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SYMPOSIUM PROCEEDINGS

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Intervention Programs Aimed At
Increasing Minority Participation
In Mathematics-Based Fields



UNIVERSITY OF THE DISTRICT OF COLUMBIA

Friday, May 27, 1988
2600 Woodley Road, N.W.
Sheraton Washington Hotel
Washington D.C.

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Saturday, May 28, 1988  
University of the District of Columbia  
Van Ness Campus - Building 42  
Washington, D.C.

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# Symposium Proceedings

## Intervention Programs Aimed At Increasing Minority Participation In Mathematics-Based Fields



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# **Symposium**

## **Proceedings**

### **Intervention Programs Aimed At Increasing Minority Participation In Mathematics-Based Fields**

**Sponsored By:**

**The Office of Naval Research  
Department of The United States Navy**

**And**

**The College of Physical Science, Engineering  
and Technology of  
The University of the District of Columbia**

**Beverly J. Anderson  
Editor**

## **Preface**

In recognition of the under-achievement and under-representation of blacks and Hispanics in mathematics and mathematics-based fields and some of the reasons therefore, the University of the District of Columbia and the Office of Naval Research, Department of the United States Navy joined forces to co-host this symposium on how intervention programs could be used to enhance the achievement of these minorities and to increase their representation in the sciences and mathematics. Their joint commitment to address the issues of under-achievement and under-representation began in 1982 with their support of one of the oldest academic intervention programs at the University of the District of Columbia: A Summer Program in Mathematics and Computer Science for Academically Oriented Students.

This document is a product of the effort to consider those factors that may have grave impact on the achievement and representation of blacks and Hispanics in mathematics and science; those intervention programs which are facilitative to student success and interest in mathematics and science; and those recommendations which should be considered by various institutions in their effort to include more blacks and Hispanics in science and mathematics.

Sincere gratitude is extended to the many individuals who helped to make this program possible and successful. Appreciation is extended to the university and specifically to Dr. Rafael Cortada, President, for offering his support to the project in its initial stage; to Dr. Mohamed El-Khawas, Associate Vice President for Academic Affairs, for his assistance in seeking funding for this project and to Dr. Philip Brach, Dean of the College of Physical Science, Engineering and Technology for providing financial support from his limited college budget. Also, I acknowledge with gratitude the efforts of the Office of Naval Research for its consistent support and especially to Dr. Bob Hayles, Past Chairman of the Historically Black College Council and Dr. Neil Gerr, Program Officer in the Mathematical Sciences Division for their roles in securing funding from the Navy.

I deeply appreciate the seriousness with which the program participants, facilitators, and recorders responded to our call for papers and/or leadership. They should be praised for their contribution to this document. The panelists on psychological and sociological issues and intervention programs were informed from the outset that the papers presented by them would be combined into a volume. They graciously provided erudite papers. The representatives from funding agencies aptly spoke to the characteristics of proposals that could be funded by their agencies; and, the facilitators and recorders provided an atmosphere in the worksessions for the breadth of recommendations contained in this document.

I acknowledge with deepest gratitude the support and guidance of Colonel Ruth Lucas, Assistant to the Dean of the College of Physical Science, Engineering

and Technology, for her encouragement to pursue this project and for her time and talents throughout this endeavor.

A very special thanks to Mr. and Mrs. Robert Gaines of Convention Systems Services, Incorporated, who demonstrated good spirit and a high level of competence in the typing and the electronic composition of this document, and to Yingying Zhou for her clerical assistance and sincere effort.

Finally, I applaud my colleagues at the university and those in universities across the country for their efforts in maximizing the achievement and representation of blacks and Hispanics in mathematics-based fields. I hope that this document will be helpful to those and others as measures are taken to remove barriers so that we will see full participation from all Americans.

Beverly J. Anderson  
Editor and Symposium Organizer

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**Symposium**

**Proceedings**

**Intervention Programs Aimed At  
Increasing Minority Participation  
In Mathematics-Based Fields**

## Introduction

Many black and Hispanic students are capable of success in mathematics-based fields. But frequently, they have not been stimulated to seek careers in those areas nor have they acquired the appropriate background in mathematics to succeed in college level mathematics courses.

Although the black minority comprises roughly 12% of the total population, this ethnic group comprises only 2% of the employed scientists and engineers in America. Equally distressing is that the Hispanic population comprises roughly 6% of the total population and only 1.5% of the employed scientists and engineers in this country (Employed Scientists and Engineers in the U.S., National Science Foundation, 1985). A recent report of the National Research Council ("Washington Post", February 16, 1988) showed that the number of black students receiving doctoral degrees has dropped by nearly 27% in the last decade. The actual number of doctoral degrees going to black students dropped from 1,116 in 1977 to 820 in 1986. Of note is that only 14 were in Engineering, and 25 were in the Physical Sciences.

At the same time as the number of black doctoral candidates is dropping, fewer blacks are studying medicine, dentistry, law or business at professional schools. We must address the factors: educational, economical, psychological and sociological, impacting this trend and take corrective and/or preventive measures immediately.

In recognition of this under-representation, we have to work hard to equip the black and Hispanic school students with the necessary academic and psychological tools to alter this state of affairs. Specifically, the United States educational system must ensure that these students feel good about themselves as learners, especially learners of mathematics (the hub of the sciences). We cannot permit these students to yield to conditioning averse to success in school. They must acquire the necessary skills in science and mathematics to increase their career options when they reach college and their self-esteem must grow to allow them to aspire to and succeed in college and graduate studies. Our country must guard against the continued diminutive of brainpower in mathematics and science by not accessing these minority groups.

It was the intent of the symposium to bring together practitioners in education and psychology, as well as scientists, intervention program directors and representatives from funding agencies to place the problem of under-achievement and under-representation in its proper perspective. That is, the learner was characterized in the school setting and the environment in which he operates outside of school. Attention was given to how some minority students view themselves as learners of mathematics and the apparent reasons for their perception. Also, the symposium participants explored how intervention programs could be used to foster self-esteem, help students set appropriate goals, stimulate student interest in

mathematics and mathematics-based courses, increase knowledge of mathematics and science, reverse negative conditioning, and raise educational aspirations. Finally, funding possibilities for these programs were examined.

Additionally, since the elementary school teacher is an important factor in the development of student interest in mathematics during the formative years, attention was given to intervention programs for the elementary school teacher. Programs of interest were those which enhance the knowledge of the subject matter to the degree that the teacher is comfortable with school mathematics and able to communicate this knowledge to students of varying abilities.

In this critical technological era where applications of science, mathematics and technology are sorely needed to meet the needs in medicine, transportation, national security and the environment, America must draw upon the best minds of her citizenry. It is not a question of good will to allow for the emergence of talents from blacks and Hispanics, but rather a necessity.

## Welcoming Comments

Rafael L. Cortada  
President,  
University of the District of Columbia

Greetings from the **University of the District of Columbia**. I am pleased to welcome you to this **Symposium on Intervention Programs Aimed at Increasing Minority Participation in Mathematics-Based Fields**. During the registration period, I had the occasion to talk with some of you, and I learned that you have come from several areas in the country. I must admit that I am impressed that you have decided to spend a portion of this Memorial Day weekend to address this timely topic in our nation's capital.

In this two-day session, I trust that this group, representing some of the best minds in this country, will pool its resources to assess and address the value of pre-college intervention programs of minority achievement and representation. We realize that the real preparation for science careers must occur at the junior and senior high school levels. I am sure that the recommendations that evolve from this conference will be seriously considered by the decision-makers in America, as they plan for future pre-college programs. Also, I am convinced that you will not be just whistling in the dark.

Recently, I had a heartening experience, as I read of how a teacher of mathematics, Jaime Escalante, in a Los Angeles high school, believed that his Hispanic students could achieve at a level far beyond that which other teachers, administrators, community members and psychometrists thought possible. This teacher believed that with appropriate motivation and hard work over time, his high school students could get prepared to take the calculus while in high school; succeed in the calculus; and pass the Advanced Placement Examination, thus acquiring college credit for taking this course. This story, revealed in the movie, **Stand and Deliver**, tells of the success of Mr. Escalante and his students. Their hard work paid off. Together, they received the support from parents and administrators alike, and they reversed a trend and helped to reshape the thinking of many Americans about ethnic capability. **They made a difference!**

It is disconcerting to note that the most recent evidence shows minority participation in the hard sciences, which was increasing during the 1970s, has leveled off, and may be declining. Perhaps you will examine the reasons for this trend and offer some recommendations for corrective measures. There is no doubt, however, that we need more believers and doers like Mr. Escalante, and more hard-working students like the seventeen in his class.

The University of the District of Columbia is committed to attracting local students, many of whom belong to under-represented groups, to pursue majors in science, mathematics and engineering. We are committed to increasing the retention

of these students in the hard sciences and strengthening them so that they will graduate to become productive scientists and engineers in this country. Their pre-college education is critical toward that end.

Best wishes for a successful program and please let me know if I can be of further assistance to you. Thank you.

## Opening Remarks

Philip L. Brach  
Physical Engineering Dean,  
College of Physical Science, Engineering and Technology  
University of the District of Columbia

Good morning, Dr. Cortada, Dr. Anderson, and conference participants. It is indeed a pleasure to welcome you to Washington on behalf of the College of Physical Science, Engineering and Technology. You are gathered here today and tomorrow to explore how intervention programs might be used to stimulate greater interest in mathematics among minority groups.

