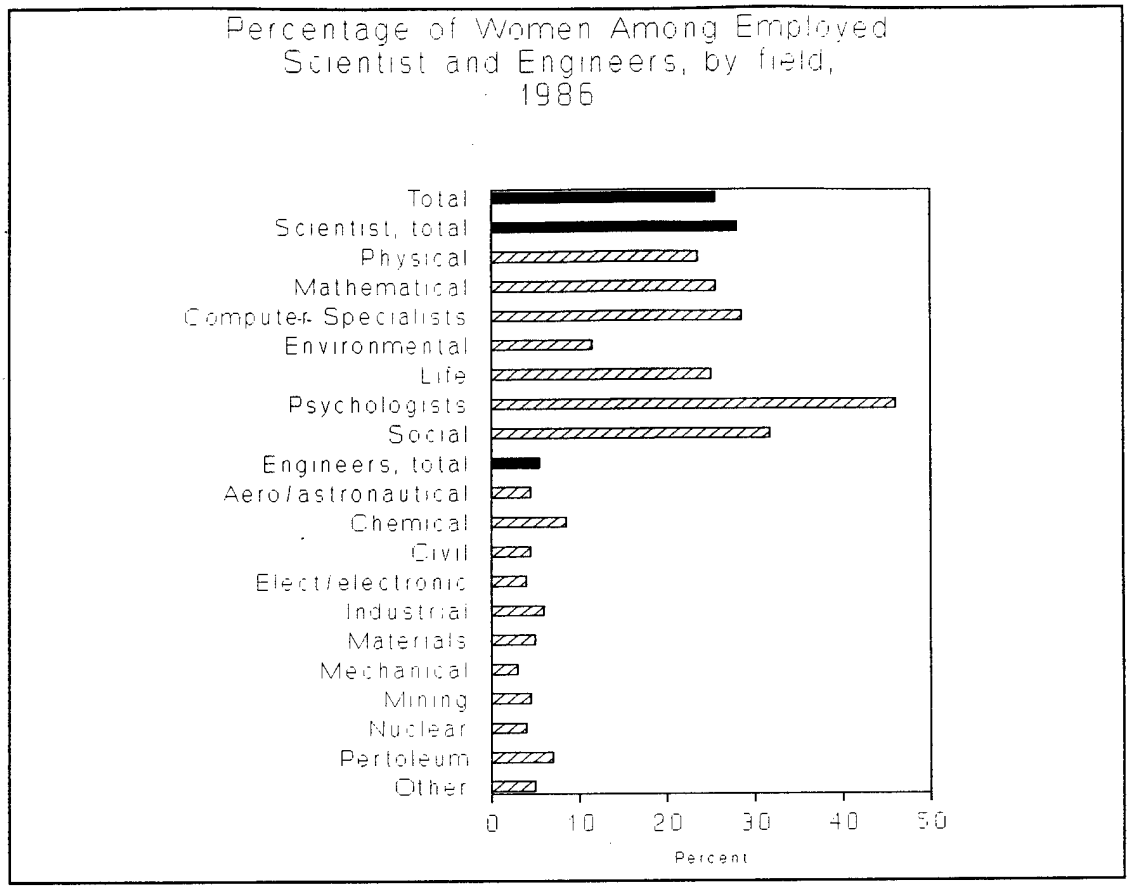

Mathematics is an interesting field and we have a lot of good data on this topic (Graphic #9). Dr. E. E. David wrote an influential report on mathematics and graphic #9 shows data from that report. This view graph shows what has happened to the U.S. males in mathematics. It shows that they are not going into mathematics the way they used to; specifically they have declined in Ph.D. awards over this period by a factor of two. The Ph.D. awards have been taken up to some degree by foreign nationals, but the women are right in there percentage-wise. Women seem to hold their own, but they are not increasing in great numbers, either. Anecdotally it is also said that women tend to get their Ph.D. degree from less prestigious universities than men.

**GRAPHIC #10**




In the next view graph (Graphic #10), we see that the foreigners take up the slack. In every field, physical science, mathematics, and engineering from year 1965 to almost the present, we see a rough doubling of foreigners in these various fields. Engineering has the largest percent increase in foreign nationals and the physical sciences also have a very large increase, because the demand increase has exceeded the supply.

**GRAPHIC #11**




Now looking at graphic #11 we see that we have lots of women in science and engineering, especially in science (over 25%). Whenever our students tell us there aren't any women in science, we can point to this view graph (Graphic #11) - and show that they are there. In engineering there are a very few, but these numbers will increase because this view graph shows all the women in a given field. Right now women engineers are young, not all, but most of them are young, so the average age will ten to increase over time.

The probability that women go on for advanced degrees is rather limited in almost every field. You can see a decrease in the participation of women as we go from B.S to M.S. to Ph.D. (Graphic #12). So for science as a whole, women are awarded an average 45 percent of the baccalaureate degrees, to 40 percent at the M.S. level, and then to 30 percent at the doctorate level. Similar data are found in graphic #12 for individual fields, though some of the changes are larger than others. In those fields where there are lots of women, like biology, the differences between degree levels are smaller, and in mathematics they are large. In engineering when the difference between degree levels has been normalized for the phase lag in time between male and female cohorts, women who have entered engineering in recent times don't drop off relative to men quite so much as in the sciences.

**GRAPHIC #12**

**TABLE 4: Science and Engineering Degrees Granted to Women, by Degree Level, 1986**

| SCIENCE AND ENGINEERING FIELD | S/E baccalaureates [1] | | S/E master's degrees [1] | | S/E doctorate [2] | |
|---|---|---|---|---|---|---|
| | # of Women | % of Total | # of Women | % of Total | % of Women | % of Total |
| **Total** | 121,439 | 37.7 | 18,298 | 29.9 | 4,906 | 26.1 |
| **Sciences, total** | 110,123 | 45.2 | 15,970 | 39.9 | 4,681 | 30.4 |
| Physical [3] | 6,698 | 28.1 | 1,352 | 23.3 | 605 | 16.4 |
| Mathematical | 7,036 | 46.1 | 1,011 | 35.0 | 121 | 16.6 |
| Computer | 14,431 | 36.9 | 2,037 | 28.7 | 49 | 12.3 |
| Life | 25,149 | 43.5 | 3,491 | 39.9 | 1,448 | 30.2 |
| Psychology | 27,422 | 68.2 | 5,417 | 63.9 | 1,564 | 50.9 |
| Social | 29,387 | 43.5 | 2,662 | 37.8 | 894 | 32.5 |
| **Engineering, total** | 11,316 | 4.5 | 2,328 | 11.0 | 225 | 6.7 |
| Aeronautical/ astronautical | 241 | 8.4 | 31 | 5.1 | 1 | .08 |
| Chemical | 1,875 | 26.0 | 268 | 17.3 | 53 | 11.1 |
| Civil | 1,233 | 13.4 | 337 | 10.6 | 19 | 4.9 |
| Electrical | 2,422 | 11.1 | 434 | 8.4 | 33 | 4.7 |
| Industrial | 1,167 | 29.1 | 227 | 15.5 | 14 | 13.9 |
| Mechanical | 1,754 | 10.4 | 205 | 6.7 | 14 | 3.2 |
| Other | 2,553 | 16.4 | 741 | 12.5 | 91 | 7.9 |

1: 1985 2: 1986 3: Includes environmental sciences.

SOURCE: National Science Board, Science Indicators--1987, Washington, D.C.: U.S. Government Printing Office, 1987.

Graphic #13 shows some interesting data. The previous view graph showed that in the physical sciences, 26 percent of the Ph.D.'s were awarded to women in 1986. Interestingly 27 percent of the Assistant Professors are women, and 27 percent of Post Doctoral appointments are women. These data are very hopeful. I find an encouraging note in these data that tell us that, while discrimination was very common two decades ago, the numbers in Fig. 13 however don't support significant discrimatory practices today. When women get their degrees they get appointed to jobs in their fields and on average they do good jobs in those appointments. The figure also shows that women get Post Doctoral appointments and they get faculty positions. In the last decade the greatest increase in employment of women scientists and engineers has been in industry not academia.

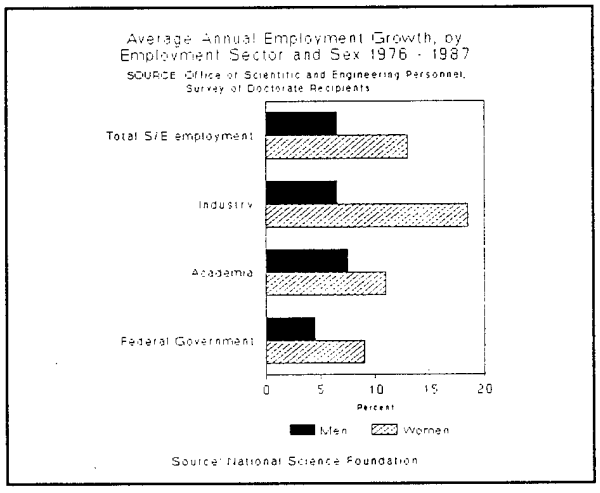
**GRAPHIC #13**

**Academic Ranks of All U.S. Doctorate Recipients in Science and Engineering, 1987**

| Academic Rank | Total | Male # | % | Female # | % |
|---|---|---|---|---|---|
| Total | 210,581 | 175,340 | 83.3 | 35,241 | 16.7 |
| Faculty,Total | 190,955 | 160,039 | 83.8 | 30,916 | 16.2 |
| Professor | 85,558 | 79,259 | 92.6 | 6,299 | 7.4 |
| Asso. Professor | 50,539 | 41,787 | 82.7 | 8,752 | 17.3 |
| Asst. Professor | 36,708 | 26,630 | 72.5 | 10,078 | 27.5 |
| Instructor | 2,385 | 1,395 | 58.5 | 990 | 41.5 |
| Lecturer | 2,080 | 1,149 | 55.2 | 931 | 44.8 |
| Adjunct Faculty | 2,604 | 1,626 | 62.4 | 978 | 37.6 |
| Other Faculty | 11,081 | 8,193 | 46.9 | 2,888 | 26.1 |
| Postdoctoral Appoint. | 9,554 | 9,554 | 72.2 | 2,612 | 27.3 |
| Does Not Apply | 4,196 | 3,091 | 72.1 | 1,105 | 26.3 |
| No Report | 5,876 | 5,876 | 89.7 | 608 | 10.3 |

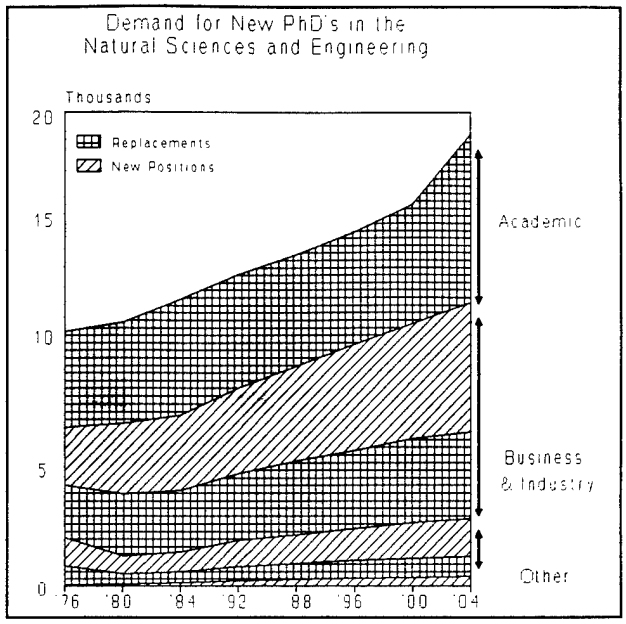
SOURCE: Office of Scientific and Engineering Personnel, Survey of Doctorate Recipients

**GRAPHIC #14**




Graphic #14 shows the increase over time of women in different fields of science and engineering, and in the different sectors. Graphic #14 shows data for industries, with the largest percentage increases of women.

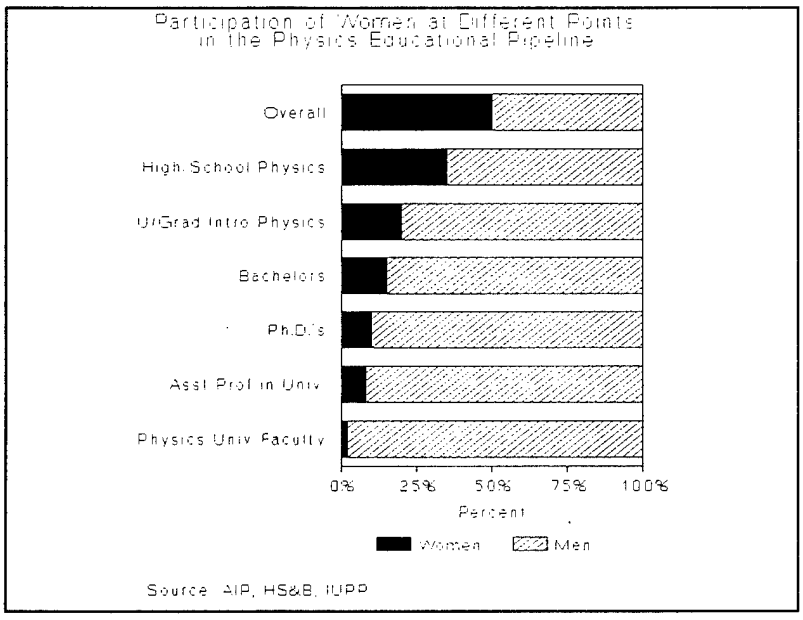
**GRAPHIC #15**




The next view graph (graphic #15) is interesting because it shows why the job market is as poor as it now is from a long term perspective. As many of us know, the job market for people getting their Ph.D's now is very poor. Here we have a conference that tries to increase the numbers entering the pipeline. It turns out from this view graph that we're providing enough students into the pipeline right now relative to the available jobs. This picture for Ph.D. demand was generated a few years ago before they knew anything about the end of the Cold War or about the recession, and it shows a declining need when you add up all of these different sectors. But here in 1995 (Graphic #15) the need for Ph.D.'s starts picking up. Then the need goes up beyond that, and this increase after 1995 has to do with anticipated retirements in academia and industry. So even though the job market isn't so good right now, we have to look out there into the future.

Many young people are discouraged because the jobs are not there; the funding for research isn't there; and this is not a good scene for encouraging the widening of the pipeline. If the government were really interested in increasing the number of women in science, or anybody in science, for that matter, it would take steps to turn things around by improving the prospects of careers in science and engineering. The government seems to be doing absolutely the wrong thing to enhance the number of new scientists and engineers.

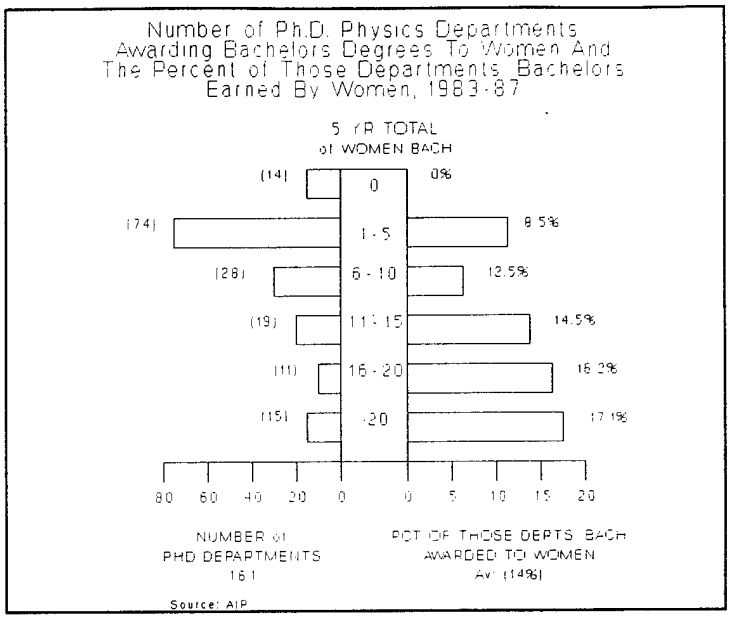
**GRAPHIC # 16**




Now let us look at this graph (Graphic #16). It shows something about why women are not out there in science. I think that there is probably a similar picture for mathematics, but I happen to have here the statistics for physics. We see here that 50 percent of the high school students are female and 50 percent are male, and that is not a great surprise. But, of those who study physics in high school, 65 percent are male and 35 percent are female. Although that may not seem to be a great difference, in order to go on to engineering school or to study science further, one pretty much needs to have some high school physics. The fact that high school girls are not going into physics is something that we have

to work on. Luckily, there are various people at this conference who are seriously addressing this issue. Graphic #16 shows that we have another big dropout for undergraduate women enrolling in introductory physics, where the female representation is at about the 20 percent level. At every level we see further percentage decreases for women. The number of majors pursuing physics to the bachelor's degree is 15 percent and Ph.D.'s eight percent. Women going into careers get less and less as you go down the pipeline. Clearly some work has to be done to improve this situation. If one doesn't have the training, one can't get into the professions.

**GRAPHIC #17**



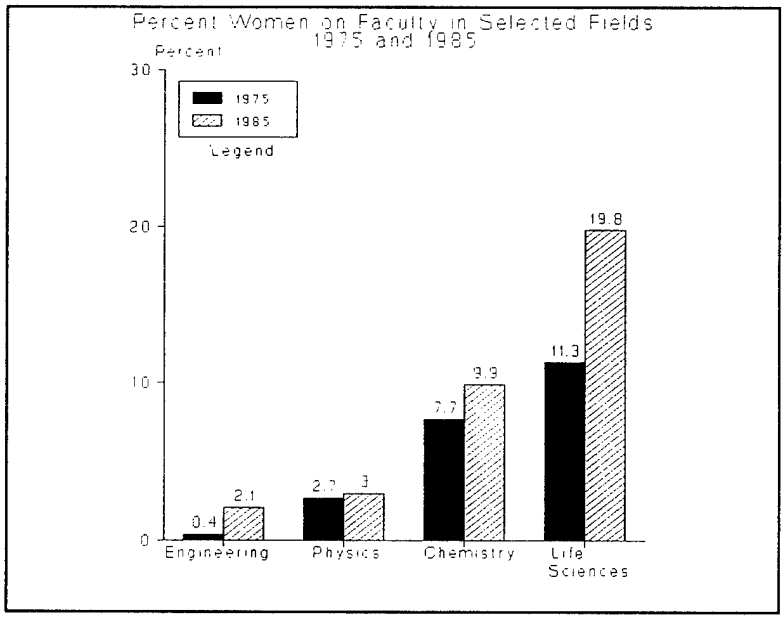

The next view graphs are the most important view graphs I am showing, because they give information on the nonlinearity of our United States educational system. Let me explain what the next view graph (Graphic #17) shows. Of the 161 physics research universities in the U.S., the right hand side of Graphic #17 tells the percentage of undergraduates in a class that is female. The national average of women undergraduates getting bachelor degrees in physics is 14 percent, but how is this 14 percent achieved? The view graph shows that most of the departments, that is, only forty-five out of a hundred and sixty (roughly 25 percent) are doing average or better. This tells you that most departments or 75 percent of the physics departments are doing worse than average. Fourteen have no women bachelor's degree recipients in physics, and roughly half of the schools have 8.5 percent or fewer women B.S. recipients. So we have a lot of schools here that are well below average. If we wanted to double the number of women in physics, we could work on some of these schools that are doing well and get them up to critical mass (15 percent) and we will have increased the pipeline dramatically. The other thing that we have to look at is the upper region of the chart, where there are fifteen schools that have over 17 percent women students and some of these have up to perhaps 50 percent. So there is a large distribution in performance here. We need to look at these "good" schools and ask, "What they are doing that help women to succeed in studying physics?" The magic number, in my opinion, to affect student's performance is 15 percent. If you get above 15 percent, you have more than two women students in an average class, so they can talk to one another, and they will ask questions in class so that the quality of education goes up by a lot. On this basis you can see that only a very few schools of the total are in the critical mass group. So we have a lot of work to do to get the other schools up there, and I believe that this can for the most part be done during the 1990's.

In Graphic #18 we see something about Ph.D. production, and that is why Nina Kay invited me to this conference. When she invited me, I said, "Okay, sure I'll come." My willingness to come has to do with this picture (graphic #18). Look at how many law degrees go to women, fourteen thousand; M.D.'s, five thousand; physics, one hundred; mathematics, one hundred; engineering, two hundred. Now Betty Vetter has given us a more dated picture of these data, but the message in these data is clear. We are talking about very small number of women Ph.D.'s in science and engineering. When somebody like me comes to give a talk such as this one, there is a good probability that we can increase this number by one. One person represents 1 percent on this picture for physics and mathematics. Maybe that is amazing to you, but that is where we are right now with women in the sciences. A few percent will make a difference, because if we can ever get over the 15 percent critical mass figure, (I'll tell you later about our experience at MIT), the whole situation changes.

**GRAPHIC #18**

| Number of Women Receiving Degrees in Selected Disciplines, 1985 | |
|---|---|
| **Physics Ph.D.'s** | 97 |
| **Mathematics Ph.D.'s** | 106 |
| **Engineering Ph.D.'s** | 198 |
| **M.D.'s** | 4,874 |
| **L.L.B.'s** | 14,421 |
| Source: U.S. Dept. of Educ. & N.A.S. | |

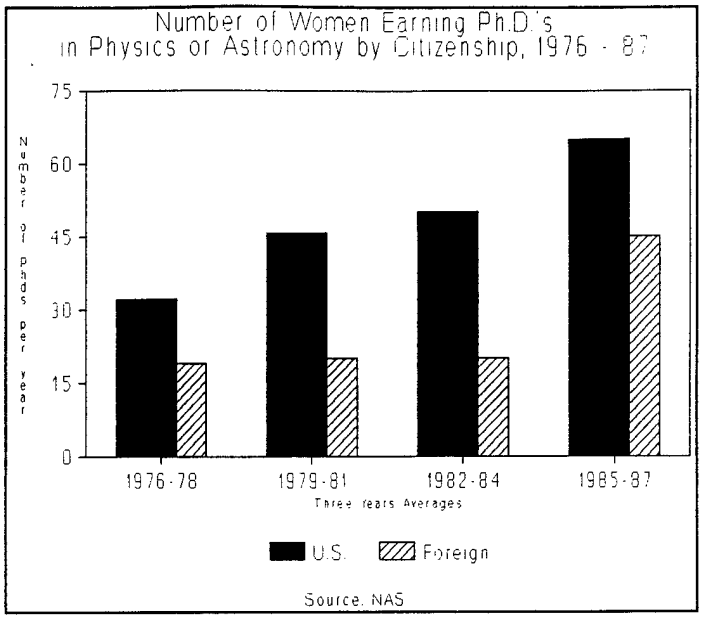
**GRAPHIC #19**




Now let us look at the relation between Ph.D. production and faculty hires. There are some fields like engineering where, when women Ph.D.'s are produced, the faculties hire them. Over the ten year period indicated, 1975 to 1985 (Graphic #19), the women engineering faculty increased by a factor of five. This roughly mirrors the Ph.D. production for women, or perhaps exceeds it. So the engineering schools have made an effort to recruit women faculty members. In other fields where there has been a significant increase in women Ph.D. production, there has been almost no change over this decade in the faculty ranks. Chemistry is one where we have seen big changes in Ph.D. production, but very little change in the faculty ranks. In biology the rate roughly mirrors the increase in Ph.D.'s. So graphic #19 shows that the faculty hiring of women does not always mirror the Ph.D. production in a given field.