There is a story about a prudish lady who once accosted the learned Samuel Johnson shortly after the publication of his monumental dictionary of the English language. Said she, "Dr. Johnson, I am distressed that your dictionary contains so many vulgar words". Replied the gentlemen, "Madam, I am immeasurably distressed that you actually looked them up!"

This is a monumental task you have before you. There are so many aspects of the problem that I trust we will be able to set our sights on the overall goal—that of increasing minority participation in mathematics-based careers, and not end up immeasurably distressed over the large number of problems we will discover in our search for solutions.

"When you are up to your knee caps in alligators, it is difficult to remember your objective was to drain the swamp".

It is imperative that we change the current under-representation of minorities in mathematics-based careers. Your efforts today and tomorrow hopefully will contribute toward that end.

### Objectives of the Symposium

1. To begin a dialogue with practitioners in education, scientists, psychologists, program directors, administrators and representatives from funding agencies that would focus on the needs in mathematics education for minority youth;
2. To get clarification and different perspectives on the causes, extent, and implications of the dearth of minority representation in mathematics and mathematics-based fields;
3. To become aware of some of the psychological and sociological factors that impact achievement and representation;
4. To become aware of some intervention programs in the United States, designed to increase minority participation in mathematics and science;
5. To identify approaches and strategies through intervention programs to increase minority representation in upper level courses in high school and mathematics-based majors in college;
6. To initiate networks and linkages among individuals and organizations with interest and resources to address the problem of underachievement and underrepresentation;
7. To gather data from program directors on the effects of their intervention programs in order to develop a comprehensive plan for improving mathematics education for minority school students and teachers at the elementary and secondary levels;
8. To begin to promote an environment for success in mathematics—one that will stimulate interest in mathematics, encourage minority students to strive for excellence in mathematics and one that will be receptive to student success in mathematics;

9. To develop strategies and articulate the roles to maximize the potential of the university, school, community, (including private industry) in fostering an environment for success in mathematics for minority youth;
10. To make recommendations on what could be done by the university, school, government and the community in response to the under-representation of blacks and Hispanics in mathematics and mathematics-based fields.

Symposium  
Intervention Programs Aimed At Increasing  
Minority Participation In Mathematics Based Fields

Program

FRIDAY, MAY 27, 1988

Sheraton Washington Hotel  
2600 Woodley Road N.W.  
Washington, D.C. 20008

\*\*\*\*\* MORNING SESSION \*\*\*\*\*

8:00 AM  
(Holmes Room)

Registration  
Continental Breakfast

8:30 AM  
(Marshall Room)

Introductory Remarks:

Beverly J. Anderson  
Professor of Mathematics,  
University of the District of Columbia  
Symposium Organizer

Welcoming Comments:

Rafael L. Cortada  
President,  
University of the District of Columbia

Philip L. Brach  
Dean, College of Physical Science,  
Engineering & Technology,  
University of the District of Columbia

9:00 AM  
(Marshall Room)

**FORUM: "Psychological and Sociological Issues"**

- Thematic Overview:  
Claude Mayberry  
President, "Science Weekly"
- Self-Esteem and Aspirations:  
Edgar Epps  
Professor of Urban Education  
University of Chicago
- Cultural Expectations:  
Lois Powell  
Professor of Psychology,  
University of the District of Columbia
- Parent-Child Interaction Patterns:  
John McAdoo  
Associate Professor  
School of Social Work,  
University of Maryland-Baltimore

10:45 AM  
(Holmes Room)

Coffee Break

11:00 AM  
(Marshall Room)

**PANEL I: " Academic Intervention Programs "**

- Thematic Overview:  
Beverly J. Anderson  
Director,  
A Summer Program in Mathematics and Computer Science

Larry Lim,  
Director,  
Minority Engineering and Science Achievement (MESA) Program,  
University of Southern California

Winson Coleman  
Director,  
The Saturday Academy,  
University of the District of Columbia

Manuel Berrioza'bal  
Director,  
Pre-Freshman Engineering Program,  
University of Texas-San Antonio  
San Antonio, Texas

Carrie Kendrick  
Co-Director,  
Certificate Program for Elementary Mathematics Specialists,  
University of the District of Columbia

12:30 PM  
(Holmes Room)

## LUNCHEON

Introductory Remarks:

Herman Brown  
Director,  
Evening Services and Professor of Educational Psychology,  
University of the District of Columbia

Keynote Address:" The Algebra of Academic Achievement "

Barbara Sizemore  
Professor of Education  
University of Pittsburgh

**\*\*\*\*\* AFTERNOON SESSION \*\*\*\*\***

2:00 PM                      Continuation of Intervention Programs  
(Marshall Room)

**" Innovations in Education—Impacting Intervention Programs "**

William Guillory  
President,  
Center of Creative Inquiry  
Midvale, Utah

**\*\*\*\*\* ANNOUNCEMENTS \*\*\*\*\***

Work Session I:

Task: To make Recommendations, Outline Proposals, and  
Identify Strategies and Resources for Successful  
Intervention Programs

|       |     |   |        |   |                 |
|-------|-----|---|--------|---|-----------------|
| Group | I   | - | Silver | - | Johnson Room    |
| Group | II  | - | Gold   | - | Truman Room     |
| Group | III | - | Red    | - | Eisenhower Room |
| Group | IV  | - | Green  | - | Roosevelt Room  |

4:00 PM  
(Marshall Room)

Group Reports:

**\*\*\*\*\* ANNOUNCEMENTS \*\*\*\*\***

**SATURDAY, MAY 28, 1988**

University of the District of Columbia  
Van Ness Campus  
Building 42, Second Floor  
Washington, D.C. 20008

**\*\*\*\*\* MORNING SESSION \*\*\*\*\***

8:30 AM Continental Breakfast  
9:00 AM  
(Second Floor Lounge)

**PANEL II: "Funding of Intervention Programs"**

Jean Green  
Education Planner  
Office of Postsecondary Education, Research and Assistance  
District of Columbia Office of Postsecondary Education

Ted Reid  
Program Director  
Career Access Programs  
The National Science Foundation

Neil Gerr  
Scientific Officer  
Mathematical Science Division  
Office of Naval Research—Department of the U.S. Navy

Lewin Warren  
Deputy Assistant Administrator  
Office of Equal Opportunities Program  
National Aeronautics & Space Administration

10:30 AM

Coffee Break

10:45 AM    **Work Session II:**

Task: To make Recommendations on What Could be Done  
By Various Groups in Response to the Under-  
Achievement and Under-Representation of Blacks  
and Hispanics in Mathematics and Mathematics-  
Based Fields

|           |   |        |   |                                                      |
|-----------|---|--------|---|------------------------------------------------------|
| Group I   | - | Silver | - | The College/University<br>(Room 208)                 |
| Group II  | - | Gold   | - | The Government and Private<br>Agencies<br>(Room 209) |
| Group III | - | Red    | - | The Schools<br>(Room 210)                            |
| Group IV  | - | Green  | - | The Community<br>(Room 211)                          |

12:00 PM

(Second Floor Lounge)    \*\*\*\*\* REPORTS/LUNCH \*\*\*\*\*

**THEMATIC OVERVIEW**  
**Psychological and Sociological Factors Affecting Minority**  
**Participation in Mathematics-Based Fields**

Claude Mayberry  
President, "Science Weekly"

I have been asked to give an overview of the problem facing the future of minority children and their preparation to participate in mathematics-based fields. Thirty minutes are not enough time to give an appropriate overview. However, this morning, I will attempt to share with you some things to think about, elaborate on, substantiate, or refute as you deliberate the next two days.

Within the urban community, there is a growing subculture that is incompatible with self-respect, self-confidence, respect for others, and independence. It is a subculture that is compatible with isolation, fear, irrational thinking and behavior, defiance, and self-deformation. It is a subculture that obscures truth, reality and the humanization process in general.

We have a panel of scholars here this morning who can speak on the social and psychological implications and possible remedies for this sub-culture. I will spend the few minutes I have left to look at the state of the problem that may prevent us from generating a pool of blacks and other minorities who will be prepared to meet the economic and technological demands of the 21st century.

In 1981, I had the opportunity to leave my academic and administrative post at Colgate University, and come to Washington, D.C. to serve in a number of positions in the United States Department of Education. One of those positions was with the National Commission on Education, that in 1983, released the historic report "A Nation at Risk" which spearheaded the first wave of the recent education reform movement in the nation. During the eighteen months of the study, the Commission focused its attention on the nation's high schools. But as I traveled the nation, I spent my free time visiting and talking with elementary-school teachers to gather information on the kinds of problems they were experiencing in teaching science and mathematics. Data published at that time stated that nationally the average time spent teaching science in the nation's elementary schools was less than 17 minutes per week. The information I gathered from my visits and talks with elementary-school teachers supported this data.

All of this happened during the time an international study indicated that among the twenty nations with whom we compare ourselves, the United States rank 18 and 19 on student achievement in mathematics and science. In 1987, it was re-

ported in "The Underachieving Curriculum", a national report on the assessment of United States school mathematics, that in problem solving and geometry we rank among the bottom 25 percent of all countries.