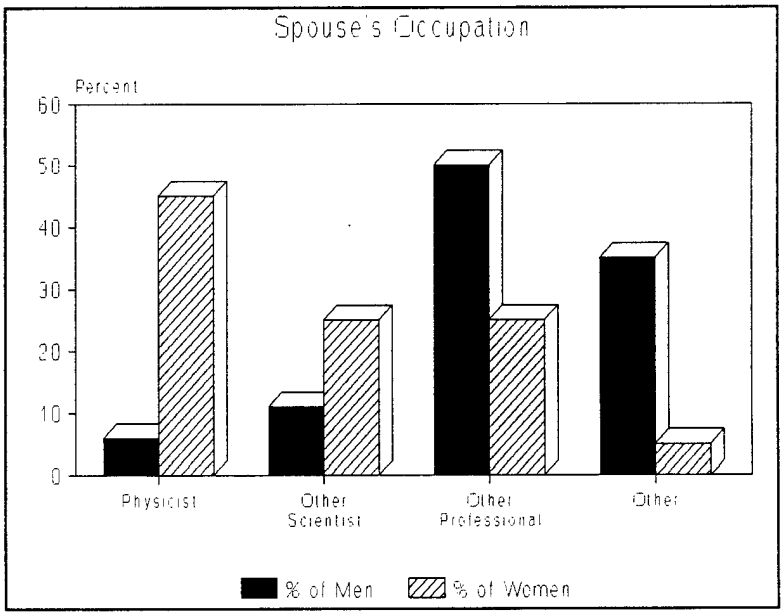
**GRAPHIC #20**

The increase in recent years of women Ph.D.'s in physics has been due to a very significant increase in foreign women (Graphic #20). The numbers today show, at least my perception of what I see in the classes that I teach, is that the number of women is increasing, but that many of these are foreign women. Maybe the reason is that women have pretty good opportunities in the U.S. relative to other countries, so they come here to study and to make their careers. This is of course good for U.S. science and technology.



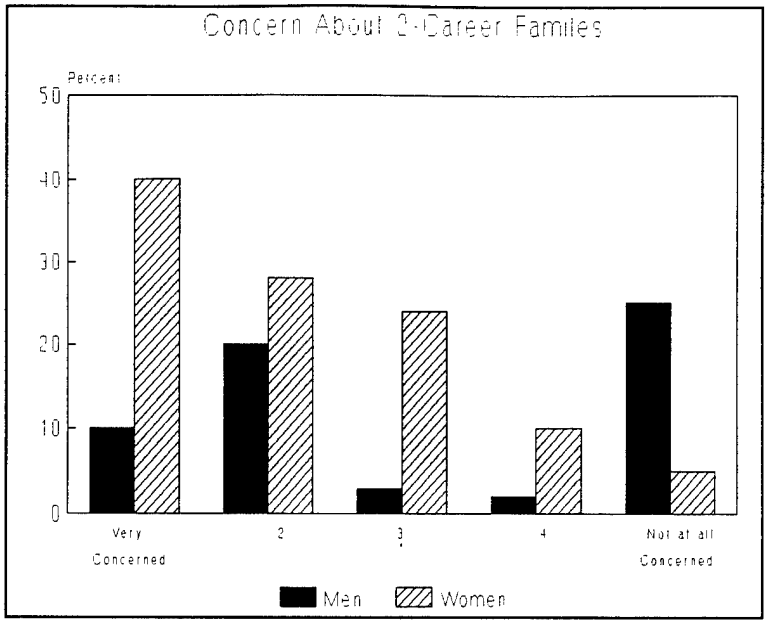

**GRAPHIC #21**

I have some other things that I now want to discuss. This has to do with combining career and family. Women and men are very, very different in dual careers. Among women physicists, for who I have data (Graphic #21), almost 50 percent are married to men physicists. It is very, very interesting that there is a factor of seven to one difference relative to the complex conjugate situation of men physicists married to women physicists. But, these data tell you that a woman in physics tends to be very devoted to her career and she doesn't spend much time anywhere else.



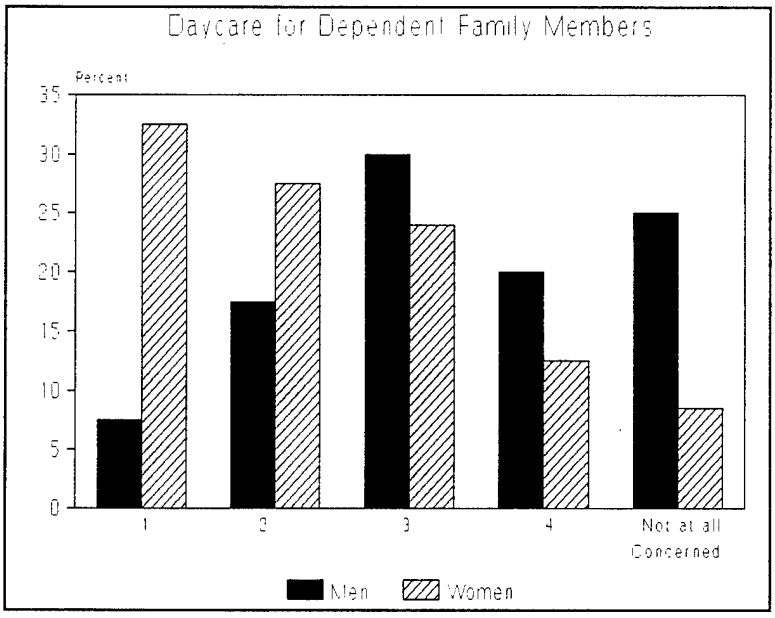

Most of the people that she sees are other physicists and that is one explanation for these data. Besides the 45 percent who are married to physicists, another 25 percent are married to other scientists, 25 percent to other professionals, and only five percent are married to others who are not in any of these categories.

**GRAPHIC #22**



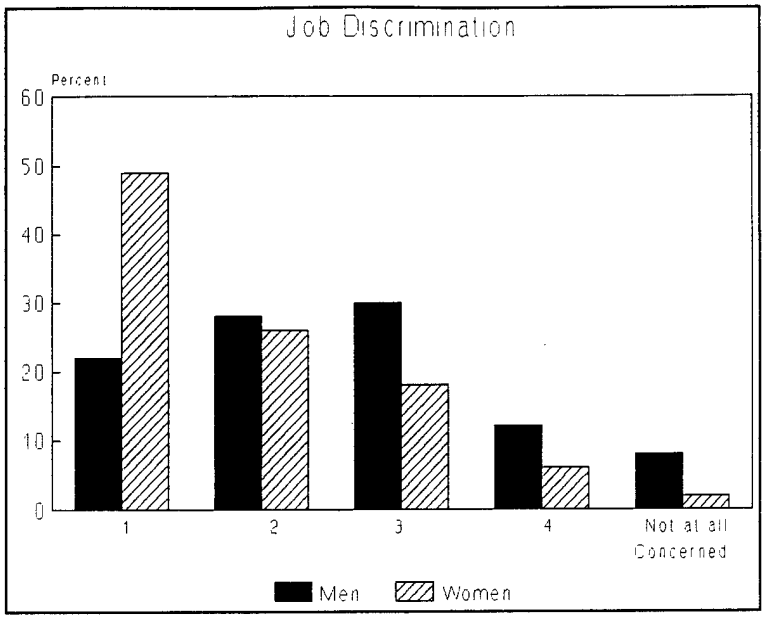

The next view graph (Graphic #22) shows women's concern about two career families, and again, the concerns of women and men differ by about a factor of seven to one.

**GRAPHIC #23**




Women are very much concerned about two career families. Men on the average show more concern if they are young. Women are very much more concerned about the availability of reliable and quality day care as graphic #23 illustrates.

**GRAPHIC #24**




As for job discrimination (Graphic #24), women are again more concerned than men by more than a factor of two. These findings are likely relevant to some degree in other science and engineering fields.

I now will make a few remarks on how I got into science. I could say that I got into science through the violin. In reading Simon Ramo's autobiography I learned that he also got into science and engineering through the violin, so I have some good company. I grew up in New York City of immigrant parents on the wrong side of the railroad tracks. I didn't know people who had gone to college. With regard to the violin, I was a scholarship student. My brother was a child prodigy on the violin and it was through his talent that I became a scholarship student. I retained that violin scholarship through my youth and I still play the violin a lot today. The violin has been a nice avocation for me. But, through the violin scholarship I found out about people who go to college. I decided through the people I met at music school that people with college degrees had a better lifestyle than the people that I saw around in my neighborhood, so I decided that I wanted to go to college, too.

The kinds of careers available were in education, as a secretary, or a nurse. Nursing and secretarial work didn't exactly fit me, so I decided to become a school teacher. I found out when I went to Hunter High School that mathematics and science courses were very important to me personally. Having gone to Hunter High I already had about two years of college work behind me. For a degree from Hunter College, one had to take a long list of required courses. But I already knew quite a bit about many of these courses, so I was able to do many of the required courses without much work, using a time sharing mode, which I developed for myself at that time. The rest of the time, my good time, I could spend doing science for fun.

Through doing science for fun I met, early on, Rosalyn Yalow. (Who shared the Nobel Prize for Physiology and Medicine for her contribution to radioimmunoassay (RIA) in 1977.) She has a complex conjugate story to tell of how she met me when I was a young student, and how she told me that I belonged in science. If Rosalyn Yalow tells you something, you do it. She is an authority figure, and she told me that I was going into science, so I did. After a couple of years at Hunter College I made this transition. Since I had a good background from Hunter High experience, I was able to basically complete three majors through my time sharing mode, which I still like to pursue. And so it was that I did physics, mathematics, and chemistry majors as an undergraduate, though my chemistry major was somewhat incomplete. But I didn't really know what I was gong to do when I finished my undergraduate work. In fact, I applied to graduate school in mathematics and I was ready to become a mathematician, since that is what I thought I really wanted to do. Then one day I saw on a bulletin board someplace an ad for a Fulbright Scholarship, the first or second year of that program. I applied for the Fulbright Fellowship on a lark, and was selected. My scholarship was in physics, and so I became a physicist. During my Fulbright Fellowship, I studied at the Cavendish laboratory in Cambridge, England, which was a kind of mecca for physics in the 1930's and 1940's.

After my Fulbright Fellowship was over, I eventually went to the University of Chicago, at the time when it was a top university in physics worldwide, partly because it was the place where Enrico Fermi was located. As a student, I became very well acquainted with Enrico Fermi, who gave me special attention and guidance, and mentorship. He had a daughter who was six weeks younger than I, which means that we were essentially the same age. She was in art, and I was in science. I thus became his science daughter, so to speak. Well, I got a Ph.D., not in the traditional field of high energy physics, which I might have done, and probably would have done except that I didn't like the life style of the high energy physicist - the large groups and the suitcase science. I went into a new area that was unknown and unheralded at the time. It was solid state physics. There were no solid state courses at that time because it wasn't a field yet. But, by the time I completed my Ph.D. all of a sudden we had "Sputnik," and there was a great need for people in this field. I was right there with a Ph.D. So being a woman didn't hurt me. As a graduate student I had discovered some new phenomena in superconductivity, and so I was already known in the field when I completed my degree.

***"Nobody makes it on their own and each of us had to accept help from mentors, from collaborators, and from all kinds of people. Many people contribute to the careers of each of us."***

After two years of postdoctorate study at Cornell, I wound up with a job at MIT in 1960 and I have been there ever since. I didn't move around because in the meantime I had gathered a husband and four children and a family of that size represents a large inertia against moving. My children were all talented, especially in the field of music. They were in an excellent music education program in Boston and we became tied to that program. Thus I made my whole career around the MIT campus. It has been a real pleasure and privilege to work with such gifted students as I have had. My first seven years at MIT were on the research staff at the MIT Lincoln Laboratory while my children were young. My youngest child was three years old when I became a full professor in the Electrical Engineering Department, so I never went through the tenure process. I feel that I have had a lot of excitement in my life.

What does it take to be successful in science and engineering? The question is really what it takes to achieve satisfaction from the standpoint of the individual. Here are a few thoughts on the subject. Determination may be the top one. Don't stray from your path. Everybody is going to tell you that you can't do this, or you can't do that. I always tell my students that they can do it, too. I tell them to "go for it." Probably the most important single thing that I have contributed to the education process of women students in science and engineering is to give them the message that "they can do it, too." Determination is an important ingredient for success.

The second ingredient is flexibility, because life always turns out very differently from what we expect. To be successful, one has to be able to shift around and take advantage of opportunities when they present themselves. One never knows when an opportunity is going to come. In many cases a person has only one good shot. When the opportunity comes, either we take advantage of it or the opportunity disappears. Well, that is more or less the way it used to be for women in science, and maybe it still is the same even now. When the opportunities present themselves, it is important to recognize the opportunity and to take advantage of the opportunity.

I also give a good deal of importance to vision and direction. We each have to have some sense of where we are heading. What are the priorities, what's important to each of us in this world, and are there some things that are more important than others? I find as an educator, that the need to set priorities is one of the most difficult things to teach. We have at MIT so many really gifted students but many have little idea of what their main goal is, what's most important to them. Many students spend a lot of their time on details that won't matter tomorrow. So vision and direction are important.

The next ingredient for success is to be able to accept help. Nobody makes it on their own and each of us had to accept help from mentors, from collaborators, and from all kinds of people. Many people

contribute to the careers of each of us. In my career many people helped, especially my husband who was behind me through thick and thin. It is important to have people who work with you. By the same token, not only does one have to accept help, but one has to give help. When I was an undergraduate, perhaps the most important thing that I learned at Hunter College was the importance of giving help. I'll tell you this story and maybe you'll remember it. The cost of a Hunter College education was five dollars a semester, which included tuition, books, and laboratory fees. The whole bit was only five dollars a semester. And we were told, and I heard this story many times, so I can remember it well: "You are getting all of these freebies from society and it is expected that some day you will return something of value to society." I would say that Hunter graduates have, on average, returned a lot and the $5/semester was a good investment. To give help is as important to the giver as to the receiver.

These are some of the things that I think are important in making a successful career. I believe for the various reasons which were amplified by the view graphs that this is a time of opportunity for women in science, and a time of opportunity for everybody in science. Never before has science been so interesting and challenging. The various databases indicate that there will be a manpower shortage in science and engineering toward the end of this decade. We are now importing a lot of talent so that there is more opportunity for our own people than they are themselves utilizing. One can analyze and explain the reasons why our people aren't going into science and engineering. I think that we understand a lot about this issue. There are lots of people out there who give lip service to increasing the numbers of women in science and engineering. Many have good intentions, but these good intentions are not always implemented. Women still have to remind their mentors about unfulfilled intentions.

***"I think that there is absolutely no trouble for the U.S. to reach whatever level of science and engineering manpower we would like to have. We did it at the time of World War II, and we did it at the time of Sputnik."***

I would now like to comment on role models. We have to look at the role model institutions in our own country and the role model institutions around the world to see what it is that they are doing that other less successful institutions can emulate. Linda Dix said, "Talk about MIT because you know that best." I don't plan to say that MIT is the best, because there may be other places that are even better. MIT has, however, done pretty well. When I joined the faculty, we had four percent women students at MIT, and there were few of them who were doing very well academically or personally. Most of them were just hanging on by the skin of their teeth. Many of them were dropping out and not completing their degrees. The retention rate was low.

Today, we have between 35 and 40 percent women undergraduates doing science and engineering. That's one order of magnitude increase in the participation of women. I didn't expect when I joined the faculty, that MIT would ever go beyond 20 percent. That was sort of my lifetime dream, and we have now exceeded that by nearly a factor of two. I think that any gains in numbers from here on will be small, because we are already doing so well. There are a lot of things that have contributed to this success. The equal admissions policy increased the intake of women students by a factor of between two and three. Getting above critical mass (15 percent women students in each academic department) has been very, very important. I discussed on many occasions the importance for a woman to have at least one other woman in her class so that she feels free to ask questions and participate fully in class. This has now happened at MIT and the academic performance of our women on average is now equal to or exceeds that of men in every single academic department. Even in some of these male bastions such as physics and electrical engineering, the women are now showing equal academic performance.

In graduate programs the percentage of women students (20 percent) is somewhat less impressive. The numbers are however steadily increasing and I think in due course they will approach those for the undergraduates. But it will take a longer time for this to happen for various reasons that we could discuss, were there time to do so. The percentage of women graduate students varies from department to department and there are even some departments in the engineering schools where the percentage of

women is close to 50 percent, such as material science and engineering. It is quite surprising that we have made so much progress to date. Once women are above critical mass the career patterns of women become more similar to those of men.

To give you another example of progress in my field, I go to meetings of the Materials Research Society (MRS) every year, and I see women in the audience. In the past they were usually silent. The MRS meetings are usually in a large lecture hall with perhaps a thousand people in attendance. Nowadays, I frequently hear a female voice ask a question. I am always pleased when the voice is from a woman student that I taught ten years ago. Such an experience makes me feel very, very good. In my own department, electrical engineering, we now have a hundred and thirty women graduate students. I think that's an impressive number. During the last three years we have been turning out about ten women Ph.D.'s per year. Now let me give you some context for what that means. During the first one hundred years of electrical engineering at MIT (prior to 1974), the department graduated less than 10 women Ph.D.'s. Now we do so in a single year!

I think that there is absolutely no trouble for the U.S. to reach whatever level of science and engineering manpower we would like to have. We did it at the time of World War II, and we did it at the time of Sputnik. If we did some of the same things at present as we did then, we could greatly increase the available scientific and engineering manpower. What we would need to do is to widen the pipeline at the entry level, and later at the professional level. At the entry level we need to have some kind of national campaign that convincingly makes the point that the study of science and engineering is important.

At the time of Sputnik the U.S. had a big national campaign in science and technology that attracted lots of youngsters. We increased our pipeline flow almost overnight by a factor of two because it was perceived that the nation needed people in science and engineering. Nobody is that serious now. We just have low level lip service, which is enough for women and minorities to get into the field, but there is no serious campaign beyond that. Beside the psychological campaign that science and engineering are important, I think that we need some scholarship help to implement a serious program. Scholarship help would go a long way to widen the pipeline, first at the undergraduate level, and then later at the graduate level. We need to do something to make science and engineering careers appear equally or more attractive than other careers.

Betty Vetter tells me that the smartest young people in the high schools, by any indicator that you might choose, are not now going into science and engineering in the same numbers that they used to. The reason for this change relates to national priorities and incentives. For the professionals in science and engineering, we have to make the careers more attractive in terms of pay, rewards, and public perception. It is important to match the expectations with reality. We raise our young people in science and engineering to believe that they are gong to have research careers. We take them through the graduate programs, through the Ph.D. degree and through a postdoc. And then they find out that there is little money to support their research. We do not now have a good match between good career opportunities and the campaign to widen the pipeline of students in science and engineering. I think that most people in the various fields of science and engineering feel that the present funding levels for research are a factor of two less than the expectations. We have never had more money in science and engineering than we have right now, so why are we complaining so much? The reason is that as people are retiring, they are being replaced by young people, and the expectations of the young people are very different from the expectations of the people that they are replacing. If we want our faculty members in every small university to focus on world class research, instead of undergraduate education, we simply don't have the research funds. We have to make up our minds, about whether we are going to continue this myth about research careers and match the expectations with reality.

I think that my goals for women in science and engineering at MIT have been met and surpassed by a substantial margin. I never thought that in my lifetime we could get to the present percentages of women students and that women would achieve their present level of success in academic performance. On the national scene, women are not on average doing as well by a fair margin. I think that in the next decade, if we watch those programs that are successful, figure out what they are doing that clicks, and try to translate their success into other locations, we should be able to double the national numbers of women in engineering and in some of the other underrepresented fields. I think this is a realistic goal and I don't think it will cost a lot of money. We didn't put a lot of money into the MIT program to make it a success. It happened because of desire, commitment, and personal effect. This success can be replicated elsewhere.

# PREPARING FEMALE STUDENTS FOR TECHNICAL CAREERS: Dealing With Our Own Elitist Biases

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Educators concerned with gender equity in the United States have been addressing the underrepresentation of women in mathematics and science careers for about a generation. Their success in calling attention to the problem is reflected in the recent abundance of books and articles on the underrepresentation of women in professional positions in math, science, engineering, and technology by such mainstream organizations as the National Science Foundation, the congressional Office of Technology Assessment, and the National Academy of Science. The impact is beginning to be reflected as well in the attention being paid by research universities and technical employers, although the concern of this sector may relate less to the equity issue and more to the need to compensate for the changing demographics that predict a decreasing supply of white males for advanced education and the technical work force.

## THE MYTH ABOUT TECHNOLOGICAL CAREERS

Despite all this attention, an examination of the recent literature and conference presentations about women in math and science careers reveals a curious assumption: that at least a bachelor's degree (and preferably a doctorate) is necessary for a career in math or science. There are many examples of this assumption. In a report by the National Science Foundation (NSF), *Women and Minorities in Science and Engineering* (1986), the chapter on eduction and training of women covers "precollege preparation" through "postdoctoral appointments." A major American conference held in July, 1987, on women in science and engineering, described itself as "a national conference on barriers and solutions in science and engineering for women from the precollege to the professional level." A review of the papers presented at that conference indicates that almost all were written by people affiliated with colleges and universities. And, not surprisingly, the focus of almost all the discussion of "the precollege" population was on the college-bound student. A report by the Office of Technology Assessment (1985) on demographic trends presents detailed supply and demand projections for science personnel; but it considers only persons with advanced degrees.

*"The prevailing notion that math and science are only for the best and the brightest results in serious consequences."*

The terms used in discussing this issue are a clue that an assumption exists: the term "precollege education," for example, implies that the function of elementary and secondary school, even the most rigorous, is to be a precursor to college education. The goal is clearly a college degree. Lucy Sells' (1973) excellent description of mathematics study as a "critical filter" suggests a mechanism which blocks the progress of many at the high school level and permits the progress of only a few to post-secondary attainments in quantitative fields.

Perhaps the most revealing phrase is the math and science "pipeline," a frequently heard metaphor to describe persistence in these fields. The pipeline concept communicates the gradual reduction in the number of potential Ph.D.'s, starting with the number of students interested in these subjects in elementary or secondary school and tracking the losses through subsequent levels of education. The pipeline in Figure 1 (The Task Force on Women, Minorities, and the Handicapped in Science and Technology, 1988) reflects the attrition of 1977 high school sophomores at key points in their subsequent education, culminating in the few who were expected to attain the Ph.D. in 1992 in science and engineering.

The pipeline metaphor implies that those who don't make it to the Ph.D. goal line are dropouts. It fails to recognize the legitimacy of quantitative study for those not seeking a Ph.D. It also fails to recognize that such study has a value worthy of the support of the educational community and does not simply reflect a failure to persist.