How did the nation respond? It started one of the most prolific educational reform movements since Sputnik. We set off a high school graduation reform like no other in the history of modern education.

Today five years after the 'A Nation At Risk' report, which stated that this generation of American students will be the first to graduate from high school knowing less than their parents, states are competing with each other for position on the United States Department of Education report card. A card that theoretically is to offer a measure of how well states are performing in the education reform movement. One problem with the reform movement, and I will talk about other problems and how they are having a negative impact on preparing minorities, is that for the past five years it has been mostly concentrated on the high schools.

In most colleges and universities, 50 percent of all the mathematics and science taught is remedial. Most of the mathematics taught in our high school is below tenth grade, and for science it is worse. So, no one would argue against curriculum reform in our high schools. But this isolation is causing some severe problems for black and other minority students in the urban public schools. For one, it's causing an increase in high school dropouts. The reform movement was imposed on school systems that were not equip for such rapid change. Students were not prepared for their new curriculum, and too many of the teachers were inadequately trained to teach the new curriculum. For example, most of the students entering the urban high schools are functioning in mathematics below the seventh grade. In science it's much lower. In addition, studies indicate that not only is there a shortage of mathematics and science teachers, but that 85 percent of the teachers who teach the new mathematics and science curriculum are either under-trained or not certified. Putting this in the perspective of teaching and learning, it is not difficult to understand why more students will opt not to meet the new graduation requirements. Let us examine a few other problems the reform is causing.

To begin an educational reform movement at the secondary level with almost total disregard for what is going on in the elementary schools, is either an arrogant disregard or an admission of ignorance of child development theory by educational policy makers.

Development theory tells us that there are four distinct child development stages: pre-operational, operational, concrete, and formal. Studies indicate that race

and socio-economic differences in mathematics and science achievement are evident by age 9 (concrete stage), and are clearly in place by age 13 (formal). This pattern continues to increase through high school. This is demonstrated by test scores which indicate that by age 9, minority students score substantially lower than whites on standardized achievement test in both mathematics and science.

When educational researchers with their reports, studies, and books, began to push for a national thrust in the elementary schools, it was full speed back to basics. Time was never taken to define what are the essential basics for the 'Class of 2000.' So, without a clear definition, it was back to reading, writing, and arithmetic. School district personnel, afraid of being left behind, began rushing to the starting line.

Little did they know that in doing so they were making a statement: the basics were not being stress in their schools. When you examine the back to basics programs, the only distinguishing factor that separates the essentials for the 'Class of 2000,' and the 'Class of 1960,' is computer literacy. Whereas problem solving, critical and reflective thinking are talked about at almost every educational conference, the implementation of such concepts is little more than lip service in many elementary schools. For example, the National Council of Teachers of Mathematics has advocated more discrete mathematics for the elementary schools for the past decade. Yet, very few school district elementary-school curricula reflect this change.

The big push for computer literacy without looking at the negative impact its having on minority achievement exacerbate the long range problem of increasing the pool of black and minority students entering high school prepared to meet the new reformed high school graduation requirements. Whereas, I would strongly agree that computer competence is essential for the high school curriculum, I question that that is an essential skill for elementary students. To be thought of in any terms other than for enrichment or as an instructional tool for trained teachers is pedagogical error, and a disregard of how children develop.

School district personnel, that continue to spend tens of thousands of dollars on computers and computer literacy programs for students, at the expense of teachers who need training in mathematics, science, and computer literacy themselves, place those students being taught by such teachers at risk of being denied the opportunity to prepare themselves for a successful high school experience. Appropriate staff development should have priority over any intervention program. Black students have long experienced their share of experimentation and program intervention. Urban schools have become experimental laboratories for those whose personal lives depend on research and publishing. It is not uncommon to see

multi-intervention and/or experimental studies or programs going simultaneously in an urban school district. This is being done without any data on how the programs interface with each other, or what negative effect it may have on a mobile student body. In fact, most programs are implemented and evaluated independently of each other. How often do we see and hear of school districts that have not provided textbooks for all of its students, or who deny students and teachers access to adequate supplementary material and laboratory equipment. Yet, many of these same districts continue to expend tens of thousands of dollars on computers, program interventions, and the like. School districts heavily populated with minority students should place a moratorium on any program intervention that diverts funds from providing adequate materials and supplies, and on-going staff development. School boards must give this the highest priority to ensure that the achievement of black and minority students increases in mathematics and science.

Let us look at the three interrelated factors that have a high correlation with academic achievement in mathematics and science.

- 1) Students need 'quality access' to quality mathematics and science instruction. To measure 'quality access' one needs only to examine whether the students have access:
  - a) to a teacher who has adequate training/or experience in teaching mathematics and science to elementary-school students,
  - b) an adequate supply of updated textbooks,
  - c) home environment that encourages achievement and high expectations,
  - d) a well constructed curriculum and trained staff to implement it, and adequate supplementary resources to enhance the total teaching and learning process.
- 2) Students need the opportunity to 'achieve early' in mathematics and science, which in turn leads to and enhances other learning opportunities. To teach at any level without knowledge of content or the necessary teaching methodology to apply the content to classroom use, or without the respect for the stages of child development and readiness, places a student at risk of not attaining a high level achievement in mathematics and science.

- 3) Students' 'attitudinal development', such as confidence, interest, and willingness to study mathematics and science, is essential. Early exposure will aid this process.

Of course, high expectations and encouragement from parents, school personnel, and quality contact with academically-oriented school peers are highly important influences on these factors.

When you identify poor and minority students who are not achieving in mathematics and science, check these factors thoroughly. The first sign of black and minority divergence from these critical factors appear early in elementary school. This is the beginning of their image of the future: self-image, self-esteem, poor attitudes, and lack of confidence.

Let us examine several examples of divergence from these factors.

- 1) Ninety percent of all talking that goes on in the elementary-school classrooms is done by the teacher. How, then, do we expect students to learn how to speak well, or to develop higher-order skills through oral discussion. Students get few chances to test their ideas in open classroom discussion.
- 2) The most skipped chapters in elementary schools are those covering geometry. These chapters are critical to developing skills in logic and problem solving, and are essential to later study in mathematics and computer literacy.
- 3) Textbooks are not written to meet the needs of all students, and many teachers are not trained to modify or develop material taken from the text.
- 4) Because too many elementary-school teachers are not trained in teaching intermediate concepts in science, most minority students are denied quality science instruction in grades 4 to 6. Therefore, many students are never carried beyond the observation stage (operational or concrete) to the formal stage of their science exposure or development.
- 5) In an effort to improve science learning and understanding, school districts have gone to more hands-on approach to teaching science. Unfortunately, many schools have gone too far with this method. For some districts their entire program consists of the hands-on approach to teaching science (concrete stage). The risk in this is that many of the students may remain in this

stage too long, and thereby slowing their progression toward the formal stage of their development. If this happens, it will be very difficult for them to remain in the mainstream academic track while they are developing their higher-order thinking, reasoning, and problem solving skills.

While we are talking about increasing minority participation in mathematics-based fields, we must ask ourselves in what capacity. When we search a curriculum designed to educate black students about American democracy or economics, we usually can find reference to preparation for, or the right to a job. Notwithstanding the importance of preparing for a productive job, little or no reference can be found in the curriculum that would inform black students of the relationship between American economics and entrepreneurship. Black students are not taught that entrepreneurship is the cornerstone of our economic system, and the glue that holds our democracy together. Almost all black students go through their entire school life thinking that the only job options they have, outside of being a physician or lawyer, is working for someone other than themselves. They don't think of themselves as future entrepreneurs. Neither does the school offer this as an option. Other minority groups don't seem to have this difficulty. As their political power develops, economic growth follows.

In order for students in the 'Class of 2000,' to get a good decent paying job, they will minimally have to have the equivalence of a two-year associate degree in some area of mathematics, science, or technology. However, unless we do a better job teaching these subjects in elementary school, studies indicate this pool will be too small to accommodate our technical needs. It is too late for most students who enter high school achieving below the seventh grade in mathematics and science to become accomplished in mathematics, the hard sciences or engineering.

Surprisingly, many of the analytical and technical skills necessary to make it into the 21st century technical service pool are also essential in the development of a successful entrepreneur: organization, communication, self-reliance, confidence, risk-taking, and technical and human skills. A study done at Harvard University's business school over a period of 25 years, concluded that to become a successful entrepreneur these skills must be developed in elementary school.

If we take a look at our business schools, we will find that black students do not do as well as whites. In one of our leading business schools, out of 148 black students in the Class of 1988, only 44 graduated on time. Can this be related to skills these students missed in elementary school?

In closing, let us look at what the world of work will look like 25 years from now (2010-2015). Take a look at the skills/needs curve that was handed to you. Notice that in 1960 most of the labor force in this nation was in the center of the graph. If a black could read, write, speak well, and do very basic computations, he could find some type of career ladder. It was not necessary to have analytical skills to remain employed. Notice how the curves will shift by 2020. If we continue on the same course with the present back to the basics movement, most of the employed will be on the left side of the curve. These will be low-end service jobs, such as fast food chains, domestic, and entry-level clerical jobs. For example, by 2020 a secretary will have to type 65-70 words per minute, have excellent word processing skills, and minimal to skilled computer and software experience in order to obtain an entry level technical position. It will be too costly to hire someone with typing skills only. To be under the middle curve, it will be necessary to be competent or have technical experience, in some area of mathematics, science, or technology. The following are some examples of the jobs that are projected for the middle of the curve: processing mechanics, computer operators, computer analysts, machine mechanics, office machine service technicians, climate control environment systems technicians and analysts. It is important to point out that none of these positions necessarily require a four year college degree.

This is consistent with studies that suggest that only 20 percent of the jobs in 2020 will require four or more years of postsecondary education. This projection is based on a labor trend that has already begun. Labor is becoming too costly, and therefore, forcing more and more companies to export their production functions overseas.

We must keep this in mind while we search for answers and intervention programs aimed at increasing minority participation in mathematics-based fields. Are we offering the appropriate curriculum and options that will prepare our minority students for the 21st century? Should our curriculum reflect more vocational options that are technically focused to meet the needs of the projected labor pools of the 21st century? Are we prepared to pay the price to ensure that minority students get a quality education from well-trained elementary-school teachers in mathematics and science? If we deny students a good elementary-school education, then we will have denied them their constitutional and human right to enjoy the many options and opportunities this nation has to offer them as prepared adults.

Thank you very much for being such patient listeners. Now let me introduce the other panelists.

## Self-Esteem And Aspirations

Edgar G. Epps  
Marshall Field IV Professor of Urban Education  
The University of Chicago

### Self-Esteem and Academic Self-Concept

This essay is based on reflections about self-evaluation, motives and values taken from my own research and that of others during the past twenty years (Epps, 1981). Those of us who have used survey techniques to study self-esteem and related issues do not share the general notion that Black American students in general are afflicted with low self-esteem. Comparisons with white students have consistently shown that race differences in general self-esteem are insignificant and favor blacks as often as they favor whites. However, research by Bruce Hare (1980) has helped to clarify the relationship between self-esteem and school performance. He found that the basis for self-esteem differs for black and whites when specific dimensions of self-esteem are examined. His instrument assesses three dimensions of self-esteem; peer, home, and school self-esteem. It was on the school dimension of self-esteem that blacks, especially black males, fared poorly when compared to whites. In other words, the general self-esteem (general self-esteem is determined by combining the scores from the three subscales) of blacks compared favorably with that of whites because blacks scored relatively high on the peer and home subscales, while whites scored better on the school subscale. The general self-esteem of blacks appears to be more or less divorced from the school dimension. These youngsters could feel very good about themselves in spite of the fact that they were not doing very well in schools.

I have usually found a low positive correlation between school performance and general self-esteem. However, general self-esteem is much less important for predicting performance than academic self-concept (Epps, 1969; Hare, 1980). If students are asked a series of questions about how they feel about themselves overall, there is little correlation between their responses and their performance in school. The self-evaluation may be based upon perceptions of acceptance by peers or by family members (or on other skills such as athletic ability or musical talent). In sociological jargon, we say that self-esteem is based upon the individual's perception of how he or she is evaluated by "significant others," that is, the persons (family or friends) who are most important in the life of the individual.

On the other hand, the academic self-concept is based more directly on school experiences, and specifically on perceptions of ability to do well in comparison to other students. Thus, the self-concept of ability scale is a relative measure anchored to the level of competition faced by the student. More accurately, it is anchored to the level of competition the student chooses for a personal reference group. Therefore, a student's self-concept of academic ability may be relatively high in spite of mediocre scores on standardized achievement tests. For example, in a racially integrated school, black students may compare themselves only to other black students when answering questions about how well they are doing relative to others in their class or school. In other instances, students in a general education track may compare themselves to others in their own classes, ignoring students in an academic track for comparison purposes. However, in spite of these weaknesses, the academic self-concept instrument is a better predictor of school performance than a measure of general self-esteem.

### **Characteristics of High Achievers**

Mathematics and science majors are most likely to come from the ranks of high school achievers. My research has shown that black high achievers differed from low and average achievers in grade point average, achievement test scores, self-concept of academic ability, self-esteem, and educational aspirations and expectations. The high achievers also had little alienation and relatively high satisfaction with school as well as low test anxiety. In other words, a picture emerged of academically successful students who were self-confident, highly motivated, and highly ambitious.

### **Characteristics of Low Achievers**

The unsuccessful student has a profile that is directly opposite to that of the successful student. Unsuccessful students tend to have slightly lower self-esteem, significantly lower academic self-concept, low sense of personal control over the environment, a relatively high fear of failure (as indicated by high scores on a test anxiety scale), and relatively low educational aspirations and expectations. By junior high school, many of these students are alienated and exhibit anti-academic attitudes. What is not alarming about this "loser syndrome" is that it begins early in elementary school. The pattern is already well established by fifth grade. Probable causes include low expectations by teachers, poor teaching, assignment to low ability groups, frequent criticism by teachers for poor performance, and a history of failure in school subjects.

Some students experience what is called math anxiety; that is, a deep seated fear of arithmetic and subjects that depend heavily on mathematics. The cause of this anxiety is thought to be a series of negative experiences in arithmetic resulting

in failure, criticism and punishment. A combination of poor teaching and excessive criticism and pressure by teachers and parents leads to a fear of being evaluated (tested). This math phobia may result in a pattern of course selection in high school that involves taking the least demanding math courses and only the minimum requirements for graduation. Programs designed to alleviate math anxiety are most successful when they focus on improving skills and problem solving ability rather than solely or primarily on reducing anxiety. (Allen, 1971).

### Self-esteem and Achievement

Some educators have advocated the implementation of programs designed to raise students' self-esteem as a means of improving achievement. Research has not supported the assumption that raising self-esteem leads to improved achievement. The best available research points to the conclusion that improved achievement precedes increases in self-concept (Scheirer and Kraut, 1979). In other words, if one wants to improve math self-concept one has to improve math achievement.

### Peer Attitudes

A recent article in the Harvard Educational Review (Fordham, 1988) referred to students with characteristics similar to those of the high achievers described above, as "white oriented." The article implies that serious attention to academic work in a predominately black high school causes students to be rejected by their peers; it also suggests that students who aspire to be scientists have rejected traditional African American values and chosen to emulate whites. Such a stance seems to deny or reject the importance of the contributions of blacks in the academic world as well as in the scientific arena. John Ogbu (1985) has made similar observations. He also contends that academically serious students are considered by their peers to have chosen an "assimilationist" or white orientation. It is important that black teachers and community leaders emphasize the fact that academic and scientific excellence are indeed an important part of the black experience in America. Black children must be taught that the African American experience consists of much more than "sex, drugs, and rap music."

### Individual vs. Collective Achievement Orientation

In our study of black students attending historically black colleges, Patricia Gurin and I (Gurin and Epps, 1975) raised the question of whether or not there is a necessary conflict between black identity and achievement among black students. That research was conducted during the late 1960s at the high point of the civil rights movement. We found that there was a conflict for some students who felt that they had to make a choice between their academic work and participation in the movement. However, there was also a substantial segment of the student population

who found it possible to maintain high levels of academic achievement while actively participating in the struggle for civil rights. These students expressed concern for using their education to help improve the status and condition of the black race in America. In other words, these students exhibited what we called "collective" or group achievement motivation as contrasted to "individualistic" achievement motivation. In the current climate on most college campuses, the collective achievement motive is probably being subordinated to individual achievement interests.

### **College Successes**

At this point it may be well to identify the individual values and expectations that we found to be associated with college success. Competency based expectations; i.e., feelings of personal control over the environment and academic self-confidence were consistently related to heightened occupational and educational aspirations, to better performance in college and to realistic aspirations. Measures that assess personal expectations of success were more relevant than those that assessed commitments to cultural values.

### **Aspirations**

Our analyses also showed that the student's perceptions of financial restraints and opportunity factors were important determinants of their aspirations and expectations. In addition to academic performance and self-concept, family social status was also found to be strongly related to aspirations.

Thomas (1987) speculates that black student's aspirations may be lower during the 1980s than they were during the 1970s. However, national surveys taken annually by the Survey Research Center at the University of Michigan show that black youngsters continue to have high educational aspirations. This is important because research shows consistently that aspirations are the best predictors of actual attainment. A student's family has a strong influence on aspirations in two ways. First, there is a direct relationship between family social and economic status and aspirations; secondly, there is a strong relationship between family encouragement and educational support and aspirations (Epps and Jackson, 1988; Gurin and Epps, 1975). This is consistent with Maxine Clark's study which found family social status to be higher among black science majors than among non-science majors (Clark and Pearson, 1983).

Other factors that influence aspirations are: ability as measured by test scores, academic self-confidence, number and type of high school courses taken,

track placement, and type of school attended (private vs. public). These variables suggest that students' personal attributes (ability, academic self-confidence) affect the expectations, in turn, affect the type of education available to the student through ability grouping, course selection, counseling, track placement, and choice of a public or private school. Clark and Pearson (1983) noted that science majors were more likely than non-science majors to have at least one parent who has attended college. One implication of this finding is that many potential minority scientists are lost because they are not identified as winners at an early age and steered into productive academic patterns.