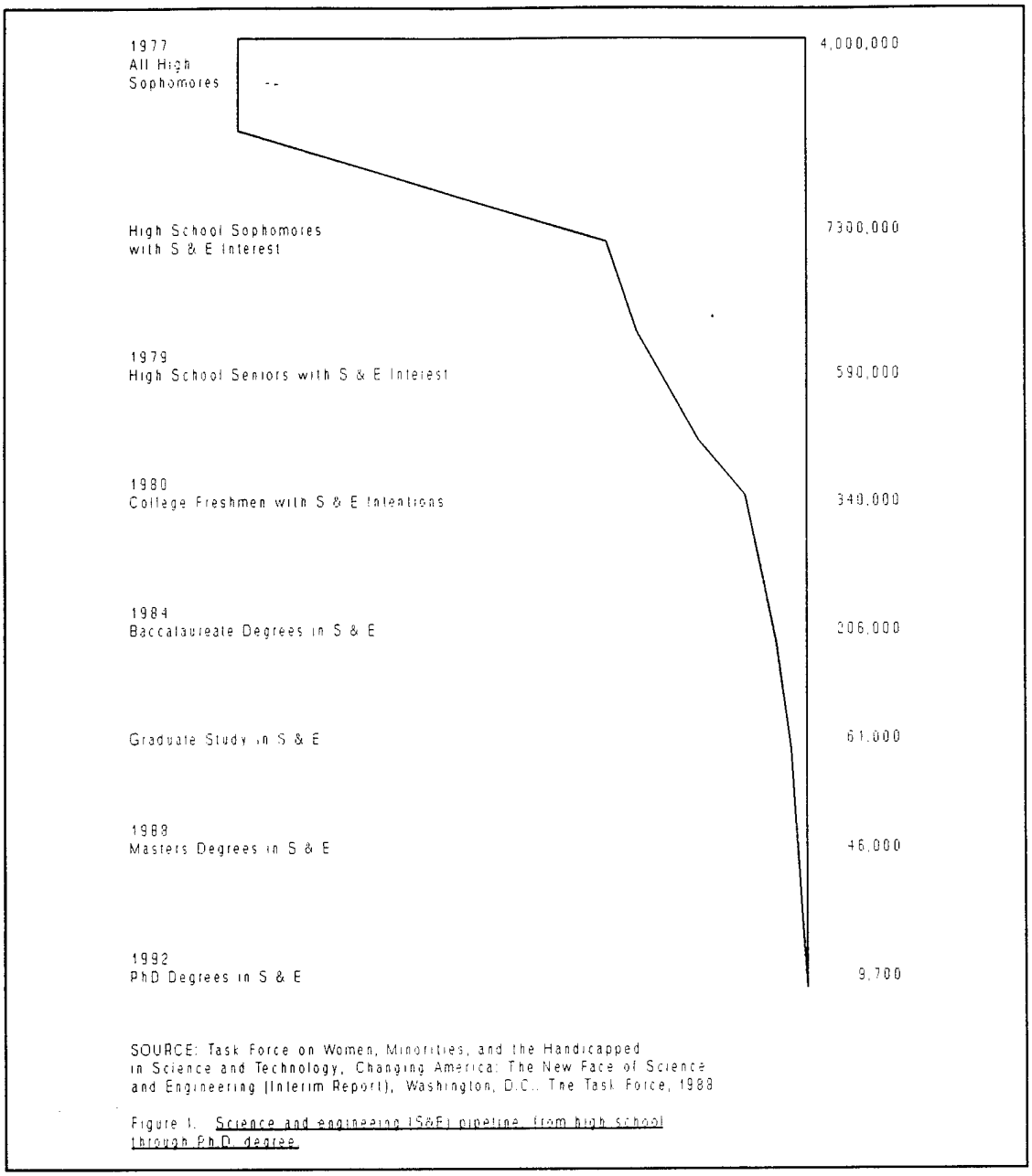
The prevailing notion that math and science are only for the best and the brightest results in serious consequences. All too many students come to believe that if they are not Nobel Prize material it is pointless to continue in math and science. The progressive weeding out of students as soon as math and science become elective in high school is seen as fitting, and educators often support the idea that students who are not planning to major in math or science in college don't "need" to take more than the one or two required years of study. This does not happen in our English departments, where four years of English are required, and teachers are expected to cultivate, not weed.

## DISPELLING THE MYTH

The notion that a career can be characterized as math or science only if it requires an advanced degree is unsupportable. Technicians have careers that can be accurately characterized as math and science

careers. There are some technician fields for which one qualifies with just a high school diploma while others require a one-year post-secondary certificate and still more are available to people with a two-year associate's degree from a community college or technical institute. The limitation of math and science careers to college graduates does not correspond to the real world.

**FIGURE 1**




SOURCE: Task Force on Women, Minorities, and the Handicapped in Science and Technology, Changing America: The New Face of Science and Engineering (Interim Report), Washington, D.C., The Task Force, 1988

Figure 1. Science and engineering (S&E) pipeline, from high school through Ph.D. degree.

A common, but mistaken, impression is that upper-level math/science jobs are far more numerous than technician-level math/science jobs. When asked to estimate the ratio, frequent responses are three to one, or even four to one. In fact, math and science technicians actually outnumber the professional

mathematicians, scientists and engineers. As Table 1 shows, in 1987, the total number of people employed as professionals was somewhat more than 2.5 million compared to almost 3.5 million technicians (U.S. Department of Labor, 1987).

As surprising as the extent of technician-level jobs in the American economy are the salaries in these fields as indicated above. It is true that in 1987 natural scientists earned a very respectable median salary of nearly $32,000 a year. But considering that natural scientists have invested considerable amounts of money and time in advanced education to attain their $32,000, the engineering technician's salary of almost $25,000 with fewer resources invested becomes quite attractive.

Furthermore, technician occupations are projected to grow much faster than other occupational fields. As a Department of Labor official recently wrote, "The BLS [Bureau of Labor Statistics] projections show that the most rapid rate of growth is among technician jobs." Employment projections to the year 2000 indicate that under a moderate growth scenario, technician occupations will grow 32 percent, more than twice the growth of all occupations, projected at 15 percent (U.S. Department of Labor, 1989).

**TABLE 1**

| OCCUPATIONS | TOTAL EMPLOYED | MED. WKLY. EARNINGS | NO. WOMEN EMPLOYED | WOM. AS % OF TOTAL |
|---|---|---|---|---|
| Professionals | 2,626,000 | | | |
| Engineers | 1,641,000 | $720.00 | 107,000 | 7% |
| Mathematical & Computer Scientist | 648,000 | $624.00 | 222,000 | 35% |
| Natural Scientist | 357,000 | $615.00 | 86,000 | 24% |
| Technicians | 3,419,000 | | | |
| Health Technicians | 847,000 | $348.00 | 685,000 | 80% |
| Engineering Technicians | 825,000 | $467.00 | 144,000 | 18% |
| Science Technicians | 171,000 | $432.00 | 59,000 | 35% |
| Other Technicians * | 953,000 | $506.00 | 376,000 | 40% |
| Electrical/Electronic Equipment repairs | 622,000 | $514.00 | 58,000 | 9% |

* Pilots, air traffic controllers, broadcast equipment operators, computer programmers, numerical control tool programmers, legal assistants, and other technicians.

## THE EFFECTS ON WOMEN'S CAREER PREPARATION

The limited expectations for the science education of the average or non-college bound student results in a serious loss of our national technological capability as well as to the lifetime prospects for all students in this group. Our neglect of this population is particularly critical for women, however. It is easy to forget that the college-educated population is still the minority. Most women do not have college educations: only 17 percent of American women aged 25 and older in 1987 had four or more years of post-secondary education, compared with 24 percent of men. Another 17 percent of women have had one to three years of college. The reasons that the majority of women do not get college educations are many. They may lack academic preparation, they may not be academically inclined, they may not be able to afford it, and/or their responsibilities or family and educational backgrounds make college an unlikely aspiration for them. These women need to maximize their personal incomes even more than their better educated sisters, who are

much more likely to have a higher family income with which to support their families during marriage, and are more likely to receive at least some contribution toward family support if the marriage ends. Furthermore, even though the average woman's 29 years of full-time involvement in the work force is far longer than her full time involvement in child rearing, women without college educations have invested very little in the skills needed to advance in a long-term career as opposed to a short-time job.

> ***"The limited expectations for the science education of the average or non-college bound student results in a serious loss of our national technological capability as well as to the lifetime prospects for all students in this group."***

Few women are taking advantage of the rapid and dramatic growth of the technical jobs. Of the 1980 women high school graduates who had completed a vocational associate's degree as of 1984, only 10 percent had concentrated in the technical/engineering area compared to almost 50 percent of the men. Over 61 percent of the women had selected office and health programs as their fields of study (U.S. Department of Education, 1989).

These facts should be uppermost in the minds of those who are concerned with math and science careers for women: first, technician-level jobs in math, science, and technology are and will continue to be abundant, require relatively little education, and yet pay well; second, most women do not have college educations; and third, women with less education need well-paying jobs because their families are more likely to be dependent on their incomes. Encouraging women to pursue the study of math, science, and technology only if they can make it to the professional level is tantamount to consigning the majority of women to dead-end, sex-stereotyped careers, many of which provide an income below the poverty level.

The failure of equity advocates to focus significant attention and effort on the sub-professional levels of math, science, and technology careers is damaging to women in several ways.

1. Girls are less likely to aspire to technician careers because these careers are less visible to them than the alternatives, i.e., the traditionally female ones, on one hand, and the professional math and science ones, on the other.

2. High schools and post-secondary schools are content to leave the enrollment in technician-level programs largely male.

3. Since many technicians work for large companies that offer paid college and graduate tuition as a job benefit, women lose out on an opportunity to obtain low-cost academic degrees and resulting career benefits.

4. Because technician jobs pay better than most female-intensive jobs with similar educational requirements, women lose out on an opportunity to earn salaries on which they can support themselves and their families reasonably.

5. Mainstream math and science organizations are not pressured to expand their attention below the professional level.

6. Finally, the next generation of girls is deprived of an opportunity to have female role models for technician careers.

## WHY HAVE WE LAGGED IN ADDRESSING THIS ISSUE?

Given all these consequences of promoting only professional-level math, science, and technology careers for women, why do we, as educators and equity specialists, fail to broaden our scope? We can only speculate. Perhaps, since most of us have advanced degrees ourselves, we are more interested in devoting our attention to women who resemble us. On the other hand, there has been a fair amount of research and advocacy directed to women in the trades. Do we see blue-collar women as exotic, their work tasks and environments fascinatingly different from our mundane books and desks? Could it be that we are uncomfortable with technicians because we see them in status terms as inferior to professional scientists and engineers, and therefore perpetuating the traditional female subordinate position? Since the non-college bound population is increasingly diverse ethnically and racially, is it possible that we, who are mostly white and middle class, fear the charge that we have lower expectations for them than for their white sisters? And as most of the math/science intervention programs are affiliated with colleges and universities, and since many of us are similarly affiliated, is our orientation to this issue influenced somewhat by our self-interest in increasing enrollments in our own institutions?

*"Technician jobs are options that are real, challenging, and too frequently absent from school programs."*

Whatever the reason, we must devote the same degree of care, attention, scholarship, and passion to those young women who may or may not be the Nobel Prize winners of tomorrow, but who need the opportunity to work alongside them in well paying, secure, and challenging careers in mathematics, science, and technology.

## WHO ARE THE STUDENTS?

Before we consider what forms interventions might take, we need to identify the groups of women who do not enter math, science, and technology careers but who, with some attention during their high school years, could do so in far greater numbers. These women, when they were 12 or 13, believed that they would not need math beyond the required one or two years in high school. They believed that it didn't matter whether they took general or business math or algebra to fulfill this requirement.

The first group that comes immediately to mind is the young women who enter community college (or the equivalent) directly after high school. Most of the them prepare for office occupations, health careers, cosmetology, and retailing. Despite their high school diplomas, in these female job ghettoes they are likely to be at the start of a lifelong track of low pay and poor career advancement prospects. If this group, which is obviously capable of postsecondary work, were to take more math and science in high school than they do now, technical careers could be readily accessible to them.

The next most promising group is the young women who graduate from high school and go directly into employment in such occupations as cashier, supermarket clerk, file clerk, data entry work, fast food worker. With appropriate and timely intervention there are some technical careers they could enter right away; others require some advanced training, which can often be undertaken while employed.

Finally, there are the educationally disadvantaged girls, often poor, sometimes minority, many of whom drop out of school before graduation. Many of them will become single mothers at a young age, and will have to support their children alone. These are the young women who, if they have jobs, become institutional aides in nursing homes and other social service group homes, laundry workers in hospitals, waitresses, hotel housekeepers, home child care providers, and so forth. This population is so universally ignored in school that they are neglected even by those programs specifically designed to serve the disadvantaged population, which are frequently male-oriented. With encouragement and the right

preparation, many of these women could enter a variety of technical occupations.

Without mathematics intervention in school, many of these women are bound for one of the ten lowest-paid occupations in the United States. Nine of them are overwhelmingly female, as Table 2 indicates (U.S. Department of Labor, 1988).

While schools, particularly those in affluent areas, are experiencing increasing success in encouraging girls to consider nontraditional professions like medicine and law, they are failing dismally at helping non-college bound girls, and girls for whom college has to be delayed, to recognize that there are higher-paying, more challenging options for them as well.

The evidence indicates that these young women do not receive a sufficient sense of challenge from school. Their experiences in and out of school fail to convey images of exciting possibilities in adulthood through their own achievement. Some authorities suggest that teenage pregnancy is partially a response to young women's perception that the future is bleak, a satisfying job is unlikely, and poverty is seemingly inevitable. Technician jobs are options that are real, challenging, and too frequently absent from school programs.

## WHAT KINDS OF JOBS ARE THESE?

Technical jobs have excellent future employment prospects. They require math and technical skills, but not necessarily a four-year college education. Examples are: chemical technician, respiratory therapist, broadcast technician, avionics technician, shop engineer, generating plant technician, surveying technician, hazardous waste technician, and refinery operator. There are also many technical repair occupations: business machine service technician, computer service technician, electronic repairer and others. They provide options for young women who do not plan to go to college, or those for whom a technical job will make postsecondary education possible. They provide the prospect of a "good job," one of the most important factors in encouraging students to remain in high school. And the special benefit is that the academic preparation needed for a technical career can put women back on a college-bound track if and when college becomes a viable alternative in later years.

**TABLE 2**

**THE TEN LOWEST-PAID U.S. OCCUPATIONS, 1988**

| OCCUPATIONS | % FEMALE |
|---|---|
| Child care workers, private household | 99 |
| Cleaners, private household | 97 |
| Food counter clerks | 71 |
| Kitchen workers | 73 |
| Child care workers, except private households | 83 |
| Pressing machine operators | 72 |
| Cashiers | 79 |
| Sewing machine operators | 89 |
| Farm workers | 11 |
| Sales workers, apparel | 79 |

## WHAT CAN WE DO?

1. **We need to assure that all intervention activities are for everyone, not just for the gifted and talented.**

Schools have a tendency to limit their "enrichment" programs to only their best students.

The Consortium for Educational Equity at Rutgers has conducted more than 40 Futures Unlimited conferences for girls on many diverse college campuses. Schools are invited to send 7th through 12th grade female students to the conference to become exposed to math- and science-based careers and role model practitioners. We have found that the schools invariably select their best students, leaving the average ones without exposure to the careers that math and science can open to them. We even noticed this restriction to girls from above average-classes when the conference was conducted at a community college with its rich variety of technology offerings.

Intervention programs are not new. What is new is the recognition of the need to extend these special programs to girls who are average or even below average in past performance, for whom our expectations have traditionally been low.

2. **We need to increase requirements of mathematics to three or four years at the high school level.**

Many high school girls are not aware of the connection between the math courses they enroll in and their subsequent career options. In most states students are required to take only two years of math in high school. We permit 13 year olds to decide which sequence and how much math they will take. A frustrated principal recently made the comment that "removing choice during high school would preserve it after high school."

A New York City study (Syron, 1987) indicated that many girls fulfill the two-year math requirement with two years of Fundamentals of Math, a remedial course, or even with two years of Recordkeeping, a course typically offered through the Business Department.

The required sequence should include, at minimum, the skills taught in algebra and geometry classes. We should stop giving girls the message that algebra is an elective, a course you only need if you are going to college. Basic algebra is needed for virtually every entry-level technical field. Failing to take algebra in the belief that they will not be going to college becomes a self-fulfilling prophecy, creating a formidable obstacle even when college becomes a realistic option later in their lives.

The Curriculum and Evaluation Standards of the National Council of Teachers of Mathematics addresses this issue well. The standards are based on the expectation that all students can become mathematical problem solvers, that all can learn to communicate and to reason mathematically. In support of this expectation topics such as algebra and geometry, which have traditionally been high school electives, are introduced far earlier and on a continuing basis throughout the mathematics curriculum.

3. **We need to infuse information and experiences about technician careers into every level of mathematics beginning in the elementary grades.**

Among the variables found to be related to mathematics participation is the perception of its usefulness. Eccles (1984) indicates that the most significant predictor of whether or not girls and boys take more math courses is whether or not they think it is important to their career goals. Girls are less likely that boys to see math as useful in their future careers. Brush (1980) found that "for middle school girls, changes in the degree to which they see mathematics as useful for their future lives... predict changes in course plans."

The relatively simple practice of providing students at all levels -- and especially girls -- with information on various careers and their math requirements would be a good start. To do this, however, teachers, counselors, and parents need much more information themselves.

An excellent way to provide this information is for math and science teachers to attend events such as the Future Unlimited conferences. More than one teacher has told us their supervisors refused to let them

accompany their students for fear the teachers might themselves be tempted to switch to the well-paying industry jobs they learn about, thus making the current shortage of math and science teachers even worse.

Many techniques and strategies can be used to enlarge girls' notion of technician-level careers in mathematics and science: internships, mentoring programs, role models imported into school or girls exported to the role models' places of work on field trips, liaisons with local industry, and job centers based in high schools to lead girls to early work experience. Some districts have even tried mobile "hands-on" vans that travel from school to school with tools and lab or workbench setups.

**4. We need to create a new middle-school course in technology.**

Years ago, boys in junior high school were required to take shop, consisting of elementary woodworking, metal working, and electricity, while girls were required to take home economics, consisting of cooking and sewing. Since the mid-seventies, we have required boys and girls to take some of each.

We think it's time to create a new middle-school course to prepare students for the twenty-first century, less than a decade away. A new "post-industrial arts" course would consist of hands-on elementary electronics. Girls (and boys) would learn firsthand how electronic machines -- computers and others -- work, and how mathematics and science concepts and procedures are integral to technology. They would be exposed to a large variety of technical careers at the technician and professional levels. Such a course is an ideal vehicle for education in its best, broadest sense and is a source of technical career information and encouragement.

## SUMMARY

In summary, women need technician jobs, employers need technicians, and society needs more women who earn enough money to support their families and pay their taxes. Mathematics educators can help to bring it about by stressing to their female students that math, science, and technology careers don't necessarily require college but certainly do require math. And the equity community can help by remembering that non-college bound women are also our sisters and deserve our attention and advocacy.

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# INCREASING HISPANIC PARTICIPATION IN THE SCIENCES

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Thank you, I am delighted to be here. I am going to depart a bit from the format, some of you might think this is kind of strange, but I think you will get the point as we go along. We are going to do hands-on science. The rule: everybody must participate. In all AAAS workshops this rule is stated so that no one can sit back with a book. Everybody must do this! Please take one cup per two people, you have to partner up, and four paper clips. In short, partner up, get a cup, and your paper clips. In your groups two paper clips will go to one person, two paper clips will go to the other person. If you've done this before, please try to do it again. The challenge is, I want you to make one of the paper clips float. Now, obviously you're going to have to work these things out. I'm not going to tell you how to do it. You have to figure out how to do it. If you've done it before, try it again.

It must float in the middle of the cup and the paper clip cannot rest on anything. You can talk and you can walk around so you can see what other people are doing. Has anybody had any successes? If need be move around and start working with others. That's the whole point! You want to find out what others are doing. You want to find out if there are successes or failures. That's part of science. Move around, walk around, talk to people. We have a success so let's all gather here.

This is one of the typical activities that we do in our workshop with parents, teachers, and students. Needless to say, students doing these activities don't want to stop. Nobody wants to stop. It's fun, you're learning, and sharing. You're interacting and you are going through a scientific process. You're exploring

surface tension. You're observing, you're doing, you're hypothesizing, and you are doing hands-on science. For many, this approach to science seems like fun! However, by working together, and problem solving what you need to do rather than being told the answer, kids and adults I might add, learn surface tension.

***"We have to take part in not only what is happening at school, but we must also reinforce at home what happened during school."***

I'm going to tell you a little bit about myself because I think it will illustrate my point. I came here a few years ago, very frightened, and I did not know English. I came with my three sisters and I was full of expectations. I had heard nothing but, "Oh, the United States, what a rich country, what a great country. You get the best education, everybody gets a great education." I believed all the stereotypical notions were true, the streets are gold and all of that. I had all that in my mind. When I came there were no bilingual programs. The closest thing to bilingualism was in the playground; kids getting together and communicating in English and Spanish. We were trying to get through what we were learning in school and, of course, falling further and further behind in all our studies as we were trying to learn English at the same time. The one thing that I didn't fall behind in was mathematics, but I quickly learned that this was not the area in which to excel. My peers pretty much thought, "Who is this person that doesn't even speak English - excelling in math?" I was told by a teacher, "You really don't need this." Needless to say, I started believing and started neglecting mathematics. However, the one thing I had that many Hispanics don't was a lot of role models. I had people who took a very active interest, who knew the importance of science and mathematics, and who really encouraged us. These people made a difference and changed a typical story: a mother trying to raise four girls between the ages of seven and fourteen, holding two jobs, yet was inadequate in English. We had role models and that's not necessarily the case for most Hispanics. With Hispanics accounting for only two percent of the science and engineering workforce, role models are scarce.

Special factors for a good education include parental involvement. Although my mother, feeling non-proficient in English, was not involved at all in school, we had a tremendous amount of support from people who came into our lives and they made sure that we did our homework. The one thing that parents can do is make sure their kids do their homework. In my case my mother was working all the time. Homework was not on her mind. The culture difference is evident in many cases. Hispanic parents are meeting their responsibilities, but not to the extent and satisfaction of getting an education in this country. The understanding of how much participation the parents have in school in this country is not something that's conveyed very well.

For many Hispanic parents the realization that school is not just someplace that our kids go to where they learn and then come home has not occurred. We have to take a part. We have to take part in not only what is happening at school, but we must also reinforce at home what happened during school. The other thing that is really hard and in my family, typical, is what I relate during parent workshops. I stress that parents buy, for a birthday or holiday, a calculator or play dominos at home. In doing this it will reinforce the mathematics and science that is going on in school and also a message will be conveyed. Every time you give a child a calculator, as opposed to a doll, think of the definite message you're giving out. Parents look at me and say, "Huh." That is, science and mathematics are important in school and at home. We talk about the economics of it, and how you can purchase inexpensive toys, books, and other resources. Generally speaking, our child does not get a calculator, but will get , for example, a truck. We talk very specifically of why it is important to try and incorporate different approaches to learning. There are different types of games, like dominos, that are very important. There are things that are very relevant to us that we can do, yet we don't do them. This is the sort of thing that we cover in our parent workshops and our teacher workshops. The point is that we know from research literature that this reinforcement and enrichment makes a difference.

One of the most important factors that influence pursuit in mathematics and science is how you see yourself. Do you have the expectation that you can do science and mathematics? Do you have the idea

that you can get into these fields? Well, if you don't see role models that is one deterrent, and at the same time if somebody is telling you that you can't do it and you shouldn't do it, that is pretty powerful. That sticks and will impact a child's career choice. Earlier, we were talking about a person that made the difference in our lives. Well it really is true, there are people (and we see this over and over again) who do make a difference in our career decisions. If somebody is telling you that you can't do it after awhile you buy the myth that family and a career in science and mathematics conflict. The truth is there are always conflicts with work and family. However, many science and science related careers offer opportunities and flexibility in hours which allow you to work out these conflicts.

***"Children need to see science and mathematics applied and in constant use to realize its' importance in our lives."***

Perception of ourselves in careers additionally plays a role in career decisions. To demonstrate, we do this exercise with students, parents, and teachers in our workshops. We have them draw this on a piece of paper but what we're going to do right now is a quick abbreviated version. So, if you will all close your eyes. Now I want you to think of a scientist. What is that scientist doing? Wearing? Okay, with your eyes closed I want to see a show of hands. How many of you thought of an Hispanic scientist? Keep your eyes closed. Nobody raised their hand. How many of you thought of a Native American scientist? Okay, keep your eyes closed. Nobody raised their hand. How many of you thought of a woman scientist or a Latino? Five, okay. Keep your eyes closed. How many of you thought of an African-American scientist? I count six hands. Keep your eyes closed. How many of you thought of a German scientist? We have two show of hands. Okay, you can open your eyes.