### **School Quality**

A related factor noted by Thomas (1987) is the fact that the schools attended by low income urban black students often lack modern science laboratories and frequently do not offer higher level mathematics and science courses. Thus, even students with high levels of academic motivation and achievement often find themselves unprepared for college science majors because they cannot obtain the necessary prerequisite courses. A final point in this connection is that frequently families, for various reasons, may not have access to information about the type of courses students need for careers in the sciences. They also may not have the resources needed to counteract negative advice students may receive from peers or from school personnel. There is a need for alternative sources of career information and educational advice. We must look to community organizations (fraternities, churches, Urban League, NAACP, etc.) and to colleges and universities to provide these alternatives.

### **Gender Influences**

In the 1980s as was the case in 1960s, males are still more likely than females with equal qualifications to enter the sciences, mathematics, and engineering. The gains made by women among the ranks of black scientists and engineers have been modest considering the fact that females are generally better students than males at the pre-collegiate level. Research clearly indicates that women's aspirations differ considerably from those of men with comparable ability and preparation. Women are much more likely than men to select major fields leading to careers that have been traditionally dominated by women. Movement into non-traditional fields like mathematics and engineering is still rather modest (Grandy, 1987).

### **Predominantly Black Institutions**

The availability of mentors and role models is very important in the develop-

ment and nurturance of aspirations and academic self-confidence. It is for this reason ( among others) that historically black colleges have been able to produce a disproportionately high percentage of mathematics and science majors who go on to compete successfully at traditionally white graduate and professional schools. The role models are present at historically black institutions, black students' abilities are recognized and encouraged, and students are well integrated into campus life. However, as we found in the 1960s (Gurin and Epps, 1975) and Fleming (1984) found in the 1970s, black colleges are much less encouraging of the non-traditional ambitions of black women than of the aspirations of black men. Thus, we find that the aspiration of women in black colleges tend to be deflated by the social expectations found on predominantly black campuses.

### **Predominantly White Institutions**

On predominantly white campuses, black students face other problems that impact their academic self-confidence and expectations. Black students entering white institutions have higher high school grade point averages and achievement tests scores than those entering historically black institutions. Black students also enter traditionally white institutions with high aspirations and academic self-confidence. However, many of these students encounter problems that cause them to lower their aspirations and lose self-confidence ( Allen, 1987). This is partly attributable to the perception that the competition is very stiff; that is, that white students have a competitive advantage due to better high school preparation, and that academic standards are very high. Black students also perceive the campus environment to be alien and hostile. There is a belief among black students that most whites, both faculty and students, see blacks as under-prepared " affirmative action cases" who do not really belong at a university.

### **Expanding the Pool**

Science, engineering and mathematics majors are usually recruited from the highest achievers in a high school cohort. Among minority students this is a very small pool. As Gail Thomas (1987) has noted, "among college-bound seniors, the percentage of Blacks who have had four or more years of mathematics and sufficiently high grades in mathematics and science is consistently lower than the percentage of whites." (p. 274) Thomas adds, " Inadequate high school and college preparation in the natural sciences also has a negative impact on the graduate and professional school access and success of Black Students" ( p. 275).

In order to increase the pool of mathematically competent minority students, better arithmetic teaching in the elementary and secondary schools is essential. Although there are exceptions, it is very difficult for students who have been subjected to years of poor teaching, low expectations and generally negative attitudes about arithmetic in the early years to overcome these academic and attitudinal deficits during the high school or college years. The popular movie, " Stand and

Deliver “, presents an example, based on a real person, of a teacher who through his enthusiasm and creativity was able to convince Hispanic students in an urban high school that they could learn calculus. The example demonstrates the impact that a dedicated and talented teacher can have in motivating and teaching students who have previously been considered to be poor candidates for advanced placement mathematics. However, in spite of the efforts of dedicated teachers, the pool is still much too small. A significant increase in the pool of potential minority scientists will require systematic changes in the way children are taught in the elementary and secondary schools, especially in the way mathematics is taught.

### Recommendations

1. The first recommendation is that high quality preschool education must be made available to all children irrespective of race and social class. The early years provide the foundation for learning as well as for the development of attitudes favorable to learning. Good preschool programs can provide the type of learning environment required for students to develop positive academic self-images and confidence in their abilities.
2. Early identification of mathematically talented children followed by enriched programs and recognition for achievement would help build self-confidence and encourage continuation of interest in arithmetic and related subjects. Motivation is a key to developing the work habits and interests needed for work in science and mathematics.
3. Collaboration between colleges and universities and local school systems is needed in order to improve the quality of arithmetic teaching available to minority children. College faculty and students can work closely with local schools to ensure that pre-collegiate education meets the level of preparedness required for higher education. College professors, graduate students and undergraduate students can serve as teachers, tutors, advisors and sponsors of students in local public schools.
4. Improving the quality of arithmetic teaching will help to reduce the number of children who develop math anxiety and to increase the number of children who enjoy arithmetic and related subjects. It is my contention that much of the problem of low achievement in arithmetic is attributable to the lack of preparation of primary and elementary school teachers. Colleges and universities should develop programs designed to improve the arithmetic knowledge and the arithmetic teaching skills of elementary school teachers.
5. Improving test scores of minority students is an important strategy for increasing the size of the pool of college eligible students. This should involve

both improving the quality of instruction and increasing the number of higher level mathematics and science courses minority students complete. Increasing the emphasis on problem solving and the development of analytic skills in elementary school mathematics classes should also help to improve test scores. Courses to assist students in preparation for standardized tests can also be beneficial.

6. Improved recruitment and retention programs at the college and graduate school level. Institutional commitment is the key to successful minority recruitment. Blackwell's research (1987) indicates that a good indicator of the commitment of an institution to recruiting, retaining and graduating black graduate and professional students is the proportion of blacks on the faculty. This same indicator would seem to be applicable to recruitment of undergraduates as well.

## Cultural Expectations As Correlates Of The Under-Representation of Blacks In Mathematics And Science

Lois Powell  
Professor of Psychology  
University of the District of Columbia

### The Black Scientist: A Rare Species

In an attempt to understand college students' impressions of scientists, Beardslee and O'Dowd (1961) surveyed the attitudes of students from four north-eastern colleges. The results of this investigation uncovered a pervasive stereotype of scientists. College students depicted the scientist as a very radical, individualistic, strange, and intelligent individual who is socially withdrawn and indifferent to others. The scientist was also pictured as being unpopular, unhappy, and having an unattractive wife. Though the students accorded respect to the scientist for his contributions, he was nonetheless, considered hard to understand, indifferent to art, and difficult to like. With this type of image of scientists prevailing on college campuses, it is little wonder that large numbers of students shun majors in science. After all, being a scientist characterizes one as peculiar, unsociable, and qualifying for an ugly spouse.

These views of the scientist appear humorous and unrealistic; however, there is considerable evidence that today's college students, particularly blacks and Hispanic, avoid majoring in science and mathematics because cultural traits support unfavorable images of scientists and make the attainment of a scientific career unattractive.

Also many minority students have internalized a self perception of incompetence in mathematics and science. To eliminate psychological distress associated with this perception, they incorporate an ego protective ideology that views mathematicians and scientists as peculiar and socially irrelevant.

Many reasons have been cited for the relatively small number of black mathematicians and scientists, but there has been no attempt to provide an integrated scheme or model of black vocational choice. There has been scant research in this area and much of that which has been written is not based on empirical research. It is clear that the selection of college majors and professional careers is differentially operationalized by black and white students. Some researchers have attributed mathematical achievement to the self-concept (Hansford & Hattie, 1982). Along these lines, Gottsfredson (1981) theorizes that there is a progressive and permanent circumscription of vocational choices from childhood to adolescence which is tied to the developing self-concept. Nevertheless, the relationship of self-concept to academic achievement is equivocal as shown in research such as that conducted by Lay and Wakstein (1985).

Black college students are over-represented in occupations generating low incomes such as education, the humanities, and the social sciences. Writers such as Hall (1987) have suggested that blacks tend to select occupations in which they have had contact with successful role models. Perception of opportunities for

employment is also cited as a likely cause for many blacks to select careers in the social sciences. Another line of reasoning cited by Hall (1987) for this type of educational preference is the fact that since blacks have a cultural orientation and expectation to help others, they tend to choose college majors that will prepare them to work in the helping professions. Seriously inadequate career guidance is another reason given for the under-representation of black students in mathematics and science curricula. This is the case according to Boyer (1983) who also observed that large numbers of high school students received career guidance from peers and parents. Since many of these "advisors" have not attended college, they offer inadequate occupational information.

Finally, sex role stereotypes tend to predispose women from all cultural groups to select more traditional occupations such as the fields of teaching, nursing, and social work. An investigation by Thomas (1985) revealed that enrollment in a predominantly white college has a significant negative effect on majoring in the natural and technical sciences among black women. Sex differences in career interests were also noted by Holland (1979, 1985) in the explanation of his theory of vocational choice. He devised a classification system comprising the following six categories of interests: Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C). Holland (1979) found that men preferred Realistic, Investigative, and Enterprising occupations, while women preferred Artistic, Social, and Conventional activities.