We do this in our workshops. We have kids draw who they think of as a scientist. What we get back, typically, is this type of scientist. One thing for sure is we rarely get back a woman. The drawings of the men look like the *Back to the Future* scientist: the hair is sticking out, slightly dishevelled, glasses, you know, he is always blowing up something. He is always blowing something up! The only ethnicity, if any, is German. I'm really surprised there were only two of you who visualized a German scientist. It amazes me how many times a child or parent will mention visualizing a German scientist. Women, no. Afro-American, Native American, Hispanic, no, no, no. It's not in the child's mind, it's not in their parents' mind, it's not in the teacher's mind, and as we demonstrated, not even in your minds. If we don't believe it ourselves, we'll pass this on to our children. We can't fool the kids, we all know that.

Another powerful influence in keeping children interested in science and mathematics is the way it is taught and presented in school. What we did earlier highlights a different way to teach science. For various reasons science and mathematics are not presented this way. Classroom management comes up as the number one reason not to have hands-on cooperative learning. Teachers tell us, "Well, kids are walking around talking and I have people who come in and say that my class is too loud." So teachers don't want to do this. Another reason, it takes too much time, and it's hard to control the class. My personal belief is that teachers have a hard time not being the center of attention anymore. I can say that because my husband is a teacher and I feel that is truly the case for him. In any case, the first thing we do with teachers and parents, as well as the kids, is show them that you can do science in different ways. Show them that you can work together, you can walk around, and this is <u>how</u> we learn. Literature tells us that we learn better from each other. How many times have you heard somebody say, "Well, I thought I understood something, but the minute I started to explain it to somebody else, I learned it. I really learned it!" It makes a difference when you have group pairings. For Hispanics these are tremendous tools that we just haven't explored at all. This helps in understanding, particularly if English is a problem. Then we expand vocabulary by sharing with each other. Furthermore, culturally speaking, sharing as done in the family, is important. What a great way to learn science and to keep that excitement!

Earlier we explored surface tension. Somebody brought up displacement. From here, in our workshops we talk a little bit about surface tension and displacement after children explore and observe these concepts.

Then we start talking about why surface tension is important and we try to make it relate to everyday life. The point is we don't want to give them the answer, we want the kids to explore and give us their answers. We teach this method of instruction through example. In fact, nine times out of ten our workshops are to train the trainer. We can't monitor every single classroom and we can't do every parent workshop. So we train the trainer. The only way to train the trainers is for them to experience this approach. You don't want to get up there and say, "Okay, we're going to start with surface tension. Now watch as I put the paper clip on." Everybody sits there and watches. We want them to get up and do it and figure it out. We want the kids to ask questions and the teachers to ask, "What do you observe? Why do you think that happens?" And keep prompting, questioning. Then we start talking about how is this used, what do you know, what do you see, what things in everyday life use this concept.

*"There's an emphasis on Hispanics who take the SAT or ACT but not enough emphasis on why the scores are low. Language is very, very important in these assessments."*

We have a little example. Marsha Matyas, who has been working with the Girl Scouts, put together a booklet called *Linkages to the Future.* She did a nice layout of different activities like this - quick, simple, but the focus is on a basic concept. From there she says, "Okay, now in everyday life we see ships. How do ships float?" And she covers factors like shapes and the influence they might have. The science activities bring out the concepts and lead to exploring the concept in life. Children need to see science and mathematics applied and in constant use to realize its' importance in our lives.

Another influence and aspect of our workshop is what tools children use (i.e. computers, microscopes, etc.). What we are told many times is, "Well, we (teachers) can't really teach science properly, because we don't have the money. An inner-city school does not have the resources to have microscopes, etc." It's very difficult to teach science, particularly the higher we get in the sciences, without equipment. This is a realistic barrier. In order to curve around these barriers we try to concentrate on activities that will utilize inexpensive materials that focus on science and mathematics and still get out these concepts. So that even with limited resources you can still do science and mathematics. We've put together a number of science resource materials for schools and teachers. One of them concentrates on surface tension and is called "Bubbles". Through "Bubbles" we start to explore geometry. We explore how bubbles connect, angles that are formed while at the same time observing surface tension. We observe the curvature of the bubbles themselves and how often they pop. Finally, we graph information such as size and time of duration. There are different things that you can do with these packets. Although developed for middle school these can be adapted for younger or older students.

Other factors that influence a child pursuing science and mathematics are assessments and extracurricular activities. What happens outside school is important in enriching and nurturing interest. Language can be a barrier which tests and other forms of assessment do not fully take into account.

There's an emphasis on Hispanics who take the SAT or ACT but not enough emphasis on why the scores are low. Language is very, very important in these assessments. Similar English and Spanish words with different meanings in each language can partially account for scores being lower. Keeping these things in mind, AAAS Project Linkages works with community organizations and matches them with science organizations and science resources in the community. Linkages assists community organizations to incorporate science and mathematic activities into their programs and to start taking more of an active interest in science and mathematics.

We have been working with a number of community organizations - such as the Girl Scouts, the National Council of La Raza, and many others. I work mostly with the Hispanic organizations such as the Society of Hispanic Professional Engineers, Association for Puerto Ricans in Science and Engineering, Aspira, League of United Latin American Citizens, and many others. These are national organizations that have affiliates all over the country. A few years ago, we started focusing on Chicago, where about twenty-five

percent of the enrollment is Hispanic and school reform is an issue. Many of you may be familiar with that. What has happened is basically for the first time there is tremendous control right in the school. There are councils made up of six parents, two community members, two teachers, and one principal. The councils have total control of the budget and of what is being done in the school. They also have the capability of firing a principal. In Chicago, it is a tremendous time for change. However, parents are not up to speed to cope with what they're supposed to be doing in school. They are more concerned, to some degree, with catching up on the administrative tests which is, of course, important. But, there is still little to no attention to what they need to do and what opportunities they have here to really change the education of their children.

About a year ago Linkage's full efforts began with the Hispanic organizations in Chicago. We got together ten community and science organizations and ten schools with a high Hispanic enrollment. We got them together to discuss what we could do to highlight science and mathematics. The result of that was an all day conference this past June at Chicago's Museum of Science and Industry called, "Launching Our Future". The conference for bilingual students, their parents, and teachers engaged participants in hands-on science and mathematics workshops. The day was totally inundated with very different ways to approach science and mathematics. We had Senator Simon and Alderman Garcia talking about why science and mathematics are important. They talked about the kinds of skills required in the work world, the skills you build up by taking science and mathematics, and the opportunities that open up for you, whether you are going to pursue a science career or not. We also had a fantastic presentation by Earl Montoya, from NASA, called, "Do You Have the Right Stuff", that really challenged the kids. This conference is the first step and they're going to continue this momentum. To further support their efforts we developed AAAS "Proyecto Futuro".

I have some handouts that I will be passing out. I'll quickly go through this because I know I am out of time. "Proyecto Futuro" is a two-year project, literal translation, "Project Future". We'll be working with eight schools in Chicago. Each of those eight schools will be picking three teachers to go to a teacher training workshop, which we'll have in the spring of 1991. In the meantime, what we are doing is developing materials. We are trying to make sure that we incorporate activities and approaches to engage bilingual Hispanic students by discussing and using culturally relevant materials. We will be meeting with school councils as well as with the principals to get their support.

We had to make sure that everybody is clear on what they're doing so we developed a contract. In the Spring of 1991, we will be having training workshops. The training workshops for the lead teachers will start in March. Each school will get science and mathematics kits for their schools. Lead teachers are responsible for having two in-service workshops for their fellow teachers, one after their training in the Spring of 1991, and another one in the Fall of 1991. They will be encouraged to go to a Teacher Academy during July and August for which we will provide funds to offset expenses. Some of you know that Dr. Leon Letterman, who is our president elect at AAAS, started the Mathematics and Science Teacher Academy in Chicago. We have collaborated with the Academy by sharing materials.

In the Fall of 1991 we will start our parent training called, "Parent Nights". The parents will do activities and will get science and mathematics materials and activities to take home. We do school evaluations in the fall and then in 1992 we'll start writing and getting it ready for publication. It's an exciting two-year project for us. For the first time, we're seeing an opportunity to really develop a model for the Hispanic Initiative and for others to follow. We'll determine how to reach Hispanic parents which everyone else says, "I don't know how." Of course, we need to really try. I mean the more we talk to parents, the more we realize that there are things that should be done, that are not done and can be easily incorporated. Marsha Matyas is the Project Director of Proyecto Futuro and I am coordinator of that project. I do have handouts. Another handout we have put together is a publication called *Making Mathematics and Science Work for Hispanics*, authored by Dr. Laura Rendon and myself. I brought a copy for everyone. I welcome your questions, and thank you.

# PARTNERING FOR SUCCESSFUL CAREER DEVELOPMENT

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*Cecile M. Springer is President, Springer Associates, an innovative new organization that provides comprehensive, cost-effective consulting services in corporate and philanthropic programs and institutional development. This group assesses performance through program evaluation, strategic planning and focused program design for foundations, colleges and universities, government agencies and community organizations. Dr. Springer was formerly Director, Contributions and Community Affairs, of Westinghouse Electric Corporation, from 1978-1989. She also served as President, Westinghouse Foundation, and was responsible for the portfolio of contributions made by the corporation worldwide. Throughout the years Dr. Springer has received many honors and awards, including a Professional Excellence Award from the Hispanic Society of Engineers and Scientists. She is on the Board of Trustees of the Pennsylvania State University and Carlow College, and was recently elected to the Alumni Council of the University of Pittsburgh. Dr. Springer received her bachelor's degree in Chemistry from Manhattanville College in Purchase, New York; a master's degree in Urban and Regional Planning from the University of Pittsburgh, a master's degree in Chemistry from Wellesley College in Wellesley, MA, and an honorary doctorate from Seton Hill College in Greensburg, Pennsylvania. Dr. Springer resides in Pittsburgh with her family.*

It is indeed a great pleasure for me to be here. The pleasure for me is the subject of the symposium -- women and technological careers.

My particular interest and avocation for the past 15 years is technology and engineering opportunities for both minorities and women.

What I would like to share with you today are three adventures -- programs, processes -- that have successfully used the talents of minorities and women to assure successful career development for themselves and other minorities or women. These three adventures are:

- Steering Committee for Minority Communications;
- Intergenerational School Volunteer Programs; and
- The Strategic Study Group on the Status of Women.

The Steering Committee for Minority Communications was established by Westinghouse Electric Corporation in 1977. The Committee's mission since its founding was to develop communications bridges and strengthen relationships between the corporation and minority communities throughout the United States. The message to minority youth is increased awareness of career opportunities in engineering, science, and technology plus awareness of the corporation's interest in and encouragement of minorities entering these fields which represent not only the corporation's employment needs of the future but the technical jobs of the future in the United States.

The Committee is composed of a corporate-wide group of Westinghouse management who developed and implemented programs to carry out the Committee's goals:

- To encourage minorities to pursue opportunities in engineering and technical careers.
- To make the corporation's interest and involvement in the minority community known.
- To encourage people to become more knowledgeable about the interrelationships among technology, energy, and jobs.
- To develop links between local management and the minority community, and to improve their relationships.

In order to carry out these goals, a number of programs were developed -- Spokesperson Program, Community Ambassadors Program (CAP), Career Conferences, and the Award of Excellence.

The Spokesperson Program recruited minority engineers from throughout the corporation -- Black and Hispanic, male and female. These volunteers were trained to be communicators and then sent on media tours -- television, radio, and print media interviews -- essentially with a single message: I'm an engineer; with my education, I now have enormous possibilities for employment and growth; I have a good paying job and I want you to consider engineering and technical careers by majoring now in math and science and staying in school.

The interviews were a great opportunity to spotlight who these individuals were in detail. The Communicators developed into local and national role models, real life examples that the young listener or reader could emulate.

The Community Ambassadors Program developed out of a need to respond to minority and economically disadvantaged youth in the community surrounding a Westinghouse plant. Engineers, scientists, and professionals in technical fields are trained to become communicators and to speak to students about the importance of science and math careers. These ambassadors are on call to speak at schools; to demonstrate equipment and computers in science classes; to target middle-school students so that they can prepare early to enter technical fields; and to serve in their home communities as mentors and models.

Career conferences are designed to educate minority youth about current skills sought by employers; to tell students about opportunities in engineering and technical fields; and to point out what is needed to pursue technical careers. These career conferences have been held in Philadelphia, Harrisburg, Pittsburgh, Los Angeles, Raleigh, Idaho Falls, Charlotte, and Hanford.

OUTCOME: the message is being delivered by minorities who are dedicated to getting parents, teachers, and the students motivated to achieve a technical education.

The Award of Excellence was initiated in 1983 to recognize Westinghouse employees who make a strong commitment to their communities in the area of minority affairs. Winners are selected on the basis of their efforts to:

- Encourage minorities to pursue careers in engineering and science.
- Improve relationships between management and minority groups in plant communities.
- Demonstrate exceptional performance in matters related to minorities.

The awards are lithographs by outstanding minority artists. The first awards were signed lithographs by Romare Beardon of an original commissioned painting by him entitled "Starlit Dreams." The current award is a lithograph of a commissioned piece of art by Humberto Chavez, an award-winning Hispanic artist.

These Awards of Excellence are made to the candidates who have displayed outstanding leadership in the minority community and to the winner's work site in order to recognize management's support of the winner's activities.

The partnership depicted here is between a corporation and its minority engineers and professionals. The outcome of the partnership is articulate minority engineers, who are now enormously self-assured and personally successful, who today, continue to serve as mentors and models to young students. Another outcome -- letters to these Communicators and Ambassadors by students reporting that they are now in college, admitted to engineering programs, thanking them for introducing them to the possibility of and the excitement of a technical and challenging career. But of even greater importance to me -- these programs that trained minorities to communicate made them outstanding, dynamic workers who moved up, were regularly promoted, many of whom today are managers recognized for their ability and who continue to make an outstanding contribution on the job.

The next partnership is the Intergenerational School Volunteer Program which was designed by Generations Together, a gerontological program at the University of Pittsburgh, to partner two under-utilized resources -- retired technical people and underachieving minority students at all grades -- elementary through college.

This effort has been so outstanding that it received the President's Distinguished Service Award for innovation and productivity. Retirees are recruited and trained to work with students who are often from female-headed, economically disadvantaged homes. Retirees work one to one with students. For example, a recently retired engineer -- from one of the locations where I had worked -- was assigned to a high school adopted by Westinghouse. The students were at-risk freshmen who by December of their freshman year were on the brink of failing. The objective was to tutor. The result was "getting to know you." What we found out was that the students were starved for successful role models, for talk about how to solve personal, emotional and academic problems, and for a personal relationship with someone who focused on each student on an individual basis. We found that the students were distracted at school by issues outside of school over which they had little to no control.

We found that what minority leaders say are the science education needs of today are what all disadvantaged kids need:

- quality mentorships,
- improved self-esteem and English fluency, and
- elimination of cultural stereotyping ... all of which we received in this partnership.

Two outcomes that were outstanding in the Intergenerational School Volunteer Program were:

- Cultural value-system sharing often on an interracial basis; and
- Step-down mentoring -- the mentored student being trained to mentor other students ... high school seniors as mentors to freshmen high school students; college upperclassmen in engineering, science, or math as mentor/tutors to college freshmen or high school students in science and math.

Partnering here was multi-leveled and included the corporation recruiting retirees to work with students in a partnership school, partnerships developing between retirees and students, and a mentor/tutor student relating to another student in need of a role model.

The Strategic Study Group on the Status of Women at the Pennsylvania State University is an effort that resulted from a determination by the women within that system to strive for equity across the institution by the establishment of a supportive partnership with the University to implement the outcome of the study. And, by golly, it worked!

The Strategic Study Group on the Status of Women was appointed in 1985 after a year of planning by the Commission for Women and the office of the President. The issues to be addressed, determined after a number of deliberations within the University and with experts on environmental scanning and process, were:

- Institutional climate, quality of life, and image.
- Academic programs and services.
- Conditions of employment.
- Recruitment, retention, and advancement opportunities.

Each issue had a subgroup which was charged to examine the issues in its area of responsibility across all categories of women.

There were hearings; testimony presented; a telephone access number for confidential discussions; deans were interviewed; data, surveys, meetings -- all carried out for the development of reports and recommendations. The outcome, a five-package report, and accompanying recommendations. The packages were comprehensive, detailed, and in-depth:

1. addressed Job Assessment and Evaluation, Recruitment of Women Faculty, Part-time Benefits and Compensation, and Recruitment of Women Administrators.
2. addressed Family Responsive and Flexible Employee Benefits, Clerical Advancement and Development, Retention and Advancement of Women Faculty, and Sexual Harassment of Students.
3. contained three reports: Chilly Classroom Climate, Dual Career Recruitment and Retention, and Employee Relations and Representation.
4. consisted of seven recommendations: Women of Color, Sexual Minorities, Returning Adult Students, Sexual Harassment in the Workplace, Sexual Violence Against Women, Women's Athletics, and Health Services for Women Students.
5. a set of eight recommendations: Family Care Policy, Women's Studies, Curriculum Integration, the Center for Women Students, Non-Tenure Track Faculty, Staff Exempt and Staff Non-Exempt, Leadership Share, and Advocacy for Women.

In a word, comprehensive! These packages were subsequently updated and the final report and recommendations were structured in a new framework:

1. Leadership Share
2. Structure and Quality of University Work Life
3. Structure and Quality of the Academic Environment.

There were 26 general recommendations. The complete set of recommendations numbered 192!!

OUTCOME: An enlightened view of the worth and value of the women in the university system; annual reports to the Board of Trustees detailing the accomplishments of the 192 recommendations; two women deans; a female head of the library system -- a first; a climate that addresses the issues raised by the report; more attention to women athletes; dedication to achieving equity in position and pay; and women admitted increasingly to the engineering school, agriculture school, medical school -- all technical disciplines.

And, since I am the Trustee Chair of the Advisory Committee on Affirmative Action, it is my committee to which the status of accomplishment of the recommendations is given by the Provost of the University annually.

Partnerships work -- to advance the notions to women, minorities, and the economically disadvantaged that math, science, and technological education is the winning path to the future; that the message is provided by mentors who are women, minorities, many of whom have had the same experience of being economically disadvantaged; that a process that focuses comprehensively on the issues faced within a system in partnership with the management of the institution can change the outcome for all for the better.

Many thanks for your kind attention!

# INFORMAL LEARNING AT SCIENCE MUSEUMS

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There is something (at least in academia, but not in the museum field) referred to as the "Three Mothers of Science." I had never heard this phrase before - "The Three Mothers of Science." I am speaking of Ruth Hubbard at Harvard, Evelynn Fox Keller, and Ruth Ann Blyer who does Biology in Women. It was a phrase that I heard from Sharon Traweek, an anthropologist of science who teaches at Rice University. She gave a guest lecture at a University of California at Los Angeles seminar that I attended. I thought that she was brilliant.

So this is all going on in the back of my mind - thinking about these issues and feeling a sense of excitement about them because they opened up a whole new paradigm for looking at what I had been doing. At the same time I experienced a great deal of isolation. I can't tell you a single person in the science museum field who has read any of the books that I have read, so they don't want to talk about them.

I'm going to take a minute to tell you about how popular science museums are becoming so that you can take them seriously and think about the implications of this. More than two hundred American cities have science and technology centers now. Almost all the hands-on museums, with a couple of exceptions, have all occurred since 1969. More than three hundred American cities have children's museums. That's a lot of cities. That's the fastest growing segment of the museum arena. The other thing about museums, in general, is that they're moving into the domain of the economic planners. Whereas, it might have been the robber barons of the past and the cultural mavens, now economic planners have a great deal to do with the planning of museums. Youth museums are a little bit different: it is really the mothers who put them together, or sometimes the school teachers, or something else. Then there are the vanity museums that are happening in which everybody who owns a collection gets their own museum or exhibit hall. Most of the energy is coming from the mothers, the moguls, the vanity people, and the economic planners.

I'm going to give you some examples of the kind of dollars that museums are generating. Then you'll begin to understand some of the things to which museums are responding. St. Louis museums commissioned a study that found that for every one dollar of public tax money invested, there was a sixty dollar return. Regarding visitation at historic sites, 59 percent of the people making highway travel trips visit historic sites and 34 percent of the people who travel by airlines (including business travelers) do the same. Science Museums can learn to take advantage of history by showing the historical development of

certain kinds of science and certain kinds of technology. When the Monterey Bay Aquarium opened in 1984 retail sales in the city rose 53 percent the first year, Transit Occupancy Tax receipts rose 50 percent, and tax receipts to the city rose 225 percent. The museum is currently planning a forty million dollar expansion. A 1976 Washington D.C. study showed that an art gallery attracting only 25 visitors a day from out-of-town generates dollars for the economy equal to a new business with a 125 thousand dollar annual payroll.

*"St. Louis museums commissioned a study that found that for every one dollar of public tax money invested, there was a sixty dollar return."*

Tourism is now the number three employer worldwide. It's projected to be the number one employer worldwide by the year 2000. Cultural tourism, which can include scientific tourism, is a part of that story. As of 1988 tourism was the largest export industry of the United States surpassing even agricultural commodities, automobiles, and electric and computer products. There are many ways of counting exports, but these are fairly-well accepted numbers. Another thing that the National Science Foundation frequently says, "The total attendance at science museums, and that includes zoos and arboreta, is greater than spectator sports." So it's a big field, and economics is playing a big role in it. Very, very roughly, tourists are half of the audience at science centers. Which means their income is dependant on tourist attendance. The number one attraction in museums are the hands-on museums or science museums in many cities and states. Chicago's is the number one attraction in Illinois. Indianapolis Children's Museum is the number one attraction in Indiana and so on. What's happening is that there is such a tremendous redundancy in what's going on and that the tourist market is just not going to be excited. It's growing on one hand, and it's also, incidently, aging a lot. The tourists are going to start to see the same things everywhere. There's something like thirty or forty aquaria on the boards right now. Aquaria are new hot projects. An aquarium has very high capital investment costs, but it gets a lot of traffic per square foot, and once you build it you don't have high maintenance cost relative to labor intensive science centers.

Two years ago I was in Denmark. We had a client called "The Experimentarium," which is a museum that is being developed in Copenhagen. We were there on a one week consultation to help them think through what they were doing. They're sort of far along, but really what they brought us there to do was to make sure that they were doing it right, because they already had a direction. We said, "But, what about....?" It was a very interesting experience in many ways. In a way Denmark seems to be like a feminine country. It has a gentleness and people feel a responsibility for each other. It also meant in a certain sense that they don't have this real drive and push, that I have, to do whatever it takes to do it a certain way. They say, "Well, we're already on this path and no matter what we do people are going to say we're successful." I said, " Why are they going to say that?" "Because we don't have anything like this in Denmark. So when we open it up they'll say we're successful." There was a lot of mutual respect. Even though they disagreed with each other, the staff really wanted to talk more along the lines of what we had been talking about. The Director of the museum, who had run the post office before this job said, "We really should open up on time, don't you think?" This was their approach, not ours.

What was interesting was that they were doing a very large project. Two official boards had given them a 100,000 square foot facility right on the water. There was a lot of community support. They were doing exactly what I had been seeing everywhere else in the world. You knew the brochure that was going to come out could have been interchangeable with one in Louisville. They were either going to show the same Bernoulli Effect or the same Schalbney Plate or the same Whisper Dish. The goals for the project were in no sense rooted in the 90's or in Copenhagen. Most of what I talked about with them was how could we root it here and why would we want to. We came this close to pulling it off. They were still very excited and incredibly respectful and hospitable to us and each other. It was really unique to have seen that, to be part of that.

Question from floor:

Is it finished now?

No, it will open up in October.

One of the things that we discussed was that because "The Experimentarium" is in Denmark and they have a lot of hands on activities in high school they don't have to go through all the lab demonstrations that an American museum must go through. What if you really organized the entire museum around the format and concept of an experiment? What if in going through The Experimentarium, you enter an experiment and your attendance, or your feelings, or your behavior, or your emotions are part of a monitored experiment? What if the format of every single interactive display has variables and you observe things and you measure things and you hypothesize, so that there's no escaping the concept of what an experiment is? This was one of many possible ways that they could have been unique, I think, and at least had a stronger local identity.

Also, we talked about objectivity and subjectivity and this was the area that came closest to what would be of interest to them. What they really said was, "Well, we did this temporary show and it went around. It was about the human body and everybody loved it. So we'll just use the same method and it will be one at a time. We've hired a couple of guys for the carpentry shop. We have this woman who is a designer who has a bit of an architecture background." She loves the project, but she would love to have staff who would say, "Let's set up some formats from the beginning. Let's set up the material, the finishes and concepts." But, as it turned out it was being done one at a time. It's not that dissimilar, although they thought of the American solution (I was considered the American solution) as a mega approach. That is you know where you are going when you start out. Which is true, I did want to know where we were going when we were starting out. They were happy to turn out one idea at a time.

Nonetheless, it's not that different from the solutions that I was seeing all over the country which were really rooted in San Francisco's 1969 "Exploratorium." These science centers are very much the same and they allude to "The Exploratorium." They're atomistic. You go there and the exhibits stand alone. They're the same topics: it's bubbles, perception, the human body, now the environment, there are a couple more. They're all very much the same. San Francisco in '69 had to do with drugs and hallucinogens. It was a time that spawned "touchy feely" and perceptual exhibits. So here are "touchy feely" and hands-on, very slick, and perception exhibits, a real kind of personal freedom that was happening at that time. You had walked through exhibits that were not programmed. You know, do your own thing. You had teenage explainers. You had the whole youth clique thing happening. I really see very much that the Exploratorium is rooted in that. It was very original, and it has been a very successful model and deserves to be a successful model. I had also felt increasingly that the model deserves to be rethought, that it was time to have other models that are really rooted in a different time and a different place.

Which brings me to what I have been doing now. I have been working, for the last year or so, toward trying to rethink how the gender issue, in particular, can be part of this rethinking of time and place in what science centers can be. How many of you have read Evelynn Fox Keller? Okay, so a fair number. Evelynn Fox Keller opens up some interesting questions, e.g. it is very hard to understand what a text book of Evelynn Fox Keller's would look like. But I can begin to imagine what a science center would be like that would be imbued with some of those values, responsibility, and all the other kinds of things that she talked about.

So I started thinking, "How do science centers not serve females?" - particularly in the less obvious ways, and how can they begin to? So I started working on my own with some strategies. I came up with a plan for an exhibit on Gender and Science which would explore what science is and what gender is. We could use science and gender to look at each other. The question, "Is biology destiny?" could be used to look at the gender issues and at what biology is. There are many interesting examples in *The Female Animal*, written by Irene Elia. Although she suddenly seems to draw conclusions out of nowhere, it's filled with colorful examples. She is an American zoologist who has moved to England. I found out in her book, for example, that guppies - if you have ever bred guppies you know the males have these big colorful tails - well, guppies maintain a two to one ratio of males to females. Furthermore, if for some reason it gets out

of kilter they will eat themselves back into that ratio. So then you can talk about population strategies and all kinds of theories that follow from that. She gives many, many examples.

> ***"Junior high school students, on the average nationally, spend 13 1/2 minutes a day, outside of school, in adult-child interaction."***

There are many ways to talk about what good science is and what gender is by doing such an exhibit. So that's a project I kind of initiated on my own and funded thus far. We'll see where it goes.

Another question I had was, "What would bring women to the science museum?" - which is how I got to gender. Another question I thought of was an exhibit on Pre-menstrual Syndrome (PMS). PMS is something that is reported as occurring in about 60 to 80 percent of women sometimes, although it is not necessarily PMS. I find the recent anthropology of PMS fascinating. The biology of PMS is interesting and I think it has real potential as an opportunity to bring women together. That's sort of another direction, but that's kind of a stretch for me to think that Science Museums are going to be willing to receive this. Yet, it's something that is extremely prevalent. It happens all the time to all of these women and families. But it is "unspeakable."

Then I began to think about PMS, "Well, it probably would never fly as an exhibit, but it really might make a terrific workshop." An effective model would be for a science center to get together with the local university and/or a women's health center to hold a workshop. The other thing I heard about PMS from the University of Southern California (UCLA) health care people was that everybody was burned out on PMS, because they don't see that there is any way that they can solve it. They say PMS is an issue for the medical school. However, I don't think all the answers are there. It is a shame because I feel it is a somewhat solvable, approachable issue that you can work with. But, it takes all of these domains and not just rigorous, isolated science by itself.

I was also influenced by the book that was mentioned earlier today, *Ways of Women Knowing.* Incidently Carol Goldberger, one of the authors, has agreed to be an advisor to the Gender and Science Exhibit when and if this comes to fruition. The idea is to design exhibitions around ways in which women and the public can share things. Perhaps one of the reasons The Exploratorium is a successful model is it's a relatively more shared experience than the earlier models of science museums or natural history museums where you go to observe in isolation. Science museums, incidently, are more social than art museums, where you tend to have a one-on-one, or two-on-one sense of community. The science museum attracts the family, and people spend a lot of time reinforcing their experience.

Now we're talking about the 90's. What could a science center be? There are no science centers that are organized around the systemology of science. There's nothing that says, "Well let's just look at nature and reality." Where are the meta-solutions and meta-plans? That's not on the floor plan anywhere I know of. The museum space is not organized to look at observation, hypothesis, measurement, and so on which would reflect the philosophy of science. This is not how it is organized. It continues to be organized in "topics."

I'm interested in how subjectivity and objectivity can be looked at. I'm sort of thinking that's another way that these things can be tied together - particularly as subjectivity may have special affinity in some ways with thinking and working, and also seems linked to quantum physics. I'll tell you a little bit about a project that I am doing at Dayton which is an initial concept for a project that will probably cost 40 million dollars. Wright Patterson Air Force Base does more applied research a year than MIT. A big part of the project is that it should reinforce and broadcast Dayton's character and heritage of technological innovation. The planners are interested in hearing about women's issues, not too much about them but they are of interest. They've raised daughters and they don't quite know why their daughters are not engineers. They haven't figured that one out.

I interviewed about a hundred and twenty people in Dayton, some of them more than once; it was a pretty big project. There's no way that this is going to be deeply rooted in Dayton if we don't understand

the Daytonites. I asked some of the technical engineers, "What was your earliest experience of technical achievement or prowess?" All of a sudden you could almost see the left brain switch to the right. The answers were lax, and they would say, "Wow, you know my grandfather took me up on the roof to help and I was only like six years old, and he wouldn't have done that if he didn't trust me." The next one said, "My father brought home a clock, because he knew I wanted to take it apart." They had stories about grandpa and dad. It was very emotional, it really touched them, and it usually just opened up the conversation.

Junior high school students, on the average nationally, spend 13 1/2 minutes a day, outside of school, in adult-child interaction. That's not enough to pick up life skills and values, much less technical skills and values, much less the values that go with technological innovation. A little over 23.5 percent of children are brought up in families headed by single mothers and if you add families headed by aunts and grandmothers I think you're over 25 percent. I thought, "Well let's be honest about this. The technological skills are in the hands of men. They've got the heritage to pass on."

I thought about the fact that Dayton has 10,000 retired engineers. That's a lot of engineers. Then we tried to create a program that would not be separate from this institution. In a lot of museums they do conventional girl stuff. They bring in the Girl Scouts for an overnight visit and they stick with the issue of treating girls the same, but give them a special time. And I, having been influenced by all this reading, thought, "Let's focus on a different issue for a while and see what we can do in this museum or learning center that will address the differences in race and in gender." It is fraught with paradox. I called up the Retired Officers Association president and I said, "What do you think of this idea?" I described two projects that we might do. He said, "It makes me so excited it makes my head dizzy. We have all this wasted talent," and he only has 600 to 800 people in his group. So that was a good sign. It turns out that only 15 percent of science centers use seniors as volunteers.

I met one of the Wright Patterson Air Force Base Colonels who is also a museum buff. I asked him, "What's going on here with gender and race and how do people really feel about this?" He said, and I found it quite genuine, "We don't care if they are green, we need engineers." This was pretty close to the expressions of corporations that I heard around town. That doesn't necessarily mean that they consider the issues of gender and race as somebody else would, but they do mean that they want those engineers. They recognized the need to solve some of these problems. It also doesn't necessarily mean that they're going to locate the project downtown, which is really the same question, but it's part of the issue of how it will be decided.

This colonel said to me that he felt that women performed just the same as men in almost all categories except, maybe, spacial thinking. I thought, "Well, let's use that as an opening for doing a Three-D gallery and do something special for the girls, not only special, but let's make sure there are things girls are especially comfortable with in ways of working and in ways of knowing."

There are all kinds of stereo and Three-D projects going on at Wright Patterson such as cockpits that reach to Mars with your hand and other stuff. They could do a Three-D sign that only 2/3 of the population could actually see. There's all kinds of ways to enter that. That's a very telegraphic way of telling you that there are different kinds of strategies. How can we gear something toward a particular population? We thought about doing a computer diary workshop.

In a nutshell, that's what I have been looking at in the science museum and science exhibit field. I have found post-modernism to transect a lot of this and give me vocabulary and concepts for thinking about these issues.

Thank you.

# WOMEN IN ENGINEERING

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It is interesting that I know a lot about women in engineering. As I prepared this talk, I started to think, " How did I get into this and why?"

My dad died when I was about two years old, and my sister was about eight months old, or something like that. We were very close, my brother was four. So I grew up in a family where my mother was the principle bread winner. Women have dominated my life. I use all of that sexist language and my daughter, who is a lawyer and has given up the law to raise her three boys, always is straightening me out by saying, "Now, that's sexist, dad." "Father," she would say, "No!" Of course, my wife to whom I have been married for forty-five years, also has been one of the people who is straightening me up. We married when we were just kids and everybody said, "You shouldn't marry young," and everything else. But probably the best decision that I ever made was to get married. I have learned a lot from women and have gotten into some of this kind of thing in engineering education.

I think Betty Vetter became one of my first role models when she spoke about the Korean Draft at an Association of Higher Education meeting. She has been one of my role models for a long time. So it is always delightful to be with Betty and to share my research with other people. I am not a very well organized person, so we'll see how these flip charts and my overheads work out. I always carry more. Linda

Dix always shakes her head about how many overheads I have. They always say that I can't get through it and stay on time. I will try to keep within my time frame.

I am going to start with some data. Why is engineering important for us to focus on with regard to women? Engineering always comes up on the bottom line, whether you're looking at B.S., M.S., or the Doctorate Degree. I tried to extrapolate these data. We're up to about eight percent of women with Doctorates, about 15 percent on the Masters Degree level. We're still flattened out at about 15 percent for the Baccalaureate Degree. That is as close as I could get on the data. That is why it is important. We all make comparisons between what is happening with regard to other underrepresented groups. Women look very good if you look at first year enrollments, and even if you look at Baccalaureate Degrees. If you extend that data you still find that this is flattened out. The Bachelors Degrees are flattened out. The Masters Degree is really up here, it is about 15 percent now. The Doctorate has gone up roughly to eight percent. I think that may continue to go up.

I would like to say a little more about that. I think there is a new way that women can go into engineering where they won't have to go through the undergraduate and through the Masters Degree thing. I see an increasing number of women graduate students coming to Purdue from other disciplines at the master's degree level. That is another kind of re-entry thing that really we haven't talked about. We tend to be masochistic in engineering and we try to say, "Well, you have to take all these undergraduate courses." I think people have found that it is not necessarily required that you do so. We had somebody from Artificial Intelligence, for example, who is now in our Electrical Engineering School. This person came in just like that and fits in very nicely with some of the things that they're doing over there. So that is something we may want to talk about. That is one way of making a gain. Although engineering has been primarily a Baccalaureate Degree-oriented program, I think the Masters Degree is certainly going to be the norm. I think if you look at engineers under forty, but over twenty-five, you would probably find a Masters Degree about the median level. The Doctorates still seem the one for academia, for you are not going any place there without it.

Yes, do you have a question? Please interrupt me as I go along because you may disagree or have some other point to elaborate.

Question from the floor:

> With regard to students who had Bachelor's Degrees in other fields, are there some prerequisites, or is it a longer course of study?

> Not necessarily; that is the point. It depends a little bit on the program. What is happening, I think, at the graduate level at Purdue is to tailor a program to meet the individual student's needs. The problem with the Master's Degree is that often that is a nonthesis course of study. Many of us are familiar with evening classes and things. But if you take a residence-type of Master's Degree, I think that the situation is some what different. Most of the people who are in residence are really looking for the Doctorate, and so a thesis or something like that is in order. I think that now the Doctorate Program is pretty well personalized to meet their needs.

A comprehensive program in Engineering, in my opinion, requires some work on recruitment, retention -- I don't know the right thing to call it -- I like to call it the R's. So I sometimes call it renewal or relations. But you really need to have a comprehensive program. We've done most of our work at the senior high school and college levels (for example: recruit). We talk a lot about employment. We haven't done much work on the graduate kind of thing as far as retention is concerned. We do concern ourselves with the retention thing. But there are different things people go through in different careers. So I think that renewal is somewhat different for the one taking first employment, whether it is with Bachelors, Masters or Doctorate Degrees. I compare this to when they go through their career crisis, which can come ten years or twenty years down the road. Some of us are always in a career crisis.

I think these one shot programs at the middle school level, when that is all they have in their program, are doomed to failure. You have to have a comprehensive program. I think the number one message is

you have to start small, but if you just do a little thing here or there, that will make a difference. I do lots of evaluations and in most cases it's not going to show much difference.

Question from the floor:

Are you talking about the Engineering Department taking the comprehensive approach, or just all of us?

This can be used by the Engineering Profession or it can be used by the Electrical Engineering Department in a particular school. I think that you really have to look at the big picture. I guess that is what I'm saying. You know how institutions are. Sometimes the Electrical Engineering Department can do it, but they might not be able to do it in Agriculture Engineering, or vise versa. I think that you can use that. We use this same thing very often in our Minority Improvement Program. I'm just kind of looking at this in the context, in other words, the story is that you have to have a comprehensive program and it has to be kind of top down in my opinion.

Question from the floor:

By comprehensive do you mean that they visit the school one month, with a follow-up the next month?

If you do a good job in recruiting them, but after they get there you don't provide a support program for them, then you are going to have a very high drop out rate and your retention will be very poor. You can't just recruit them. You can't just work at the junior high school level with them, and think, "Well, four years from now we are going to be set."

A lot of the time our resources are limited. For example, we have had increasing difficulty in getting the money for our women's program. One of our solutions has been to say, "Look at what we are doing," and trying to optimize our resources. One of the things that we found with the greatest payoff for the least expensive outgo is a "One Day Career Day." We have one in the Fall that just ended last week. I brought some copies of that program and I will make them available afterwards. It was for seniors whom we couldn't accommodate in our summer program, because we're limited in the resources we have for summer programs. We will have one in the Spring for juniors in high school. For those one day programs you don't have to pay overnight expenses. They usually pay their own travel and we pick up the meal ticket. Usually, companies come in or the students that we use are all volunteers, so it's a very cost effective thing. Yet, they are doing some pre-college things.

Question from the floor:

I was wondering about the funding of these. Is this because your institution perceives that getting women to enter engineering is no longer a problem?

No. This problem is with getting the outside funds. If anything, we have increased our internal resources. Purdue has a Director of Women in Engineering Programs, Dr. Jane Daniels. One thing that has helped her is she has been working with some of her colleagues on the West Coast. They now have an Advocates Program and they do have some National Science Foundation (NSF) support. I'll talk about that later. But, I don't think, internally that's the case. I think that it is the external funds that become a problem. A couple of reasons: One is because of the economy, there isn't as much money. The second is that a lot of companies are de-centralizing their efforts. So we can work at the corporate level. So what we try to do is give fewer Merit Awards now as scholarships. They are expensive and we can put on one of these workshops for the equivalent of the cost of the Merit Award. So that's an example of where we've pulled in our horns. But I say you must have a comprehensive program. Also, we've been given resources to provide a seminar for seniors. We

used to have just one for freshmen. So that is an example of where internal resources have been used. I think if you do a good public relations job, then you can get the administration's support. I think that Jane and her colleagues have done a good job.

Question from the floor:

For these One Day Career Days that you have for the seniors and juniors in high school, do you charge? Do you charge the students for those?

No, we don't charge. For summer programs we do. Then we have a week-long program and that might cost two hundred dollars. At the one-day events we have a luncheon, and we usually get the facilities for zilch or nothing. Certain people whom we bring in from the outside pay their own travel. The internal people we get -- The Society of Women Engineers -- volunteer to be guides and things like that. It really is, over all, inexpensive. The luncheon is the main thing we charge for -- five dollars a person, or something like that. We probably had two or three hundred people there. So you see what I am saying, that is about the cost of one Merit Award. If we give up one Merit Award we can do that and if we give up two, we can do it in the Spring.

Question from the floor:

The one problem we have is, we all know that this is a good idea, but it is very difficult to get our faculty to see this as in the institution's self-interest or in anyway related to their self interest. Have you done any workshops with the faculty?

One thing that we do is try to get the Dean and the Department Heads to show up. That helps somewhat. We will often introduce them at the luncheon. That has a way of, sometimes, working. It depends. You can't get all of the faculty. (Some of them, maybe, you're not sure that you want them there either.) However, I really think that you do need the support of the faculty.

Let's look at a couple of these elements. I am going to talk about recruitment first. I think that a comprehensive recruitment program involves several factors: role models, information, hands-on activities, particularly when working with younger people. We have some kind of counseling as we find that for women, one-on-one counseling is very important. Then I think in order to do an effective job you have to do some evaluation. We need to know what is paying off and what isn't. The evaluation can be on the background of the students, the change of characteristics of students coming in. We do a lot of pre-and post-things, and we do longitudinal follow-up, five years, ten years and so on. Those are sometimes expensive to do, but I think that follow-up programs are important.

To give you an illustration of the program at Purdue, we started our program before we had our first director appointed in the early seventies. Our first effort was largely a one day, future focus, kind of a "One Day Hometown," where you go out to the hometown. We have had that program and it has had different names "Target Cities," or something like that. One program that we have had for quite a while is the Summer Seminars. We started those in the mid-seventies and we usually try to have our Summer Seminars with an equal balance between men and women. We try to stay at a fifty-fifty level. We've had some problems in recent years and I will discuss that a little bit later. Then we have Merit Awards. They range from five hundred to two thousand, but as I said, we are pulling in our horns on the Merit Awards. We're increasingly stressing graduate work for that is very important. We had a One-Day Career thing where we were trying to get juniors and seniors in college to talk about the graduate program. We are trying to do that a little bit more.

Question from the floor:

Are the Merit Awards awarded to those students who go to your program?

If they are admitted, they are eligible for a Merit Award. What we have done in recent years is, instead of having just limited awards, we're riding piggyback on what used to be called the "President Awards," Now we call them the "Dean's Award". A significant number of the women are eligible for those awards because they usually have to have a good academic background. One of our problems has been to convince the Director of the Honors Program that he shouldn't put so much weight on the SAT scores. He ought to put a little more weight on grades, which in general is a better predictor. We haven't been able to do that, unfortunately. Personally, I think there is too much weight on SAT scores. So what we've tried to do is make sure that the criteria they use is the screen in those programs where they're generalists. I am not happy with it, yet, but we have made some giant steps to try and get it. For example, one of our problems in setting up our summer programs occurred when they decided to make it an honors level thing. They put such a lot of weight into this thinking that we weren't a fifty-fifty mixture any more. But, we're continuing to work on it and we are moving in the direction of beginning to look more at academic grades and things like that.

To give you an idea what a typical program might be, this is one we call "Seminar for Top Engineering Prospects." This is similar to what we have done for years. We may have them come in, we will give them a campus tour, a group thing. They will have somebody talk about what engineering is, they will go to labs. Then we give them projects. Sometimes they will work on building bridges or they may have a rocket project. It seems as though aeronautics and things like that are popular. We tried doing some things on ethics this last year and that went over very well. We always have a computer thing. We hope by the end of the week or two-week program that they will have developed some pretty confident new skills, problem solving-type skills, as well as maybe learning Pascal or some computer language like that. Always when they come in we do a pre-test to get some mileage out of the panels of professional engineers. We continue to work on the computer thing. We often have a casino. I'm not sure that is a good idea, but that is what we do. We tried it for two weeks, and we had some other things, but then we had students over the weekend. So we had to have some organized portions, provide for religious activity, and things like that. We usually end the program with what we call "Mr. Wizard Program." We have them evaluate the program. We help them to pick a field of engineering, science, or technology. We try to interpret for them, at least in the group program. That is the kind of thing that we do. We often give some awards, and almost everybody gets a certificate or something. Often the parents will be at the luncheon at the end. For the one-week program it would cost, usually, about a hundred and fifty dollars a week. The two-week program might cost two-fifty to three hundred dollars. For people who have socio-economic problems, we always have some money to take care of that. But, we don't have the funds to pick up the tab for everybody. This is one that is pretty much self-funded. In fact we look around for help to assist in paying for some of the preparation. This gives you an idea of what a program would look like. I brought some of those programs with me and some of the literature on it if you would like to get this information.

Question from the floor:

Are they in high school? Are they seniors?

They are what we call "Rising Seniors". They have finished their junior year and they are going into their senior year. Our follow-up studies indicated almost all of them go to college. It doesn't matter if we are talking about the ".....STEP..... Program", which is a high achievement group, or a regular group, they almost all go to college. We get about 25 or 30 percent in engineering and maybe 10 percent in some of these other areas. They usually end up at other institutions. We really work hard on the prospects of high achievement students. We are doing a little bit better on that.

Question from the floor:

Can I ask a question? How many students can you accommodate in your summer program?

We found that in the two-week program we could only handle a hundred with our resources. But, we've gone back to one-week programs and then we can accommodate about two hundred or two hundred and fifty, something like that. It turns out that our show rate, recruitment and everything is better for two weeks than one week, and it is a lot more cost effective. We do pay some of the students who help run those programs. Some of the staff also helps. It is not all gratis. That's the other thing about a one-day program, you can get a lot of dedicated service. But when you are talking about tying somebody up for two weeks, a week, or even a whole day, that is hard to do.

***"Look to the left of you two people, and look to the right of you two people. Four of five of you will probably graduate from Purdue and the other one might end up being your boss."***

We talked a little bit about retention. Actually at one time our retention rates were very poor, graduation rates were very poor. But, now we really don't see a great deal of difference between the colleges when you are talking about retention. They usually run around fifty or 55 percent for men and women. That used to be as low as 25 percent. Also, we considered university graduation another important thing and we usually graduate 75 to 80 percent. This happens to be graduation rates after attending the university for five years. We have a co-op program, so it may be closer to six or seven years. I like to tell a story. We used to say, "Look to the left of you and look to the right of you. Four years from now only one of the three will be around." Now I don't use that. I try to encourage everybody to say this, and you might want to; "Look to the left of you two people, and look to the right of you two people. Four of five of you will probably graduate from Purdue and the other one might end up being your boss."

The reason that I say that is, I think too often we have said to the person who withdraws that withdrawing is a failure, and it isn't necessarily true. They are very talented. The number that we drop for academic reasons, overall, is very small. I think it's maybe five percent, and even many of those will come back. They're late bloomers, maybe, in our program. So I think, in general, we have to try and get away from that stigma. Because people drop out for all kinds of reasons, it doesn't necessarily mean that they're failures.

To give you an illustration. We took our winners of Merit Awards and asked how many stayed in the University. Some years we have not lost a single one, everyone of them graduated - 100 percent. The all merit awardees were running around 80 percent. This happened to be consistent after three years or six semesters. The important thing, the only point that I'm trying to make here, is that some Merit Awards recipients graduate from the University and our overall retention is not too bad. As a personal follow-up, we have the Society of Women Engineers call students who have been admitted and say, "Well I hope you're coming. Is there anything we can do to help you?", and so on like that. Then there is parent/student information. Lots of parents are very anxious over some of those things that happened early in the fall. These things made a lot of parents anxious. We're a pretty protective environment, we're an old, small university community. But we are still very much concerned about "date rape" and things of this type, so there are a lot of things that we have here for protection. We have escort services. A lot of times students in engineering have to be in the computer lab late at night and so on, so we have worked out this system that we think is pretty good and is fairly important.