#### **A Conceptual Framework For Understanding Black Students' Avoidance Of Mathematics and Science Careers**

We now turn to the major proposition of the present paper. This writer offers a learned helplessness model for conceptualizing the poor performance of blacks in mathematics and science and to show how cultural expectations of failure frequently become self-fulfilling prophesies. There is a widely held belief in American society that mathematics and science studies are extremely difficult. Though this belief system may operate at an unconscious level, it has been incorporated into the thought processes of both blacks and whites. Abundant research exists showing the mean IQ score of black falls within the low average range. This literature is well known and will not be reviewed here. It is obvious that persons of dull intellect are not expected to become mathematicians or scientists. Consequently, aspiring to scientific careers or to be a mathematician is believed to be antithetical to the cognitive capabilities of blacks. The cultural expectation for one's group to perform poorly in mathematics and science is an example of a social psychological phenomenon referred to as learned helplessness.

For more than two decades, psychologists have observed that many persons, after having failed repeatedly on a designed task, abandon the activity and determine that they can do nothing in the future to effect a more positive outcome. Such defeatist ideology has come to be called learned helplessness. When carried to extremes, this emotion is translated into a state of reduced motivation and psychological depression in which the individual believes that whatever he does ends in failure. In other words, the person learns that behaviors and reinforcements are not contingent upon each other.

Seligman (1975), after having observed animals, theorized that people can also become victims of learned helplessness in that they readily perceive when efforts for control or success do not yield the anticipated outcome. Upon encountering continuous failure, individuals may stop trying, not only in the settings where failure was initially elicited, but also in other settings where there might be a better chance for success. Seligman's work with dogs showed that chronic inability to control environmental features caused the dogs to become passive in their endurance of traumatic events.

Abramson, Seligman, and Teasdale (1978) hypothesized that the conditioning of helplessness causes individuals to attribute their failure to succeed at a task to either personal or universal factors. Personal attribution of failure is more damaging because one finds flaws in himself/herself to be the cause of the negative outcome. On the other hand, universal attribution leads one to conclude that failure was inevitable since the task is unsolvable by any person. Therefore, the locus of attribution determines how much damage is done by repeated failure to succeed at a task. Additionally, Abramson, et al. (1978) showed that individuals' cognitions of the global or specific nature of helplessness determine the degree to which failure is damaging to one's self-esteem. Globally perceived, helplessness is more devastating since it is apparent across numerous occasions and settings.

Once the helplessness syndrome becomes an institutionalized part of a person's psychic make-up, the effects can be extremely deleterious to functional capacity. The result may be emotional problems, motivational disturbances, and negative expectations regarding future performance. The defeatist attitudes associated with this syndrome are related to minority students' tendency to avoid selecting majors or being directed toward mathematics and science. Investigations such as that done by Hall (1987) show that blacks receive poor preparation in these subjects and, therefore, experience repeated failure to master basic mathematics and science concepts early in their school careers.

On-going educational encounters with failure appear to cause many black students to become victims of learned helplessness in which they observe that failure is global, inevitable, and due to a personal flaw.

Consequently, they give up, deciding that they will never be able to succeed in mathematics and science despite concerted efforts to do so. By the time such individuals reach college, a full blown mathematics phobia along with helplessness symptomology are present. Since the locus of attribution for failure is personal, the black student becomes devastated when confronted with mathematics and science. The prospect of further failure is ego dystonic and can be removed only by avoiding the offending subject matter.

Research is available documenting black students' deficiencies in mathematics and science. Two recent studies are indicative of the general trend of the findings. Reys and Stanic (1985) discovered that black students subscribe to fewer courses in mathematics and science than whites and also demonstrate achievement records below those of white students. Extrapolating from data secured by the National Assessment of Educational Progress and the College Entrance Examination Board, Jones (1984) discovered that black high school students take significantly fewer algebra and geometry courses than their white counterparts.

This is an important finding since the number of high school algebra and geometry courses proved to be the best predictive indicator of scores on standardized mathematics achievement tests. Additionally, black students were found to have lower scores in mathematics than white students. Low mathematics ability is symptomatic of the learned helplessness phenomenon which debilitates large numbers of black students in this skill.

As has been stated before, the helplessness syndrome is activated by repeated failure to succeed at a task. Learned helplessness has been shown to be associated with other factors which may shed light on minority students' poor performance in mathematics and science. Over-crowded conditions in the home have been demonstrated to contribute to the development of the phenomenon. When there is an absence of privacy due to too many people in the household, individuals tend to develop a sense of lack of control to the extent that they become passive and fail to take control when the opportunity presents itself. Rodin (1976) showed that residential crowding is a correlate of the helplessness syndrome. Children growing up in high density environments were less likely to take control of expected rewards than children from low-density homes.

Crowding as a casual factor in helplessness must also be understood within the context of overly dense academic environments. Baron and Rodin (1976) speculated on this connection, hypothesizing that large class size is positively related to the development of learned helplessness. It was their contention that large classes negatively affect students' perceptions of ability to control positive educational outcomes. Consequently, their achievement is likely to be lowered in the face of learned helplessness.

Finally, Glass and Singer (1972) discovered that helplessness can develop as a result of uncontrollable noise. Noise more readily affects performance when one is involved in complex tasks such as those encountered in mathematics and science. Choen et al. (1980) studied children in attendance at noisy schools near a metropolitan airport. When tested in a quiet environment, these children had a higher failure rate on a cognitive task and tended to give up earlier than a matched sample of children attending quiet schools. The aversive effects of noise seem to be more profound when it is uncontrollable, thus contributing to a sense of helplessness.

Because crowded conditions and noise are common features in the lives of many minority students, they are in triple jeopardy of falling victim to learned helplessness. The three components of the helplessness phenomenon most often identified by researchers thus far are persistent failure, crowded living and learning environments, and noise pollution. Each of these conditions has been associated with performance decrements when complex operations are being performed.

### **Summary and Recommendations**

It has been shown that repeated contacts with failure or uncontrollable events render an organism susceptible to the development of learned helplessness. The manifestation of this syndrome leads to passiveness, defeatist ideology, and negative emotion. If the failure or loss of control is perceived as global and if causation is attributed to personal inadequacies, then the individual becomes completely

debilitated in the performance of the task under more favorable conditions. This set of events is familiar to large numbers of blacks who learn early in life that they fail to perform adequately in mathematics and science. Even though lack of comprehension is often due to poor education and preparation, many black students place the locus of attribution on themselves, feeling that their failure is caused by low intelligence. Once this happens, helplessness syndromes begin to appear.

Learned helplessness in mathematics and science becomes more profound as black children are exposed to high density living conditions and uncontrollable noise. The impact of these factors creates the perception of an environment out of control in which the individual experiences a loss of ability to perform complex tasks. He/She falls further behind in the understanding of mathematics concepts and ultimately discontinues efforts to succeed. A stratagem often employed by such students is to bypass courses in mathematics and science and to characterize these studies as meaningless because the students do not see a connection between science and the resolution of serious social problems in the black community. This configuration of attitudes and emotions constitutes one of the major reasons for the relatively small number of black mathematicians and scientists.

The helplessness personality syndrome can be ameliorated by providing the victims with opportunities to successfully complete a task shortly after exposure to aversive stimuli. According to Abramson, et al. (1978), using a laboratory experiment, this approach was successful in improving symptoms of college students manifesting helplessness and depression. The implication for educators is to make sure that minority students are given opportunities to succeed after exposure to difficult mathematics content. Over time, the pairing of aversive and pleasant stimuli will lead to systematic desensitization of mathematics phobia.

Performance in mathematics and science may also be improved in black students by freeing the educational environment of crowding and uncontrollable noise. Classrooms in which science and mathematics are taught should be quiet, pleasant, and orderly. A small number of students should be given instruction at one time to allow for optimal interaction with the teacher and constant feedback on performance. Special counseling services should be set up in high schools and colleges to provide minority students occupational information on career opportunities in mathematics and science and to identify those individuals who should be encouraged to pursue scientific careers.

High school counselors should encourage students to take as many as possible of the mathematics and science courses offered by the school. This act alone will ultimately increase the percentage of blacks in scientific careers since the number of courses taken is the best predictor of choice of a science major in college. Additionally, there should be more funding available to research the career choices of minorities which would lead to the development of a new theory of occupational choice.

# **Patterns of Parent-Child Interactions In Young Children: Some Antecedents For Parental Influences Of Student Aspirations**

John L. McAdoo  
Associate Professor  
School of Social Work-University of Maryland

The family is recognized as the basic unit of socialization in our society. However, in the last fifty years, educators have paid little attention to the interaction patterns that goes on within the family and its relationship to the child's motivation for higher learning. The increasing decline in enrollment of black and Hispanic youth in colleges and universities has caused some educators to re-assess their ability to enlist the aid of parents in motivating their children to stay in school, enroll in the more difficult math and science courses and insist on a balance between athletics and academics.

There is a need for educators to understand the pressures and limitations that parents must face in rearing their children and for them to find ways of remedying the negative relationship that exists between home and school. Social science research may be useful to the teachers, counselors, psychologists, social workers and administrators in helping them to understand patterns of parent child relationships.

This paper will present a brief summary of parent child interactions research, discuss some of the findings from our research on parent child interaction patterns, and present some conclusions about parent child relationships from the review of literature, conversations with professionals and personal experiences in working with families.