We have about four or five different levels of English, mathematics, science, chemistry, physics, and programming that we use to try and place students. We think placement in courses where students have a very good chance of being successful is fairly important. Most of these are fairly high achievers. If we put them in what they have visualized as remedial course we do have some problem. They feel that they are being put down and so on. So we think that's important. Jane offers a seminar that brings in role models, talking to the freshmen, during the first semester. She will bring the dual couples, people who use engineering as a background, but they may be lawyers or medical doctors or what have you. We usually have a little assertiveness training in there and some things of that type. Also, we have a seminar that Jane

started last year for seniors to get them ready for the "world of work." A lot of them come back and say, "Why didn't you tell me what kind of world it was out there? We were very protected in the university environment sometimes. It is a different world out there." They learn all kinds of things. This was more of a problem, I think, a number of years ago, when many women engineers were the first ones to be employed in a certain division in a company.

## *"The name of the game is "International Productivity."*

Often we talk about critical mass. I wonder what that number is, but we have a little over a thousand women studying engineering as undergraduates. So that critical mass for us was a thousand out of six thousand undergraduates in engineering. That is in a university that has about thirty-six thousand students and about thirty thousand of them are undergraduates. It is interesting that a few years ago we had very few women in Agricultural Engineering and now almost 49 percent are women in Agricultural Engineering. They are leading the pack and that is because they made a special effort. They're concerned with a lot of environmental things, concerned with a lot of food problems. A lot of women and minority students tend to go into engineering to make it a better world, so to speak. Let me flip into a couple of other things that I think are important to a comprehensive program. I think that you have to worry about employment. We have a lot of job fairs where we bring in prospective employers. They talk to our seminars or things like that. If the students are not eligible for a co-op program or don't want a co-op program, then summer internships are just as good. We do a lot of work on job search things. Our placement center gives information on topics such as how to write a resume, how to do interviewing, the right interviewing techniques, jobs listings, and various tips for those kinds of things. The college placement service at Purdue is one that had a lot of effect on students. There are so many students who want to use it that we almost have it computerized. You can get your first, second, or third choice. We try to make sure that everybody gets a shot at it and not just the few who maybe have twenty interviews. There is a tendency in the industry to want the high flyers, so to speak. Yet, for a lot of organizations, I think that maybe the average student would meet their needs better. I don't necessarily buy, "Tell me what your grade point is and I'll tell you who you are." There are a lot of other things that people have so often that are very important. I think that some of the companies -- I have a fighting battle with the IBM people -- can get a lot of students and that's why they end up with a lot of excess baggage that they have to get rid of. There are companies who just want the top students. I think that is terrible to say. My own studies of graduates indicated that there is almost no correlation between grades, salary, later responsibility, and things like that. Yet, we worship that GPA too much. I hope you don't mind my being on a soap box.

I think that graduate school, as I mentioned, is critical. I think that we have to look increasingly at recruiting people from other kinds of disciplines. The name of the game is "International Productivity." This is very important and I think that's another asset that women can bring into it, because they often have language capabilities. Many know a number of different languages and as this world becomes smaller, I think that having a language facility is becoming more important. Last year we had a big university-wide thing, an International Program, and that is the way it's going to go.

I missed a plane out of Chicago last week and came back with President and Chairman of the Board, Ron Sharp, who is a Purdue alumnus. He said, "Five years ago about three quarters of our work force was in the United States. But, now 68 percent of our work force is overseas." The world is getting smaller. That may be a real plus for women. Women want to travel a lot more than men. I don't know why. I think that after you've traveled awhile and missed enough planes and so on, you are not quite sure. But, the travel kind of thing is certainly nice.

Let me just talk about two other things. One is: perhaps you have seen this Directory of Women in Engineering Programs. I don't know but I think they're going to update this. Preview editions were in 1982 and 1987. In 1987 you can see the various Women Engineering Programs in existence. We noticed in 1987 a lot more re-entry programs, although I think that there were some in existence before. It wasn't recorded before, so we can't really make that comparison. Likewise, we didn't talk about doing things at the grade-school level so you really can't make comparisons. At one time there was stigma associated sometimes with

the Society of Women Engineers but not any more. You can't, working with your one Director and the Assistant Director, deal with twelve hundred people. So you have got to have some kind of help. I think that the Society of Women Engineers, if they are given the opportunity to take charge, really do a first rate job. They can do a lot of our out-reach activities at grade schools and high schools and things like that. I think that's one of the things that we should encourage the faculty to do.

Pertinent information. We're going more to a video-type thing, instead of slides. At this time we're increasing scholarships less because of their cost. If you look at today, I think you find even fewer scholarships that are dedicated to that because they are very expensive and if your resources are women, you're going to have to find a better way to use them.

Question from the floor:

How are we going to continue to be able to attract and help women in Engineering Programs if scholarships and fellowships are stopped?

I think that there are other financial aid packages in place. The problem is to get them the information so they can use it. I think that's a better way to do it. I am not saying that financial aid isn't available, I think it is. But rather than use your limited resources to fund only scholarships, I think the trick is to do many of the other things I have talked about.

The last thing that I want to talk about is this National Science Foundation (NSF) grant that Purdue received. Dr. Jane Daniels is the Director and Principal Investigator for the Women's Engineering Programs Advocates Network (WEPAN). She is getting help from the University of Washington and Stephens College so we have sites in the middle of the country and on the West Coast. WEPAN had a conference in Washington, D.C. and is trying to set up a comprehensive program so they can coordinate the efforts. We are hoping for a kind of synergetic effect of working together and riding piggyback on some things so we aren't rediscovering the wheel. A lot of the focus at the Washington, D.C. meeting was on how to start a program, how to fund it, the nuts and bolts of a women's engineering program. Also, they had such things as I have talked about. You see if you can get people together for just a couple of days, you can focus on the works of things that you have been doing here... a sort of mini-advocates type of program. I think that you have done a splendid job. They had all kinds of people participate in the WEPAN program, not just those who are the Directors of Women in Engineering Programs. Sometimes you need to get those administrators and those faculty members in there. In fact, at a lot of schools the Director of Women's Programs is often an Assistant Dean who does this along with a dozen other things. It is starting to change a little bit, but it is still, I think, probably more the mode than anything else.

Specifically these are the kinds of things that the networking is going to try to do. This is what Jane Daniels likes to say, "What might have been." She is saying if we could have these things in place we might have been able to keep engineering enrollments up, instead of the way enrollment has started to drop precipitously, now. But if we could have put more of these programs in place we could have kept advancing that growth curve. We probably wouldn't have this very precipitous drop that we can expect to have in a number of B.S. Degrees in Engineering. That's my story.

# A COMPREHENSIVE PROGRAM FOR WOMEN IN SCIENCE AND ENGINEERING

**Cornelia L. Denson Gillyard, Ph.D.**

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*Dr. Cornelia Gillyard, Director of the Summer Science and Engineering Program, is an Associate Professor of Chemistry at Spelman College in Atlanta, Georgia. She has a strong interest in the science education of women and minorities. She is a member of a Community Strike force organized through a grant from the American Chemical Society to address the problem of low numbers of minorities in the sciences. She also works with local Atlanta high schools annually as a consultant and science fair judge. She has served as a panelist and presenter in workshops geared toward exposing high school students to career choices in the sciences, engineering, and technology. Dr. Gillyard's research interests include the synthesis of organoarsenicals and applied NMR Spectroscopy. Dr. Gillyard received her B.S. in Chemistry from Talledega College and her M.S. and D.A. degrees in Organic Chemistry from Atlanta University, Atlanta, Georgia.*

I'd like to first tell you something about Spelman. In talking with some of you last night, I found that some of you were not as familiar with Spelman as others. Spelman is a Black, private liberal arts college located in Atlanta, Georgia. We have an enrollment that's greater than 1,600. It usually fluctuates between 1,600 and 1,750. Of this enrollment about 37 percent of our students tend to major in the sciences and engineering fields.

[Showing pictures on the wall]

This is just one of the gathering places on campus, our Noble Sisters Chapel where we hold a lot of our convocations and other social events. That was one of our earlier buildings (second picture.) This building is where the students like to gather - the Student Center. We have constant renovation programs and building programs. We are trying to keep up with the times and growth in our school. Spelman is unique in that it's a small college, but because it is a part of the Atlanta University (AU) Center which is a consortium of six schools, the students enjoy the benefits of a broader academic climate and resources of a university center. This logo is incorrect; within the past two years Clark College and Atlanta University have become a merged institution and it is now Clark-Atlanta University.

Although Spelman does not have an engineering program housed on campus, our students have access to engineering programs through what we call a "Dual Degree Program" coordinated through the Atlanta University Center. Through this cooperative agreement our students are able to pursue engineering

degrees. What happens is that the students usually take their first three years of academic course work at Spelman and through cooperative arrangements with other institutions, such as The Georgia Institute of Technology, Boston University, Rochester University, and Auburn University, our students are able to complete the engineering degree. They end up with what we call "Dual Degrees," a Bachelor of Arts or Bachelor of Science from Spelman, and a Bachelor of Engineering from the other institution.

I want to talk to you about a comprehensive program for women in science and engineering. In talking about this program I will describe two programs which are very much integrated. That would be the Women in Science and Engineering Scholars Program and the Summer Science and Engineering Program. I'll give you a basic overview; from what I understand, you heard about this program from earlier speakers. Latonya Bailey, who will speak after me, will actually give you a detailed description of the program. This program, The Women in Science and Engineering Scholars Program (we use the acronym WISE Scholars Program), is funded by the National Aeronautics and Space Administration (NASA). It is under the direction of Dr. Etta Falconer, whom many of you know. She is a very positive and strong role model, and a strong force in the mathematics field.

The main objective of the WISE Scholar Program is to increase the number of minorities in the science and engineering field, by first of all providing them with an opportunity to pursue a major in physics, mathematics, or some area of engineering at the undergraduate level at Spelman College and providing them also with the opportunity to engage in a research activity with a Research Scientist at one of the NASA sites. Latonya Bailey will talk with you about that. There are ten NASA sites that are on the list where our students engage in a ten week summer experience. As I said Latonya will tell you about that.

In order to be eligible for the WISE Scholars Program, first of all the students must express an interest in attending college at Spelman. NASA provides 80 to 100 percent financial assistance in the form of a scholarship, room and board, tuition, and books. Also, in terms of the summer experiences, NASA provides the cost for one round trip to and from the installation. Priority is given to students who reside in areas within close proximity to the NASA sites. The student must be a senior in high school and participate in graduation. They must also be a member of an underrepresented group, and have an expressed interest in pursuing a major in the science and engineering fields. We look at students with high school GPA's of about 3.0 or better and SAT scores of 1000 or above or a combined composite score on the ACT of 25. There is no real cut-off in terms of SAT score or the ACT score. The student is usually evaluated totally in combination with several factors. Latonya will tell you about the requirements for remaining in the program. Some are:

1) The student must maintain a GPA of 3.0 or better.

2) They must maintain an interest in pursuing a major in engineering, or mathematics or the quantitative sciences.

3) They have to participate in certain academic and enrichment activities, which Latonya will describe for you.

One of the requirements for the NASA/Wise Scholars is that they must participate in the Spelman Pre-Freshman Summer Science and Engineering Program. I guess you could say that it's kind of a prerequisite to their matriculation at Spelman. I'm going to put up a design that some of the Summer Science and Engineering students came up with for our t-shirts to illustrate what the Summer Science and Engineering Program is about and what we attempt to do.

The Summer Science and Engineering Program, as it is known now, started out with NASA as its only funding source. For a number of years we've conducted other summer science programs at Spelman which tried to meet the needs of the same kind of students who participate in this program, but the program consisted of both those students who were interested in the quantitative sciences and also students interested in the health-career professions. Since that time, in fact, with funding from NASA,the programs became separate. We now have a Pre-Freshman Summer Science Program which addresses the needs of students interested in health career professions. The Summer Science and Engineering Program now is geared toward those students who are interested in the quantitative sciences. If applicants express an

interest in medicine or bio-medical careers, they are referred to the Summer Science Program.

NASA, as I said, was the major funding source initially. Since that time, within the last 2 years, we have continued to have additional funding sources, one of which is the National Science Foundation. They have contributed funds for twenty participants for the last two years. More recently, this past summer, we had funds from the William Penn Foundation which supports eight participants.

The main goal of the Summer Science and Engineering Program is to work in conjunction with the WISE Scholar program to increase the number of minorities who are entering careers in the scientific and engineering fields. It is designed to strengthen the academic background of those incoming freshman at Spelman. Again, the prerequisite is that a student for this program must express an interest in attending Spelman College, they must have been accepted to Spelman, and they must have indicated that they have an interest in majoring in one of the quantitative sciences. Our applicant pool comes from the admission list at Spelman. We have several components of the Summer Science Program designed to meet certain needs of the students. The academic component, as I said, is to strengthen their academic background. We also provide enrichment opportunities for the students where by they are able to observe positive role models in industry, academia, and governmental agencies. We also have a social component to help the student adjust socially, enabling them to make their transition into college easier. We have joint activities that are planned with other participants in other Summer Science Programs. In fact this past summer, Spelman had about a total of nine summer programs ranging from the Academic Enrichment Program for kindergarten and going through the twelfth grade; including a Middle School Summer Program designed to get students interested in science. We also participate in joint activities with other programs not housed on Spelman's campus, programs in the Atlanta University Center. One of the things that we attempt to do with other programs in the Atlanta University Center is to have a joint reception when most of the participants are there. We plan holiday activities; most of them are there during the Fourth of July holiday, so there is a joint picnic for them. Culminating joint activities include a talent show with students in the AU Center Programs participating and competing.

We also have a very strong support system to give the students a rather nurturing and supportive environment. We have people from the counseling office, and we have our assistant director live with the students, to be there to advise them and counsel them as needed.

Students who participate in this program must reside on Spelman's campus. It is a very rigorous and intense six week program. All major expenses are paid for each participant with program funds. The only expenses that participants are responsible for are incidental spending money and supplies such as pencils and writing paper.

In our academic component they take several classes. The academic component is usually conducted by six faculty, most of whom are full time faculty at Spelman during the regular academic year. The only faculty that we have that are not full time faculty at Spelman during the academic year are the faculty who teach the Introduction to Engineering course. The students as a whole take classes in chemistry and computer science. Based upon their expressed interest in a major, they may take Introduction to Engineering (if they're interested in an engineering career) or they will take a Statistical Methods and Sciences course (for those students who may be interested in areas other than engineering, such as mathematics, computer science, or chemistry.) All students take the Computer Programming I course and as part of our enrichment, we have a problem solving course which is offered to all students. The mathematics courses that the students enroll in are determined by placement tests. Based upon their results or the score on the placement tests, the student may be placed in what we call Pre-Calculus II. That means the students may be stronger than a Pre-Calculus I student, but there may be some gaps in their knowledge and this is the time to fill in so they can strengthen their mathematics background in the Pre-calculus II mathematics course based on that score. Others will enroll in what we call an Analysis or Calculus I course if they scored high enough on the pre-test. Students do not get academic credit for the mathematics course. They are in classes approximately ten hours a week, but it is just to strengthen their background. After going through the mathematics courses 85 percent of the students will place into the next higher mathematics course. If they are in Pre-calculus II most of them go on to Analysis I or Calculus I. If they are in Calculus I or Analysis I, they will move into Calculus II or Analysis II at the end or completion of the program. Academic credit is awarded for a chemistry laboratory component. We do not feel there is enough time to award full credit for the lecture course. They also earn academic credit for the engineering

course and the statistics course, as well as the computer science course.

To give you an idea of how the student's time is spent in the academic component, we have the day split up into blocks of time. In the morning the students are taking a mathematics course or a chemistry course or a computer science course. More specifically, all students will be enrolled in mathematics. Other courses are divided into sections, e.g., one section may be taking computer science, the other takes a chemistry course. They start out at 8:30 in the morning and break for lunch. In the afternoon they will have the chemistry lab, the engineering course, problem solving course, or the computer lab course. In the evenings, (and the students really complain about our rigorous schedule) they are required to come back after dinner to the academic classrooms for tutorials. An integral part of the academic component is that the faculty, including graduate assistants or tutors, actually sit in on the courses and take notes in order to know how the class is being taught. In the evenings the student participants are required to attend the tutorial sessions with the graduate assistants. Also, in the evening (two evenings), a forum is scheduled for private mentoring sessions. There is one evening, designated on Wednesdays, where we have a seminar series which is a part of our enrichment component. The students, at the end of the program, are usually very tired. In terms of the overall evaluation and, also when I see them coming down the halls now, they are very appreciative for having had this rather intense, rigorous experience. Overall in terms of the evaluations they seem to feel that the program is very good to excellent. We have had no one who has evaluated the program as being poor, so far.

In the enrichment component, the Science and Engineering Seminar Series usually consists of speakers chosen from disciplines representative of the career interests of our students in the program. We will usually have a chemist come in to give a talk and interact with them at a reception, or an engineer or a physicist. So we usually gear the seminars to meet the interests of the students. One of the things I'd like to say about the seminar component is that this is actually a co-educational seminar. Our students usually appreciate this program; it's one of the few summer programs on campus where there is co-educational experience. There is a comparable program at Morehouse College which involves the NASA McNair Scholars who usually participate in the seminar series with them. We also take various field trips to local and out of state installations. Included in our support services are a lecture series, time management, study skills, library and research skills, and mentoring. The Introduction to Engineering course requires students to do a project with some library research.

Socially, overall, in that long list of activities that is scheduled on weekends the students usually tell me, "We're so tired, we don't have time to go shopping, we don't have time to this, etc. There's too much going on." On the weekends we try to leave the schedule somewhat flexible. Initially when the student comes into the program we have a list of churches that they might want to attend, and for their first visit we will have our graduate assistants or tutors take them to the church service until they become acquainted with the city. There are residential activities scheduled. The students have access to the Spelman gymnasium on campus and the gymnasiums at other schools, as well, where they hold swim parties, volleyball competitions, tennis matches, etc. You can see that we try to meet the needs of the students and help develop them all around. Most of them feel that as a result of having attended this program their adjustment to college life has been much easier. They have fewer academic problems as a whole.

We try to restrict the number of participants in the program to no more than forty. This is because of planning field trips. NASA has given us funds for transportation for charter buses. Of course many of those visits or tours require chaperons, and it gets to be a problem if we have to try to manage two buses rather than one. So it's limited basically to forty participants. The number has varied from 30 to 40. In this number over the last two years, I think the number of WISE Scholars have varied from 11 to 13. We have enough slots for fourteen WISE Scholars participants. We think it's a good program. We're always looking at our evaluation system and what's come out of that in terms of the program. The program is evaluated by everyone concerned with the program including the faculty, the graduate assistants, the tutors, as well as the participants.

Finally, in terms of culminating activities for our Summer Science and Engineering Program, we usually hold an awards banquet. At the banquet the participants are recognized for their hard work. As an incentive to encourage them to work hard we do give special academic awards to them on this particular night. It is an affair where we invite the parents and, of course, the NASA officials are usually there. NASA also provides us with a speaker. The students also have an opportunity to show off their talent at this

particular event. The students look forward to it and, again, this is a joint activity with the McNair Scholars from Morehouse College. Are there any questions?

Ms. Betty Vetter:

Spelman is still a women's college, right?

Yes, it is still a woman's college.

Ms. Betty Vetter:

Well, you never said that. Morehouse is a male college, only men, right? Okay.

Under the cooperative agreement, our students may interchange, take courses at any of the schools in the AU Center. So when you come to Spelman, you may see almost as many males (if you come at lunch time, or after classes) as you see females.

Question from the floor:

If I understood you correctly, you separate those who are pursuing minors in the health profession from those who are pursuing engineering studies.

And sciences, quantitative sciences. We don't deal with the health professions at all. In our program, the Summer Science and Engineering Program, we try to attract those students who are interested in engineering, mathematics, computer science, chemistry or physics.

Question from the floor:

But there is a group. My concern here is, is there any crossover at all over the years, you know, the second, third, fourth year?

Yes, there is. When we're evaluating the applications for the program, we can only look at what the students tell us. A lot of them will look at our program and sometimes they are recruited by both programs. Information is generally sent out to applicants who have been accepted at Spelman, who have indicated interest in majoring in the sciences or engineering. So they may get information from both programs. Sometimes they will look at our program and say, "This looks better," so they slant their application to qualify them for our program. So we only look at what they tell us. However, once they participate in our program, and they start taking their courses at Spelman, they may change from an engineering major to a pre-med major. We have no control over that. We try to conduct activities which will maintain that interest, but a lot of times it's because of the rigor of the course that they change their majors. We've even had one student to change her major to English.

Dr. Joseph D. Atkinson, Jr.:

In real life after all this is over with, after the completion of academic work (let's take this over the course of five years) you find it fairly difficult to separate engineering from the "manned" requirements, person's requirements. As a matter of fact, one of the biggest problems we have is how you sustain a person in outer space after engineers have done their work. There is a great deal of inter-related work that goes on between the health professions and the other fields. I was just curious as to whether or not there was some preparation for this inter-relationship?

Let me just say that participants in both programs, the program that's geared toward the health professions and our program which is geared toward the quantitative sciences, are usually in the same

classes when they attend Spelman. There is no separation there except health career oriented people usually take biology, a lot of our students do not. But in terms of the mathematics, the physics, some of the other courses they tend to be in the same classes. So they have the same faculty for the most part. Am I addressing what you're saying?

Before I sit, I would just like to remind you that I did bring brochures on the WISE Scholars Program and the Summer Science and Engineering Program.

# COMMENTS FROM A SPELMAN COLLEGE SCHOLAR

**M. Latonya Bailey**

**Women in Science and Engineering Scholar (WISE)**
**Spelman College**
**Atlanta, Georgia 30314**

Good morning. Before I begin talking to you about my experiences as a WISE scholar, I would like to go into more detail about the WISE program.

The Women in Science and Engineering Scholars Program (WISE) began in 1987, and is funded by the National Aeronautics and Space Administration (NASA). Each NASA facility sponsors women each year for the program. Spelman College, a Historically Black Institution for women located in Atlanta, Georgia, is also a sponsor. As a member of the Atlanta University Center, Spelman students have the advantages of attending a small liberal arts college, while benefiting from the resources of the additional participating institutions. Spelmans' educational program focuses on Fine Arts, Humanities, Social Sciences, and the Natural Sciences. The program provides women of underrepresented groups with the opportunity to obtain undergraduate degrees in the sciences. The main objective of the WISE program is to increase the number of minority women in scientific careers, preferably at NASA. Students are exposed to NASA through seminars, lectures, and required summer research experiences. Each student is encouraged to pursue an engineering or science career, as well as a graduate degree in the sciences.

Applications for the WISE Scholarship Program are distributed to high school counselors located near NASA installations. Each year the WISE Program office receives more than one hundred completed applications from students. Scholars are chosen for the program on the basis of their scholastic achievements in high school and their desire to major in scientific fields. All completed applications are screened and ranked according to the following criteria: SAT scores, written essays, and the number of science-related courses taken in high school. The list is then sent to the Equal Opportunities Office at each NASA facility. The applicants are then assigned an essay to write and possibly given an interview. Each NASA facility then decides on the number of students it wishes to sponsor for the WISE Scholarship Program.

Each WISE scholar is expected to maintain a cumulative GPA of 3.0 during the academic school year. In addition, scholars are required to participate in all NASA sponsored activities and programs. Scholars are encouraged to attend seminars and lectures pertaining to their major field of study. The academic programs for the scholars are vigorous, but the students are given support and provided with a study skills course to help maintain their academic excellence. Each scholar is expected to major in electrical engineering, mechanical engineering, aerospace engineering, physics, or mathematics. Alternate majors are acceptable, if permission is granted by the Program Director at the sponsoring NASA facility. In addition to the summer science program that Dr. Gillyard discussed, all scholars are required to take the following courses: Honors Analysis, Honors English, and General Chemistry, which are two semester courses; Analysis III, Electricity and Magnetism, Mechanics and Heat, and Fortran or Pascal which are one semester courses. Also, scholars are required to do independent research with a faculty member. Engineering majors are required to enroll in an engineering graphics course during their freshman year. Freshmen usually carry a load of sixteen to eighteen semester hours, but many take a total of twenty-two or twenty-four semester hours with the required laboratory requirements.

Entering students are placed into one of three levels of mathematics, depending on the summer science program. Students are required to attend tutorial sessions during their freshman and sophomore years for mathematics and chemistry. At the sophomore level, scholars are required to take physics tutorial sessions. Some of the WISE scholars also participate in Spelman's Honors Program and as a result, the students must adhere to the guidelines of both the WISE and Honors programs. Honors Program students are required to take Honors Seminar in philosophy during their freshman year. As stated earlier, WISE Scholars must engage in independent research projects that culminate in their thesis during their junior and senior years.

*"... the WISE Scholarship Program has given me as well as other talented young women the opportunity to pursue scientific degrees."*

During the sophomore year students begin their major sequence. To ensure that each scholar will achieve to her utmost ability, academic core programs have been established within the WISE Scholars' curriculum. Scholars are supported by group and individual study sessions, group meetings, and by their professors, as well as the WISE program staff. In addition, the scholars form their own network. Scholars assist each other with tutoring as well as with any other problems. The freshmen receive encouragement and guidance from upperclassmen scholars. Upperclassmen advise the scholars as to which courses to take during their first year. Spelman College provides support and counseling programs within the Student Life Division, each college department and in the Freshman Studies Program.

Each scholar is required to complete three Summer Research Internships sponsored by NASA. The Summer Internship Program is designed to give scholars hands-on experience in science, engineering, and various technical fields. Engineering scholars usually complete two summer internships at NASA and then transfer to their chosen engineering institution.

I have completed two internships at the Johnson Space Center and this summer I will be attending The Georgia Institute of Technology. Next summer (the summer of 1992) I will be returning to The Johnson Space Center. After the first year is completed at the engineering institution, the NASA scholar returns to Johnson Space Center, or her sponsoring site to complete her third and final summer experience.

For my first summer experience, I worked as a computer assistant in the Aircraft Operations Division at Ellington Field. During my second summer I received hands-on experience in the Life Support Branch of the Crew and Thermal Systems Division. During my term, I was responsible for collecting and analyzing data for the Regenerative Life Support Test Box. Through the use of the test box I verified light intensity and uniformity in determining the effect of temperature and illumination for the proposed Regenerative Life Support Systems Chamber. As a result of my intern activities, I increased my knowledge of membrane technology and studied the necessities of successful plant growth. While at the Johnson Space Center I was able to participate in various on-site tours. I attended a briefing on the Astronauts Selection Candidate Process and I attended a tour of the EMU Backup Facility which is located on the third floor of the building where I was located. These activities allowed me to view a part of NASA that ordinarily I would not have seen.

In conclusion, the WISE Scholarship Program has given me as well as other talented young women the opportunity to pursue scientific degrees. By representing and supporting various underrepresented groups in the sciences, NASA has begun a program which will ensure the increase of underrepresented groups in scientific fields.

# PANEL OF NASA/JOHNSON SPACE CENTER WOMEN ENGINEERS AND SCIENTISTS


## Marilyn Lindstrom, Ph.D.

## Planetary Scientist


I am Marilyn Lindstrom. I am a Ph.D. geochemist, and my job at the Johnson Space Center (JSC) is Meteorite Curator and Researcher in the study of lunar samples and meteorites. As part of my job I manage two laboratories. One is the Meteorite Processing Laboratory where we describe, classify, and distribute samples throughout the world -- usually several hundred samples per year. I have about four people in the lab working for me who do most of the labor. Secondly, I operate the Neutron Activation Laboratory which is the research arm of my job. There we analyze samples of the lunar rock, meteorite, and terrestrial (Earth) rocks in order to understand the origin and evolution of the solar system. This laboratory is not used solely for my own research. Other JSC and CPI scientists and a number of university visitors also use the lab. Last year eight university visitors used that facility, some through formal programs; others through informal arrangements. In the sciences, as well as engineering, NASA does try to involve students and faculty (undergraduates, graduate students, post-doctorates) in the science activity, opening our facilities to them whether they're planning on working at NASA or not.

This year and next I am a member of the Federal Women's Program Committee, which Freda Marks heads. My reason for being on that committee is that I want to be able to help younger women choose and pursue careers in sciences. As we said on Monday, the Association of American University Women (AAUW) and the Federal Women's Program Committee are sponsoring a workshop for local teachers to encourage girls in these fields.

I am also married to a fellow geochemist who is in the same branch of NASA that I am. We have two children, a boy eleven and a girl eight. That basically gives you an idea where I am. How did I get here?

Basically, back in my school days I was always an excellent student. Being a student was fun for me, I loved it. It wasn't any problem. I had a lot of parental encouragement. Neither of my parents had college degrees, but both of them were intelligent. Had they not gotten out of high school during World War II, I think that they might well have gotten college degrees. My father was an engineer, but that was through twenty years of experience in the Navy. However, it was a very different route than I chose.

In school I was never told that I couldn't do anything. I think it would have been pretty dumb to tell me that because I obviously could. Nobody ever treated me differently than the boys in my class and I always felt like an equal. The teachers were always encouraging, but I didn't have a mentor. I would have a hard time deciding which way I was going to go in school because I was good at everything. I didn't let any teacher push me very much in one direction. My parents didn't try; they encouraged me to do whatever I chose to do for myself. In high school I always thought I was going to be a high school teacher of science or mathematics. When I went to college I didn't know what I was going to do.

I went to college at the University of California, San Diego (UCSD). The first year at that school was an exciting experience. My education was basically Liberal Arts because that was the only thing that was there. There was no such thing as a B.S. Degree. But it was intense science. My degree is in chemistry from UCSD. I gradually moved (I love theoretical things) from mathematics into physics and chemistry. The urge in me was to move to more and more applied stuff. I loved theory; it is the theory part of chemistry that I like best. I hate getting my hands wet in chemicals. So, I don't! What I deal with is radio

activity and nothing is ever dissolved. I just irradiate them and measure the gamma rays. I wanted something that meant something, instead of something that was all in my head. So I kept moving farther into applied science. I actually started taking my geology courses along with chemistry as an undergraduate.

My graduate school was pretty much a continuation of this. As a college student, I think that I totally gave up on the idea of high school teaching though I didn't know what I was going do in the long run. I loved school and went on to graduate school where I found a particular area of geochemistry that I majored in. The time when I started graduate school was also the beginning of the Apollo Program, and I got involved in NASA-funded research. I have been involved with NASA-funded research for twenty years, even though I have only been at NASA for four years.

***"To me the only barriers to my career have been personal issues, that of combining in my own mind, being a woman and being a scientist. Those issues have come up all along the way."***

I had lots of help along the way. The other day I mentioned that I had an AAUW Fellowship, which was very nice. But, also I had a Regents Scholarship from the University of California, a fellowship from the National Science Foundation (NSF), and grants from the Geological Society of America. So I competed with the guys by their rules, so I didn't have to worry about the flack they gave me when I had a Women's Scholarship. Anything that helped along the way was appreciated.

As I said, I didn't have a mentor during any of my schooling. I didn't have real strong motivation until well along in graduate school. As a post-graduate working at Washington University, I did find a mentor who encouraged me. I will tell you a little bit about that later. To me the only barriers to my career have been personal issues, that of combining in my own mind, being a woman and being a scientist. Those issues have come up all along the way. I think that this happens to everybody and that it is something that you have to admit when talking about things. Men have personal barriers, too. It is not any different. It is just that the barriers are a little different, and they are culturally framed.

As an undergraduate I dated the same guy for four years. He was not going to go on to graduate school, he was also a chemistry major. My work excelled over his in school, and I had a choice between marriage and graduate school. I went off for a year as a technician somewhere else to think about it and decide. It took me about three months to decide that I was going to go on to graduate school, and I started taking courses immediately. But, it took me eight or nine months to decide that I wasn't going to get married to that guy and that he couldn't handle "Mr. and Doctor" and, therefore our relationship couldn't endure. That's a problem in life and we have to realize it; men face it, too. You have to come to grips with that.

In graduate school I met the man who could deal with it. My husband was a fellow graduate student, and he is a guy who is internally motivated but not highly competitive. He has no trouble dealing with my career. We have had parallel careers for twenty years and have been able to talk about things. Sure there are rough spots every now and then. I just got a promotion and I am now one step ahead of him here at NASA. He is in the same branch that I am and that doesn't bother him a bit. This is just the way we want it to be. Making things work depends on both the man's and woman's attitude. You feel pretty lucky when you find the right guy. Even so, things are never easy. When you're both in the same specialized field, each with a Ph.D. in geochemistry, it is not easy to find two jobs. We have been lucky, however and have had two jobs all along the line. When we came down to NASA we weren't even looking for jobs when this one sort of fell into our laps. They came pursuing us.

The first job that was available was for me because of my specialty not because I was a woman. The initial question on my interview was, "What can we do to get Dave here, too?" So management finally understood our problem. When we started looking for jobs in 1975, we applied for the same academic jobs at various institutions. When we said that we would share a job we got the reaction, "What are you lazy, you only want to work half time?" We said, "No, we'll take soft money for the other half time, but we have

a problem and this is the best solution that we have come up with." We didn't want to say, "If you'll take the husband then the wife would come along for soft money" which was the traditional way of doing it. Employers are doing that a lot better now, than they did fifteen years ago. This is a problem faced by many of the women in the sciences -- they are married to men in the sciences and the couple is faced with looking for two jobs at one time. That has been the real hurdle in our life and we have managed to successfully overcome it.

The next hurdle was the decision of career vs. family and that one has been harder. After working for about three years after finishing our Ph.D.'s, we decided to start a family. We were settled into a pretty good job situation and quite happy there. When I got pregnant I told my boss, who was developing into my mentor, that after I had the baby I wanted to come back part-time. He looked at me and said, "I don't think that there is such a thing as a part-time scientist." I had a very good relationship with him, and he decided to let me try it. I succeeded very well and since then a number of women scientists at that institution have become mothers and worked part-time. I was working three quarters time; it was great.

Now at NASA I work full-time. My job is really more than full-time. I find it a challenge to maintain some sort of balance between my family and my career. There are times when I think that there is not enough time for the family or not enough time for my job. This is the sort of thing that we're always facing. But, I have good bosses here as well, who are willing to give me a little bit of flexibility. I think that the point that I wanted to make is that we're going to have to realize that there are choices all along the way. To combine a career and family managers have to be able to give you choices and provide a little bit of flexibility so that you can find your own way through the complicated scheme of your life. Thank you.

# PANEL OF NASA/JOHNSON SPACE CENTER WOMEN ENGINEERS AND SCIENTISTS

**Cordelia Foster**

**Mathematician**
**AST, Data Analysis**

My name is Cordelia Foster. I have a Bachelor's Degree in Mathematics with other study in a number of areas. I will go into that after I tell you a little bit about what I do now. Right now I work in the Engineering Directorate Flight Data Systems Division on the Space Station Freedom Systems Support Environment. We are doing some planning and getting ready for Space Station -- that is if we can keep enough budget.

What I do here at Johnson Space Center is serve as an Engineering Task Monitor. In that capacity we have a number of contractors working on some of the systems here at the center. We have NASA individuals monitoring the work that goes on in those tasks. Times have changed. As I understand it, at one point most of the people who worked on the systems worked for the federal government per se. That has changed because of the complexity of the systems and economics of the work so now we have these jobs as Task Monitors. It happens in all of the disciplines now. In that capacity we have different projects, and on this particular one we are providing the environment that will be used to build the space station systems, the ones where you will use specific languages and tools or the rules. Since the system is divided all across the country and you have a number of work packages and multiple centers involved, we want the systems to be able to talk to one another. We are drawing off the experience of the shuttle environment. We are in the start up of that program. We have been working on it now for about three years. We have been working on that. We have facilities from one end of the country to the other. We have involvement with some internationals. The start up meetings have been interesting. It is definitely interesting working with the internationals because we do have some of the same problems with language, with customs and things like that. We try to accommodate those different disciplines without touching off some hard feelings and not knowing it. That has been a test.

We do a lot of support in the area that I am in now . I monitor an area that handles the help desk and user support. We deploy the systems. We have releases of a system, install it in computers around the country. Right now we have one facility with Rockdyne in Conoga Park, California; we have one at McDonnell Douglas in Huntington Beach, California. We go to a Boeing facility in Huntsville connected to the Marshall Space Center. The one in Conoga Park is connected with the Lewis Research Center out at Cleveland. We have a number of facilities around Pennsylvania associated with Goddard Space Flight Center. We are preparing for a site outside the Kennedy Space Center associated with Kennedy. So there are a number of facilities. We are also preparing, with Martin Marietta (out of Denver), a piece of the Space Station Program. That is what I do now, and it is a challenge because of the geographical location. At one time we were not spread quite as far as we are -- most of the contractors were closely associated with the centers, as I understand it. We didn't have the some of the problems that we are having now because of the diversity of the facilities.

Before working in this job I worked in the Ground Data Systems which was the group that handled the software and the computers that the Flight Controllers use to monitor the system. Therefore, on the

consoles that were installed in the control center we handle the software, the firmware, and the coordination between the hardware so those Flight Controllers could sit down and push a button and see the right information coming out. That was a contact monitoring job, and on a number of occasions we'd come in at all times of night because you have to do your testing during some off peak hours. You coordinate the installations and things to correspond with flights that are taking place so you can have your systems up ready and running. Then everything works right when Flight Controllers come in. You don't want anything to go wrong during a real flight but you're on call just in case.

How did I get to this job? That is interesting. My life was not quite like the ones who preceded me. As a young girl I watched the mission, the manned mission. I was really excited and said, "I want to do some of that." So it really did work. The President's thrust of getting students interested in the space program and science worked for me. Because I saw and said, "I want to go to work there." My mother was a teacher (she is retired now) with a major in languages and science, and she said, "Well I want you to be a teacher." I was always very good (like the other speakers) in mathematics and science. I participated in all of the rallies and took tests and did all of that. I said, "I don't want to do that." She said, "But you can't get a job unless you do that." When I graduated from school minorities and women did not get jobs unless they were a doctor or a teacher. So she said, "I know you can get a job being a teacher." I said to myself, "I know better than she does and I am going to get one of those jobs. I am going to work on the space program."

*"As a young girl I watched the mission, the manned mission. I was really excited and said, "I want to do some of that." So it really did work."*

I went to college and for a couple of years my mother did not know that I was not majoring in education. She didn't! She didn't know that. I didn't tell her, and there was no way for her to know. She said, "Please take an education course." I told her, "Okay, I will," and I did. I told her about all this later on down the road - that if I got a degree and my degree says "Bachelor of Arts" (sort of like Marilyn) - the Arts degree carries more sciences with it. So instead of taking two courses in biology, I took botany and zoology. I took heavy physics and a lot of the analytical classes given by the department head that were more geared toward a master's degree program. I have found out since then that the master's level programs were no different than the undergraduate ones I took. That was very good because the department head said that if we went to graduate school he wanted us prepared to handle a teaching assistantship. Because of the course structure that we had as undergraduate students we were able to go ahead and not just be a paper-grader or a tutor.

Question from the floor:

Where did you go to school?

Ms. Foster's answer:

You're not going to believe this, I went to Grambling University. It's a big football school.

I took those courses and I graduated. I almost had to eat my words because I graduated during the time that the space program was laying off engineers right and left. It was a mess! I mean it was terrible. I had a real good grade point average. A guy that graduated with me with a dual major in mathematics and physics with a grade point average of a 3.98 (or something like that) got three offers, but generally it was bad. So I said, "Oh God, I am going to have to go teach. I have done enough of that." You know when you're a teacher's child you tend to do that. You grade the papers, you do all the stuff along with them.

I was kind of through with that. I had tutored in college, and in my senior year we did some teaching of the entry level course. I had done all that and I thought, "God, I may have to do that." I can go right now and go teach. They'll just tell me to take one or two education courses to become certified. However, what I ended up doing was getting a job as a clerk with the telephone company. I did that for awhile.

It was really bad in 1972 because there were all these engineers out of work. I would go to these recruiting sessions and there were all these people with all this experience, and here I was a little person out of Grambling University -- that everybody thought only did football -- with this bachelor's degree. My only experience had been working in the college. A number of the students that I graduated with were recruited to go to graduate school. I was determined, and I said, "I've got to get a job. I'll go to graduate school later." I was finally able to get a job through one of my friends who is an accountant. She picked up an application everywhere she would go for a job, like Price Waterhouse.

***"I encourage everyone to pay no attention to those who say, "It is not very feminine to be in the sciences." You can be anything you want to be."***

At this time I was in San Francisco which has a lot of scientists but they were all laid off, every last one of them it seemed. I got a job as a Geo-Physical Assistant with Chevron. If you majored in mathematics you could be anything that they wanted you to become. I took a number of geo-physical courses and planned on going that route before I came back to Houston for two courses. I said, "Son of a Gun, there is that Johnson Space Center (JSC) again!" I really did. I had never thought about it before, but that is what I did. I said, "There is that Space Center again, let me go back over there." Then a chance came up for me to get transferred to Houston working in the Chevron office here. I was looking for an improvement in my income and job as you do when you're working, and I was transferred here to Houston. I worked at Chevron for awhile, and then like most students do, I took classes at night and worked. Then I saw an opportunity to come to work at the Space Center. I worked for one of the contractors. At the time this was one of the ways you could get into the Center without being a co-op and without being straight out of school. I worked for one of the contractors at JSC. The government opened a little hole for hiring, and I came to work for NASA. I have been in this capacity, working for NASA for eleven years.

All that I can say is that I always liked the mathematics. I had a great fifth grade teacher who got me started on the right road in mathematics. I got a good understanding of that. In college I competed with the fellows and they said, "You girls can't do it!" That was a good inspiration because we had to show them that we could handle the problems as good as they did. The teacher told us later that the competition made his class harder. Because what we did was compete in there; you know, "I made a better score than you did in there -- ha! ha!" We finally cooperated because in this class he made the final test so hard that we all had to work together to finish it. He gave a take-home final exam (if you can imagine) and we had to work together to finish it.

I encourage everyone to pay no attention to those who say, "It is not very feminine to be in the sciences." You can be anything you want to be. I was ready to graduate from college, and people didn't believe that I was majoring in anything in the sciences because I had a good time with everybody else. I would just go home and study. But, I partied with the best of them, and at the end they would say, "You really did major in that! You're great!" Try to encourage others because nowadays it takes two to try to do anything in this world. It's gotten really hard. People are looking for a way to make it and be successful. So I would encourage any of the young women to go into whatever field they want. It is not a stigma anymore to be in the sciences. It has gotten so that it is a big deal to say, "Yes, I am an engineer at NASA." Everybody says, "Oh man, isn't that nice."

Encouragement is the way to push them. We need to push all the students now because I feel real funny when I go to the schools and pass by the students. I am a single parent now. Sometimes maintaining a relationship is very hard when you have this type of job because some of the fellows do feel threatened.

I don't understand why, because I am looking for someone with some help. I have a little four year old. So I work real hard all day, and then I go home and play with him at night. It is a lot of fun because it is such a change. I have to change my hat over because he has a whole other line of things to talk about. But it is a challenge, too. I take that as just another of the challenges along the way such as being a person in the sciences when it wasn't very popular (because it wasn't). I was one of the first. I was the first lady on my floor at the oil company. I was the first female and the first Black -- I had a bathroom all to myself. I had my own, you know! So you have to kind of look at it like that. I did, I had my own. It scared me to death one day when the door opened. The oil companies are one of the most conservative groups. But there I was, and I wasn't very conservative. I am a child of the sixties. I was kind of different, but it was wild the day that door opened! It has been nice talking to you.

# PANEL OF NASA/JOHNSON SPACE CENTER WOMEN ENGINEERS AND SCIENTISTS

**Elena Huffstetler**

**Supervisor**
**AST, Technical Management**

I think I will start backwards. Rather than start talking about what I do now, I will start with how I got here. My father and mother were both professionals. My mother has been dead for a few years now. My father is a medical doctor. At home there was never a question of whether I was going to go to college or not. It was always assumed and discussed that all four of the children would be going to college. My father wanted me to be a doctor! My mother wanted me to be anything but a doctor. It was quite a large range of choices to pick from.

Why did I choose science and engineering? Well, I have always been good at mathematics and science. They have always fascinated me and from grade school through college I always enjoyed the courses. The atmosphere at home, of course, has always been one of knowledge and science. My mother was an avid reader. My father is still a very avid reader. He goes back for courses in his profession all the time. So that was just the atmosphere that I grew up in. It was always expected of me to obtain a good education. It was always assumed that I could do well. My parents have always treated me as if I were very capable of doing anything that I wanted to do. Being the only girl in a very large extended family I had to compete with the best of them. I have always been able to pull my weight, whether it was by my fist or by my mind. In either case, I have always thought that I would be capable of holding my own. I have always felt that school was necessary. That was, again, a given at home.

In junior high school I had a couple of teachers - one was my physical science teacher who was male and the second was my algebra teacher who was female - who were just fantastic. I have never been enthused more about my school work than with those two. They just challenged me to gain knowledge and then to succeed as I continued on to biology - I couldn't get enough of it. I took a few of the biological samples home - with the schools permission, of course. I also bought lobsters or frogs or whatever and dissected them. My mother always reminded me of the many times she would open the refrigerator and find a rat or a lobster - not the eating kind, but the kind with formaldehyde and all sorts of stuff in it. I always had access to microscopes and other instruments in my father's office or in school after classes. When we were taking trips I would say, "Stop, stop right away!" My father would say, "What is wrong? Do you need to go to the bathroom or something?" "No, there's a pond. I want some pond scum. I want to see what is in that pond." I was always encouraged to do those kinds of things by my family and my science teachers.

We moved to Houston from Maine for several reasons. But one very important reason is the universities in Houston. My parents did not want me to go away for college. They wanted me to have a good education and since Houston has three universities to choose from, that was one of the big incentives for moving to Houston.

Through high school my parents always stressed the importance of a basic education, but especially science, math, and languages. It was inconceivable to them that anybody would be taking shop or home economics or things of that nature. That was just not done. They never even thought that was something that the school should be teaching in the first place!

My parents had a lot of acquaintances that were either doctors or scientists. One of their daughters happened to be a bio-chemist who was in college at the time. She became my role model. I was really interested in what she was doing. As I said, my father was pushing for medicine, my mother was pushing for anything but medicine, and the role model came at a very good time in my life. I said, "Okay, that sounds like what I want to do."

I went to the University of Houston main campus after graduating from Westbury High School here in Houston. I graduated with a Bachelor of Science in bio-physics, with a minor in chemistry. When I started at the University of Houston (UH) I started out in the bio-physics department. I really didn't know exactly what I wanted to do. I knew I liked bio-engineering. That sounded even more interesting than the field I was in. But UH did not have an undergraduate bio-engineering program. So I had a choice of either acquiring an undergraduate degree in engineering or one in science, and then obtaining a Master's Degree in bio-engineering. I chose the biological undergraduate degree because that was more interesting to me than the straight engineering courses.