## **What The Literature Says About Parenting Styles**

The literature on parent-child interaction patterns and school learning seems to be somewhat fragmentary and a bit speculative. What seems most clear from the literature is that the way parents interact with their children has great significance to the way they feel about themselves and significant others in their environment. A child who feels good about him or herself and the way they see others valuing them will come to a school environment better prepared to achieve.

Walters & Walters (1980) in a decade review for the Journal of Marriage and the Family have summarized the literature on the issues of parent and child relationships. In this review, they suggested that patterns of parent-child relationships are influenced by the parenting models which mothers and fathers provide each other. They noted that young children prefer the parenting style of the father; the praise-giving and physically stimulating rough and tumble, non-intellectual nature of play that fathers are apt to provide more than the intellectual approach attributed to the mother's parenting style. Many of the studies they reviewed appear to have been carried out on families with a mother being full time in the home. We wonder if these relationship patterns are the same for the working family of today and whether there may be some class differences.

Peters (1988) in a critique of family studies on the socialization of black children noted that most Black parents socialize their children to become self-sufficient, competent adults like every other ethnic group. Black child socialization occurs within the ambiguities of a cultural heritage that is both Afro-American and Euro-American and a social system that espouses both democratic equality for all of its citizens and somewhat caste-like status for its Black and Hispanic citizens. She noted that the most problematic families were chosen to be evaluated and usually only evaluated the mother's reports of the child's environment and behavior (Peters, 1988).

Two child development researchers, Diane Baumrind and Norma Radin have attempted to evaluate parenting styles and interaction patterns between parents and their young children. Baumrind (1966; 1967, 1968; 1971) discussed the differences in three types of parenting style authoritative, authoritarian and permissiveness and their relationship to social competence in young children.

She described the permissive parent as one who responds to the child's impulses, desires and actions in a totally non punitive, benign, accepting and affirmative manner. This parent usually makes few demands on their child to behave in an orderly fashion or do household chores. They depend almost entirely on reasoning with the child as a means of control of behavior. They see themselves as more of a consultant to be used for the child's desires and not as a agent responsible for shaping the child's ongoing or future behavior. This parent sees freedom as meaning the absence of restraint.

The authoritarian parent attempts to shape, control and evaluate the child's behavior and attitudes to a set of rules or a set standard of conduct. They value and expect obedience as a virtue and believes in punitive forceful measures to control the child's behavior when it is in conflict with what the parents believe is right. They allow few give or take discussions and the child is expected to accept the parent's view of what is right. He or she does not value the preservation of order and traditional structure as an end in itself.

The authoritative parent seems, from her point of view, to be a composite of the best of the other two parenting styles. This parent also attempts to direct the child's activities but in a more rational issue oriented manner. The authoritative parent is able to encourage give and take discussions and give reasons for their rules and expectations. These parents tend to value both expressive and instrumental attributes, both self will and disciplined authority. They provide firm control with explanation when the child violates family policy. They, in short, believe in using reason and power in achieving their objectives with the child.

In a series of studies, Baumrind found that authoritative parents promoted purposive dominant behavior in their children. Authoritative control was associated with the development of social responsibility in boys with achievement but not cooperative behavior in girls. Parents who were either authoritarian or permissive in their child rearing patterns had children who were either markedly high or markedly low in overall competence. No racial differences were found in the behavior of the children.

While not being significant, there did seem to be some need of further research to clarify some areas in her study. Black boys appeared to be less achievement oriented and more aggressive than white boys. Black fathers did not seem to encourage individuality, independence or provide enrichment of their daughters environment. Daughters in authoritarian Black families were found to be more independent and at ease than whites in a nursery school setting. Black families did not promote nonconformity and were seen as more authoritarian in their child bearing practices. What we may conclude from her findings is that some Black families socialize their children differently than White families. Further, that Black girls benefit most from the authoritative parenting style in terms of their competence in the school setting (Baumrind, 1968).

Radin (1972, 1973, 1975) was more interested in the type of parent-child interactions and its effect on cognitive growth in young children. Radin's main type of interaction were described as nurturance and restrictiveness. A nurturant parent was described as one who is warm and loving toward their children and at the same time provides consistent controls with some explanation when the child's behavior violates family rules. Restrictive behavior in parents occur when the parent appear more cool, distant towards their children and demand obedience without explanation. They are not likely to hug their children or exhibit warmth.

Her observational study of middle white and low income children noted that children in nurturant families did well on cognitive tasks and children in restrictive families did poorly on cognitive tasks in Kindergarten (Radin, 1972). We were also interested in parent-child interactions and the self esteem in preschool children.

The study we conducted (McAdoo, 1979, 1983, 1985) was a partial replication of the Radin studies.

We found that both Black and White middle income parents are equally nurturant towards their children. While there were no significant racial differences in nurturance, White fathers were found to interact more than White and Black Mothers and Fathers. This led us to suggest that White fathers may be less involved in the care-giving of their children. While we found no relationship between the parenting style and self-esteem, we noted that parents who nurtured each other had children with higher self esteem. The majority of the children in our study were found to have high self-esteem.

### **Implications For Learning**

What our studies and others suggest is that children who feel good about themselves and their relationship with their parents will probably achieve in school. Parents who are consistent in their parenting styles and are not restrictive with their children will have children who will do well in school. Parents need to be able to balance their need to encourage and to control their children's behavior if they expect their child to do well in school. This means that throughout the children's life cycle, parents need to be there to provide both support and encouragement, and provide consistently positive role models if the child is to do well in his/her learning.

We recognize that as the child grows older, peers, teacher and the environment play an important role in the children's aspiration and learning, however, the influences of the parents if exerted early and often, can mediate much of the negative influences in the outside environment. There is a need to continuously monitor the child's activities and behavior in school and at home. They must retain their role as providing a buffer for the negative messages that may be transmitted to their children by a school system which may perpetuate stereoscopic images of Black and other ethnic minorities (OGBU, 1978).

Black and Hispanic parents need to understand that their presence in the school from time to time in conferences with the teacher, attending the PTA and other school events can go a long way towards changing any negative vibrations between the teacher and their child. It lets the system know that the parents are serious about their child's learning and are willing to help in any way to maintain the progress of the child. It also lets the child know that they are willing to provide him/her with support wherever necessary to help in the learning process.

Where both parents are working, they can still be involved in the PTA's and call the teacher to learn how the child is doing academically and socially. However, when parents and/or teachers sense a change in the children's behavior or attitude toward school and learning, they must be willing to make a sacrifice and attempt to learn in a face to face meeting with the teacher where the problems lie and develop methods to resolve them. Always keep in mind that sometimes a change in classrooms to provide a different learning environment may possibly be necessary.

In summary, providing a home environment that is safe, warm, and comfortable, where expectations, rules and roles are clear, where parents are verbally supportive and involved in all areas of their young children's lives, where parents make clear their own aspirations for their children, where both the child and the school are aware of the parents concern for his/her learning, leads to a foundation for the development of high self regard, a quest for competence in the child and maximizes the learning potential and achievement of their children.

Elder (1962) noted that parent-child interactions patterns in adolescence fall into seven possible categories ranging on a continuum from control over every aspect of the adolescents life to no control over the adolescents life at all. He provides support for Baumrind's feelings that autocratic, authoritarian parenting styles along with parents who are permissive or laissez-faire in their relationships with their adolescent make identity formation difficult for their son or daughter and does not foster healthy interaction patterns among the family members.

Bowman (1973) in a secondary analysis of a national study on Black Americans found that Black teens' feelings of personal efficacy was positively influenced by parental strictness and race related socialization. That is, teens who perceived their parents as strict, not too lenient or over-protective, tended to have a high sense of personal control over their lives. Bowman notes that this finding is supportive of literature that suggests that parents who monitor their child's activities yet foster some degree of independence will positively influence the child's psychosocial development (Clark, 1983).

Further, it seems that Black youth who recalled receiving messages related to blocked opportunities tended to have higher levels of personal efficacy than those whose parents transmitted some other kind of messages, e.g. equality, self-development. This finding seems to support the notion of a unique cultural style used by Black parents in promoting success and a healthy adjustment for their children. They also found some support for the idea that teaching Black children about equality and self-development may be more useful when these messages are coupled with some realistic coping and survival strategies.

Parents who keep open a channel of communication with their teenage children, who provide them with a clear understanding of their rules and some active and positive guidance and some support, who consistently monitor the activities and behavior of their children have less to fear about peer influence on their child's learning, aspirations, and school achievement. Simply get to know their friends and their parents. Make it clear to your teen that chores are to be done, homework finished in regularly established times. Friends may come by only to study together during those times and weekend hours are to be faithfully observed. Make sure there are some activities that involve all of the family scheduled at regular intervals. For example, trips and fishing need not be expensive.

Black parents may also need to provide realistic messages to their children about coping and survival strategies if they expect their teenagers to make a positive transition to adulthood. If colleges and universities are serious about the wish to gain more Black and Hispanic applicants in their programs they may need to be more pro-active in their recruitment. That is, they may wish to adopt some community schools and engage the parents in a supportive program where parents learn to help their children in math and social science. They need to recruit these students much in the same way that they recruit athletes for their college programs.