The mathematic and science courses in college were not difficult. The humanities were difficult for me only because I was not interested in them - now I am, but I wasn't then. All I wanted to take was more mathematics and science. I did have a lot of troubling times at the very start of some of the semesters. I remember going into my electromagnetic physics classes and finding out that I was the only girl in the class. The guys, as they were coming in, started teasing me about being in the wrong place - that I should be going down to the home-economics department! That really made me angry, so I said, "I am going to excel in this class and show them all," and I did. It was difficult though because I didn't quite understand electromagnetism that well. However, I kept at it. The professor did not have as much time to spend with me as did others that I had badgered throughout my studies. I finally got in touch with him, and he realized that this was somebody who was really interested in the subject. He then helped me a lot, and from then on I became even more passionate about the sciences, the challenge of it! I also enjoyed some of the thermodynamics courses that I ended up taking.

How did I end up at NASA? I remember in grade school looking at television and there was John Glenn orbiting the earth. I said, "That is what I want to be involved in." Another reason for the interest in NASA was that we moved to Houston and the Johnson Space Center (JSC).

I got married when I was eighteen, after the first semester in college. My husband, at that time, was working as a mechanical engineer for TRW Systems working on the Apollo Program. Again, I had the exposure to the Space Program. That exposure has always been there for me. I graduated in 1975 and I started applying to different companies. I decided that I didn't want to work that summer because my daughter was a year old at that time. However, I applied at NASA, and many months later I finally heard from NASA/JSC. I had a choice of either going into the Engineering Directorate or into the Life Sciences Directorate. I chose the Life Sciences Directorate in the Bio-Engineering Division. I started off as a project engineer for Life Sciences experiments. The first project that I ever worked on was extremely interesting. We were flying some fish eggs on a Russian bio-satellite, and we were actually designing the hardware at JSC and building it here on site. That was the most fun I ever had - actual hands-on experience. It was a small project. Management was aware of what we were doing and interested, but they left us alone. We had a lot of opportunity to make mistakes, which we did. I remember the first time I sent drawings to the shop. When I went to pick up the hardware I went, "Uh-oh, that is not really what I wanted." They said, "That is what you drew." I was upset, but I learned a lot. What was interesting was that I was the only technical woman in the division. Some of the guys took me "under their wing". Most of them were about as old as my father was at that time. They started teaching me some of the things that we were doing there. We had an electronics lab on the second floor of Building 36. I went up there quite a bit because I wanted to learn how things worked, not just the project management aspect of it.

I decided to go back to school and take some electrical engineering courses, because that's what the Life Science experiments were all about. Just hardware with a bunch of electronics in it. Later on, the more time I spent at NASA the more opportunities and challenges were given to me. I have been very fortunate to have had bosses that really believed in me. I think that they believe in me because I have proven that I can do a lot of things and learn quickly. But, I have been given a lot of opportunities and that was really fortunate for me.

One of the things that came about was an opportunity to obtain a master's degree at the University of

Houston at Clear Lake. I saw the JSC announcement that came around for a JSC/UH sponsored master's program in public administration, and I thought, "Well, okay, but I really want to get a bio-engineering degree." At that time I received a call from one of the people in the Equal Opportunity Office (EO) who said, "Hey, how come you haven't signed up for any of these programs?" I said, "Well, I really hadn't thought about it." He said, "What you're really doing now is project management and you're really not doing pure engineering, so why not? You can go get your master's in bio-engineering later or get your master's in bio-engineering right now." So I thought, "What the heck, I will try it." I really learned a lot. I really enjoyed it. It was a very good program that NASA and the university together gave us an opportunity to participate in.

A position for manager of the Flight Production Management Office - a branch level office in the Shuttle Program Office was advertised. I applied for the position and got the job. I really believe the reasons I was selected were that I was capable and because of what I learned in the master's program.

***"I would encourage all of you to provide to your students two of the elements that I discussed: environment and mentors/role models."***

What did we do in Flight Production? We developed and managed the flight schedules for the shuttle. I don't mean the schedule for the orbiter itself, the main engines, and the solid booster rocket. I mean the schedule for what we call the Flight to Flight Reconfiguration Activities. All that mumbo-jumbo means the following: the payload related activities for each flight such as installment of the actual payload in the orbiter, all of the required analyses, and the crew training activities. For each flight we track around 150 major activities. When you have 15 flights in work you need tools to handle that much data. Our office, therefore, ended up building a Management Information System to handle all of the data.

I became more and more interested in computers and computer applications. About six months ago I felt from a career standpoint that I really wasn't going anywhere and that in a few years from now I was going to be in the same place. At that time my husband suggested, "Well, you like computers. Why don't you go talk to the Information Systems Directorate?" I thought, "I don't have a computer or systems analyst background so why would they want me?" He said, "Well, go try it." So I did; I called them and they were interested in me! I changed jobs and now I am the Chief of the Information Resources Management Office.

What our office does is establish the architecture for the Institutional Systems that we have here at the Center. The computer systems, the networks, the electronic mail, and so forth. We do the strategic planning for these systems, as well as the policies and standards that the Center is going to be using for information resources.

I think that if I were to try and summarize how I got here I would put it in three categories.

1. Environment

2. Mentors and Role Models

3. My own personality

In the environment my family, of course has had the most impact. Not only my parents who always assumed that I would go to college and have an education, but also my husband and daughter who have always supported me even when I went back to graduate school. It was very hard on them, but we all did it. It was a "we"; it wasn't Elena doing it. The family got that degree, not me.

Mentors included my teachers, my father, my working acquaintances here at JSC, and also my bosses. The JSC Equal Opportunity Office helped me when I had never even thought of getting a graduate degree in public management. I think it is also very important to have role models. I work quite a bit with the

EO office as a role model for the high school and junior high school girls -- especially with minority girls.

Last is my personality - I have always been very curious. I have always wanted to learn; if I am not learning I am very frustrated. I am also driven. I have always had the thought that I can do it. I have to keep telling myself that there is no obstacle that I can't overcome. If I succeed that is great. But, if I fail, I can also succeed if I learn from the experience.

I would encourage all of you to provide to your students two of the elements that I discussed: environment and mentors/role models. But remember, it is also important to cultivate a "can do" attitude in the students.

# PANEL OF NASA/JOHNSON SPACE CENTER WOMEN ENGINEERS AND SCIENTISTS

**Gloria Araiza**

**Flight Controller**
**Aerospace Technologist, Flight Systems Operation**

Hello, my name is Gloria Araiza and I work here at the Johnson Space Center in the Missions Operations Directorate. I am a Flight Controller and I work in the Data Processing System (DPS), also known as the Shuttle Computers. What do I do as a Flight Controller? What we do is systems monitoring. We work in Mission Control Center, and you're all familiar with that I am sure. All of you have seen it on television or have been there. I have graduated to the front room; I started in the back room. You will get some information on the Mission Control Center later on. When I started I worked in the back room, which we called Multi Purpose Support Staff Rooms, and worked my way up to the front room. We have certain requirements that we have to meet to be able to work as Planning Control Room Operator, what we call the Computer Operator. What we do involves a lot of training, reading of workbooks, a lot of simulation time, working with the customers, and interfacing with the astronauts, the people in the Training Division and in some cases with the people in the payload area. Again, I have been there for seven years and I am in the front room. We have different phases and I am certified for all the different phases: ascent, entry, orbit. Our section has just recently taken over the Space Lab computers and we are certified for that, as well.

My background is in Mathematics. I have a degree in Mathematics. I have some graduate courses but I don't have a graduate degree. In fact, I am impressed with Marilyn's educational background. I think that if a postgraduate degree is a desire of an individual, whether it be a man or a woman, you should pursue it and it can be done. Marilyn, I really admire what you have done.

What else am I required to do at my job as a Flight Controller? One of the things is discipline. You have to be very disciplined in your job. Whatever jobs you do, whether it be as educators, analysts, operators, working budgets, whatever, discipline is a very important part of your job; and it is an important part of my job. When we have missions - they come, they go - you never know when you'll have delays and when you do, you have to be patient. But, when you don't have problems they fly the missions, maybe once a month, every other month, whatever. It requires a lot from us. For example, when working a mission we sometimes have to work twenty-four hours a day. We have three separate shifts, and we rotate. Our jobs require of us discipline and dedication -- you have to be there on the job when they need you. There are really no excuses, you plan ahead for these things and it if comes, it comes. If you have to work a holiday, you work a holiday. I had to work Thanksgiving last year, but that is part of our job. Teamwork is also a part of my job. We work with a lot of different people. We work with the Engineering Director; we work with management; we work with people in Building 1 in the Program Office. We have to work with different contractors including Rockwell in California or IBM (just to name a couple of them) and the only reason I name those is because they work with the computers. They write the software for the Primary Avionics System, as well as the Back-up Flight System. So we work a lot with them. We have to work with

people at Johnson Space Center, and they themselves have different contractors. So there is a lot of teamwork involved as part of my job. It is inherent; we have to do that.

In my job, we have to have the ability to lead, as well as follow. As we sit there in the Control Room we have a Back Room support. We are the leaders. We take information from our Back Room; we work as a team. We look at our data and if something happens we say, "This is exactly what happens." We give recommendations to the Flight Director. So we are leaders as part of our sub-system. Yet, in turn we have to follow, we have to provide information to the Flight Director. We have to be able to do that as part of our job.

You need a technical background. We do a lot of training. As I pointed out earlier we use workbooks and manuals and we read up on a lot of different sub-systems because the DPS or the Shuttle Computers interface with many different sub-systems aboard the shuttle. I don't know how many of you work on site but the shuttle is very complex and an incredible piece of machinery. I am sure you have heard that before, but it is! So at my job we have to interface with all those different sub-systems -- if you want to turn a valve on or if you want to turn it off or if you want to monitor pressure, temperature, etc. -- it is all there. It requires a continuous monitor. Granted, as a DPS I Controller we are familiar with the Operating System and the Systems Software. We don't worry as much about application but we do need to know that little fine line between Operating and Application Systems where we have to interface with the different people. So it requires a lot of technical background and understanding of the design. In fact, really it is not so much from an engineering point of view, but from the view of how it works. How does your system work? How does it operate? If it fails, how are you going to save the system? What will it do if this happens? So we have to do a lot of that. We do a lot of planning. We do a lot of "what if", and "if this happens during this time frame, what do we do?"

I didn't get to work on the last flight because I was at the Grand Canyon. But, anyway that was my mission off. We look at the different things we are going to deploy and say, "Okay, if this happens for this particular time frame isn't it critical? How are we going to handle it?" We have procedures. That is the other thing that we do, we have procedures in store that in some cases are canned or in other places or maybe they are signatures that we have never seen before. In that case we get with the Engineering Committee, we work together, and we come up with new procedures. That is part of our job, and it requires that you be technically competent to be able to work in there. Just to give you some background: We have different people with different backgrounds. In Engineering we have Aerospace Engineers and Mechanical Engineers. We have Mathematicians, Computer Scientists, and a few Chemical Engineers, but primarily Mechanical, Electrical, Aerospace Engineers. We have to be able to make decisions. We have to have good communication skills. We have to be able to communicate with each other. I have to be able to communicate with my Back Room as well as with the Flight Director, listen to what is going on, listen to what the crew just said. Communication is very important because if something happens we need to understand exactly what happened so that we can try to help them.

Some people ask, "Is your job really stressful or not?" I really don't think about it, but I know that whenever a flight gets here and you are sitting there at a console you're just a little bit more keyed up. Your adrenalin is going and you're looking at your data. Granted nothing may happen: it may be boring, but that is the way you want it. You don't want anything to happen. However, when we train under simulation, they give you hundreds and hundreds of failures that you have to integrate in order to train and learn procedures and work with the crew. We are always looking at ways to do our job better.

People have asked me, "What do you do when you are not flying?" One of the things that we do is continue training. We do workbooks, handbooks, write documents about a quarter of an inch thick, or an inch thick, that explain how the system works. One of the other things I have recently taken up is side projects. I am working on a glass cockpit project that may be coming on board pretty soon. For example I get to monitor that, and I get to follow it up and to work with a lot of different people. That is separate. We have different projects along the way that help you learn and keep you excited. Then you go back and you do Flight Controller stuff.

How did I get here? I am originally from South Texas -- Zapata, Texas, near Laredo -- it is just right along the border. I lived there for seventeen years. I went to school at Texas Woman's University. I started off as a nursing major. I always like to tell this story because I think that it is important, especially to some young woman out there who may be debating if she wants to go into one field or another. You

see when I started out as a Nursing major I was doing what my parents wanted me to do - be a nurse. I have always enjoyed mathematics and science. I was always good at it. I never knew anyone that said that I couldn't do a problem, I would always do it. In fact, I always loved competing in the contests organized by University Interscholastic League. I always did that. I have always found that within the groups you could always share answers. I would provide the formulas and they would just plug in the numbers. It was simple. I had that background with me.

When I was at college I was taking calculus courses as a mathematics elective while everybody else was taking arithmetic or something. You know, just basic mathematics in other words. That is really what happened to me. So my mathematics professor said, "Look, you keep taking these calculus courses." (I had started taking Differential Equations or something). He said, "Why are you doing this?" I said, "I like it." Then he told me about a co-op program at NASA and I applied. Actually, it was the Summer Internship Program and I happened to be working in the Equal Opportunity Office for that one summer doing statistical work. While I was here I talked to the Co-Op Supervisor and signed up for the Co-operative Education Program. I got on board, and I worked in different areas within NASA. The Co-op Program alternates semesters of work and school which was very convenient for me because I was able to see the real work environment and the actual work. It kind of makes you wonder, "Will I ever get my degree?" But you know that you want one, you need one. So I went back and I eventually graduated and came on board. I got an offer to work in the Data Processing System and I have been here ever since. I really like it.

One of the things that helped me progress is that I come from a family of nine children. Right now I am the only one that has a bachelors degree, a formal one. I have a sister who will be getting hers after ten years of working on it. She has a family of three, and she will receive her degree in December. I am really proud of her. It has been hard. But I always had family here to help and support me. I always had people to answer questions. I never hesitated to ask questions. It doesn't matter how dumb or silly it sounded, it was just important to me to get an answer. I still do that today. I just pursue whatever it is that I am looking for. It is very important. You need to pick up a book. For example, if you need something there are always the yellow pages. There are always people. There are always experts out there. It is very important to seek advice from experts because they have answers and they will have the best answer for you that anybody could have. I always encourage people to do that.

I have always had support from my peers. My parents always wanted me to be responsible, and that is what I always remember. So I guess that responsibility has always been one of the things with me. In college my professors were very supportive and very encouraging. I had friends, and here at work I had managers and supervisors who have been really supportive of whatever it is that I like to do. You can do as much as you want here at NASA -- as much as you're willing to do. That is pretty neat to say, "I want to do this. This is a project that I would like to do." If you can prove yourself, you can do it. It is just a matter of setting your goals and fulfilling those goals.

A suggestion that I have for women who want to enter the technical fields is that if you're strong enough in high school in mathematics and think, " I like math. I like numbers and I want to do this but it is not acceptable." to go ahead and do it! Just do it. It is important that you pursue your goals. If there is a field or something that you want to do you are going to be happy at it, and you are going to do well at it. So just do it. If you are in college -- the same thing. If there is a field that you would like to pursue -- just do it! You don't want to have any regrets downstream and say, "Oh, I wish I could have done that." Just do it and things will come. Just apply yourself; have discipline. Pursue it. If you have a question, call someone -- there are people out there who have the answer. If it is continuing your education like Marilyn did, that is great. I am still wondering whether I should continue and get my master's (degree) or not. It is very difficult right now. Part of me wants to, and the other part of me says, "Well, you're so used to going to work everyday." Just do not be afraid. Removing that fear or barrier and pursuing your dreams and your goals is very important. Once you're in your career enjoy what you do. It is important to enjoy what you do.

# THE UNIVERSITY OF DAYTON WOMEN IN ENGINEERING PROGRAM

**Maureen B. Gonzalez**

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*Ms. Gonzalez was born in Vestal, New York and received her bachelor's degree in Bio-Engineering from the University of Dayton in 1988. Since her graduation, Ms. Gonzalez has been serving as Project Director for the University of Dayton School of Engineering Special Programs Division, directing the Women in Engineering (WIE) Program. As the program director, Ms. Gonzalez marketed the WIE program through high schools across the nation, planned program activities, and corresponded with industry and government, arranging outside participation and funding. She also is the Project Director of the Women in Graduate Engineering Studies Program (WINGES), which provides a network of graduate students to support graduate engineering studies.*

The University of Dayton offers an undergraduate engineering curriculum in ten engineering disciplines: Mechanical and Aerospace Engineering, Electrical Engineering, Chemical and Materials Engineering, Civil Engineering and Engineering Mechanics, Chemical Process Technology, Environmental Engineering Technology, Electronic Engineering Technology, Industrial Engineering Technology, Manufacturing Engineering Technology, and Mechanical Engineering Technology.

Established in 1850 by the Marianist religious community, the University of Dayton has grown to a student population (undergraduate and graduate) of eleven thousand. Located in Dayton, Ohio, the birthplace of aviation (Wright Brothers) and the electric starter (Charles F. Kettering,) it isn't hard to see how the University prevailed in engineering.

Industry, such as National Cash Register (NCR) and General Motors Corporation, and government, Wright Patterson Air Force Base, have all played a role in the development of the University's engineering program.

Susan Jane Martin was the first woman engineer to graduate from the University of Dayton in 1948. Between 1950 and 1970 few other women graduated in engineering from the University. The early 70's marked a change however, and today the University of Dayton has a freshman enrollment of 30 percent women.

With the gathering momentum of the women's movement and the shortage of students in engineering education, the 1970s heralded an era of change for engineering. Several universities discovered the advantages of enhancing the population groups that chose engineering. In 1973, the Dean of the School

of Engineering at the University of Dayton called together a Task Force to address the problem of too few women choosing engineering as a career.

The result was a dynamic program designed to encourage high school women to pursue careers in engineering and engineering technology. Entitled Women in Engineering (WIE), the program was scheduled for one week during June of 1974. This pilot program, though limited to local students, joined the beginning of a new momentum of change: women choosing engineering careers. By 1984 the number of women enrolling in engineering schools across the country climbed to as high as 17 percent, a significant increase from the one percent ten years earlier.

Industry was called upon to act as a co-educator in the University of Dayton Women in Engineering program by providing program funding and sponsoring engineers, especially women engineers, to actively participate. Industry has since played a significant role in developing and sustaining WIE.

Since its inception, the program has grown to include students nationwide. WIE has become an annual, one-week, summer program open to 100 high school women. The fee to attend the program is $225 and includes meals, campus housing, and all program activities. Financial assistance is available for students with disadvantages.

## WIE PROGRAM GOALS

To provide an intensive career awareness experience for high school students who have been identified as having high academic potential for engineering and engineering technology.

To utilize University, industry, and governmental resources to broaden and accelerate the career awareness of typical tenth, eleventh, and twelfth grade high school women.

To provide first-hand exposure to the academic and work environment of the engineer and engineering technologist.

To provide opportunities for young women to observe professional role models and to interact with practicing professionals.

## WIE PROGRAM COMPONENTS

The students are busy most of the time, focused on their learning objective of discovering what engineering is all about. Even the leisure activities and the meals contribute to their total immersion in engineering-oriented activities.

- The Parents' Welcoming Banquet Sunday evening is the introduction to the exciting WIE program. The banquet brings all of the students and their parents together for the first time. The parents meet the program staff, some of the industry representatives who support the program, and some of the engineering faculty members who will be teaching the Engineering Sessions during the week. The banquet also serves to build the excitement, anticipation, and expectation levels of the parents. The featured speaker is a woman engineer who is an alumna of the University of Dayton.

- An Orientation session, immediately after the banquet, introduces the program participants to the program by explaining and emphasizing the rules and responsibilities for the week. The University of Dayton assumes the role of parent for the WIE program and participants are expected to exhibit behavior conducive to an intense learning experience. The orientation session ensures that the students understand our expectations.

- A Team of Counselors (upper-class University of Dayton women engineering students) spend the week living in the residence hall with the program participants. More than counselors, they are role model students for the high school girls. The counselors serve many functions ranging from helping to ensure the students' safety to creating an atmosphere of fun and excitement. The counselors work all week long with the students to help translate what they have learned into a skit that the students will perform at the final parents' luncheon.

- Engineering Sessions offer exposure to ten different disciplines of engineering. The students learn about the disciplines of engineering and engineering technology through hands-on experiments in all of the sessions. These sessions, designed by the faculty, convey engineering principles, yet require teamwork and in some cases a sense of competition. For example, in Civil Engineering the students make a balsa wood bridge and test it by loading consecutively larger weights on it. The team that designs the strongest structure wins a prize.

- Innovation Modules are classroom sessions that take place on Monday and Wednesday evenings during the WIE week. These sessions show the students how important creativity is to the engineer by letting them attend presentations on Inventions, Creativity, Cad/Cam (Computer-Aided Design and Computer-Aided Manufacturing), and Rockets.

- Lunch With Administration gives the students an opportunity to learn about the college admission procedure, the Honors/Scholars academic programs for those who excel, and co-op opportunities for engineering students. A panel of University of Dayton administrators presents the program. The session puts a "human face" on categories of administrators that students must eventually interact with when they enter college. It unravels the mystery of the college entrance process.

- At the Industry Information Fair, representatives from twenty different companies speak for 15 minutes in a series of small-group rotations on the engineering opportunities within their organizations, the kinds of engineers the company hires, and the types of products and processes that engineers work on. There is opportunity for questions, and the presentations are made several times during the evening so the students can visit a variety of different displays. The Industry Information Fair is supported with trade-show quality booths and displays. It is set up in the City of Dayton Convention Center and is staffed by company representatives who are qualified to make special presentations designed for the WIE program. Even though the potential audience is limited, and the students may have little immediate need for the products or services, **the quality and size of the Industry Information Fair** give strong evidence of the support of the exhibitors for the WIE program.

- Dinner With an Engineer provides a social evening with women engineers from the local community, in the traditional and comfortable surroundings of Dayton's Engineers' Club. The students dine at small banquet tables with women engineers and can converse on a more personal level about the lifestyles of a woman engineer.

- For Engineer in the Dorm, a woman engineer spends a night in the residence hall. She speaks with small groups of students about her career, her hobbies, her life style, etc., and discusses concerns that the students may have about careers in engineering. The dorm atmosphere provides an intimate "slumber party" setting for the students to ask questions they might not ask in a more formal setting.

- A Day With Industry is a day spent off-campus at engineering facilities. More than 20 industries and an Air Force laboratory participate and lend engineers for the day to show the students what engineers in their organizations do on a day-to-day basis. The companies and the Air Force Laboratory have designed hands-on experiences that demonstrate engineering problem-solving in a

real-world setting. The atmosphere of excitement when the young women come back from their Day With Industry is a powerful testimony to the importance of real world exposure.

- The Society of Women Engineers Panel is another program component that deals with the perception of engineering being a male-oriented field. Members from the local chapter of the Society of Women Engineers speak to the participants about the excitement of an engineering career, pursuing an advanced degree, raising a family while maintaining a career, and the special challenges women face in the nontraditional career of engineering.

- Evaluations, covering the over-all program, must be completed by all WIE student participants. This is an important tool for the program staff to show program results to industry, government, and technical society supporters and to make improvements in future programs.

- Thank-You Notes are written by the students to the many supporters of the program. This personal touch shows the appreciation the young women have for the roles the outside organizations and individuals play in the success of the program.

- The Final Luncheon, Friday noon, is the final event of the week. The students perform skits that illustrate the highlights of their experience and convey the excitement of what they have learned. Parents are invited to the luncheon so they may see what their daughters have done during the week and congratulate them as they graduate from WIE.

## WIE CONCLUSIONS

Of the more than 1200 Women in Engineering alumna, 65 percent have become engineers and 25 percent have or are pursuing advanced degrees in science and engineering. This element of success of WIE is directly related to the strong, sustaining support of the program by industry and the university community. The longer WIE operates, the more women engineers there are to serve as role models, and the more support we get from all engineers.