The community needs to be involved in this process. Perhaps by providing a family life center where families can learn positive parenting techniques. Methods of nurturance and control of children's attitude, behavior and beliefs that will help to empower the family eradicate negative racial, gender and class bias that block children's road to achievement and a positive identity. Public schools, too, must change. They need to learn to do a better job of involving parents in decisions about the child's learning. They must be willing to learn to provide non-traditional teaching and learning activities in the classroom and in the community. This may include involving other professionals in the teaching and learning process.

### **Summary**

What we have been discussing are some antecedents to teaching and learning that will help increase the pool of Black and Hispanic students in higher math and English courses. Antecedents that will lead them to choose college careers related to math and English that will lead them to become productive citizens. Parental nurturance and control are two of the most important antecedents. Active parental involvement in the child's education environment from kindergarten through college is another. The school must be viewed by ethnic minority children as a supportive nurturing environment that makes realistic expectations for competence in learning and in partnership with the parents provide firm control over the students' classroom behavior. The development of positive school and community attitudes and values towards learning still another variable.

A final antecedent variable that we have not discussed is the need to develop economic self sufficiency for the family. Removing economic strain and its related stressors may go a long way towards helping the family become more involved in the child's quest for learning and their active participation in the system. Antecedents to learning need to be fully understood and utilized if we are to stem the drop out rate and increase the number of ethnic minority children in the major colleges and universities.

## OVERVIEW

Beverly J. Anderson  
Professor of Mathematics  
University of the District of Columbia

I am pleased to have this opportunity to provide an overview of academic intervention programs, as I have enjoyed my work in them since 1965 and have come to realize the value of college/university-based programs as a supplementary activity, to local school programs.

In providing this overview, I will focus primarily on the black and Hispanic minorities and will provide some of the compelling reasons for the existence of intervention programs aimed at increasing their participation in mathematics-based fields. Also, I will share the goals and characteristics of successful intervention programs.

Let us begin with Plato. This ancient Greek philosopher acknowledged over two thousand years ago that mathematics is the foundation of sciences. Later Galileo, the Italian mathematician, astronomer, and physicist who is also considered the founder of the experimental method stated in his Dialogue Concerning the Two Chief World Systems-Ptolemaic and Copernican (1632), that mathematics is the alphabet with which God has written the earth. In more recent years, Lucy Seels' research supports that mathematics is indeed the foundation of the sciences and is the language of the earth. She goes one step further and shows that mathematics is the invisible filter-students who do not acquire a sufficient background in mathematics prior to college are virtually eliminated from an inordinate number of careers, ranging from careers in the physical sciences and engineering to those in the social sciences and psychology.<sup>1</sup>

Although the black minority comprises roughly 12% of the total population in America, this ethnic group represents only 2% of the employed scientists and engineers in this country (Employed Scientists and Engineers in the U.S., National Science Foundation, 1985). More specifically, blacks comprise:

| Percentage | Occupation               |
|------------|--------------------------|
| 2.4        | Physical Scientists      |
| 2.8        | Computer Scientists      |
| .6         | Environmental Scientists |
| 1.9        | Life Scientists          |
| 1.7        | Engineers                |
| 4.7        | Mathematical Scientists  |
| 3.5        | Psychologists            |
| 4.8        | Social Scientists        |

1 Seels, Lucy, "Mathematics: The Invisible Filter, "Engineering Education ( January, 1980), 340-341.

Clearly, this ethnic group is under-represented in the employment force as scientists and engineers. It certainly appears that a large percentage of the blacks have been filtered out of these areas.

The answers to the questions of why and how blacks are filtered out of mathematics-based careers have perhaps given impetus to the development of several intervention programs aimed at reversing that trend. Let us look at some of the reasons given for this under-representation. Achievement in mathematics as it relates to test scores, and course-taking in mathematics are perceived as two of the major reasons. Of course, the dearth of appropriate role models is frequently advanced as another reason.

On the 1986 National Assessment of Educational Progress (NAEP) which measures the achievement of students in mathematics at the 3rd, 7th and 11th grades, the level of performance for blacks and Hispanics was below that of the Asians and whites at each grade level. Table I provides the mean score of mathematics proficiency for white, black, Hispanic and Asian-American students in grades 3, 7 and 11 in 1986.

Table I: \* **Mathematics Proficiency for White, Black, Hispanic and Asian American Students in Grades 3, 7, and 11: 1986**

|                         | Grade 3 | Grade 7 | Grade 11 |
|-------------------------|---------|---------|----------|
| White Students          | 219.7   | 274.0   | 309.4    |
| Black Students          | 187.8   | 245.4   | 279.2    |
| Hispanic Students       | 194.6   | 251.3   | 285.6    |
| Asian-American Students | 211.3   | 288.6   | 330.6    |

\* Mathematics Report Card, National Assessment of Educational Progress, 1988.

The performance of the blacks and Hispanics on this assessment was consistent with that on the previous assessments in 1973, 1978 and 1982. That is, these groups did not perform well as their white counterparts at any age level.

On the Scholastic Aptitude Test, the statistics for the 1987-88 academic year show that blacks and Hispanics performed below the national average in both the mathematics and verbal sections. Table II provides a breakdown of mean score for

students taking the SAT over that period. The black students fell nearly 100 points below the national average in mathematics and the Hispanic students lagged more than 50 points below the national average.

**Table II. SAT Mean Score for the 1987-88 Academic School Year.**

|                  | Math | Verbal |
|------------------|------|--------|
| National Average | 476  | 430    |
| Blacks           | 377  | 351    |
| Hispanics        |      |        |
| Mexican          | 424  | 379    |
| Latin American   | 408  | 382    |
| Puerto Rican     | 423  | 366    |

It is not surprising that black and Hispanic students are less likely than their peers to be in an academic curriculum and less likely to take advanced mathematics courses. Table III provides a breakdown of the percentage of 17 year olds reporting the highest level mathematics course taken.

**Table III.\* Highest Level of Mathematics Courses Taken By Seventeen (17) Year Olds\***

|          | Pre-Algebra | Algebra<br>I | Geometry<br>II | Algebra<br>II | Pre-Cal/<br>Calculus |
|----------|-------------|--------------|----------------|---------------|----------------------|
| Nation   | 19          | 18           | 17             | 40            | 7                    |
| White    | 17          | 17           | 17             | 42            | 7                    |
| Black    | 31          | 18           | 16             | 31            | 3                    |
| Hispanic | 25          | 24           | 16             | 28            | 6                    |

\* - The Mathematics Report Card, NAEP, 1988.

The above table shows that roughly 50% of the blacks and Hispanics report that their highest level of mathematics was at or below Algebra I; however, that same percentage of the white population reported that their highest level was Algebra II or above.

Significant research using National Assessment data support that test scores in mathematics, at the high school level, have been found to be closely related to the number of high school courses in mathematics taken by those students. Also, recent findings support the hypothesis that the content of earlier mathematics instruction is better understood by students who have taken more advanced courses. <sup>2</sup>

2 (Jones, 1984, Welch, Anderson & Harris, 1982), (Jones, 1987).

Beyond high school and into graduate and professional school, differences between the blacks and Hispanics groups and the majority population are still apparent in mathematics. Differences at this level may also be seen in the natural sciences.

Among the factors that determine medical school acceptance are the scores on the Medical School Admissions Test (MCAT). This test measures the applicant's achievement in six areas: Biology, Chemistry, Physics, Problems, Reading and Quantitative. The mean MCAT scores appear in Table V for medical school matriculants in 1987.

**Table V. MEAN MCAT Scores by Sex and Selected Ethnic Groups, 1987 Matriculants**

|                           | Black | American Indian | Mexican American | Mainland Puerto Rican | All Students |
|---------------------------|-------|-----------------|------------------|-----------------------|--------------|
| MCAT Scores-Biology:      |       |                 |                  |                       |              |
| Male                      | 8.1   | 8.7             | 9.2              | 9.0                   | 10.0         |
| Female                    | 7.7   | 8.8             | 8.7              | 8.5                   | 9.6          |
| MCAT Scores- Chemistry:   |       |                 |                  |                       |              |
| Male                      | 7.7   | 8.3             | 8.6              | 8.2                   | 9.8          |
| Female                    | 7.0   | 7.9             | 7.8              | 7.7                   | 9.1          |
| MCAT Scores-Physics:      |       |                 |                  |                       |              |
| Male                      | 7.4   | 8.2             | 8.7              | 8.4                   | 10.0         |
| Female                    | 6.6   | 7.6             | 7.7              | 7.3                   | 8.9          |
| MCAT Scores-Problems:     |       |                 |                  |                       |              |
| Male                      | 7.5   | 8.5             | 8.7              | 8.3                   | 9.9          |
| Female                    | 7.0   | 7.9             | 7.8              | 7.7                   | 9.1          |
| MCAT Scores-Reading:      |       |                 |                  |                       |              |
| Male                      | 6.6   | 8.3             | 7.7              | 7.5                   | 8.8          |
| Female                    | 7.0   | 8.2             | 8.2              | 7.5                   | 8.9          |
| MCAT Scores-Quantitative: |       |                 |                  |                       |              |
| Male                      | 6.3   | 7.9             | 7.4              | 7.1                   | 9.1          |
| Female                    | 6.0   | 7.4             | 7.1              | 6.1                   | 8.3          |

\* - Minority Students in Medical Education, Association of American Medical Colleges Section for Minority Affairs, 1988.

Again, the performance of blacks and Hispanics in every area is below the national mean. The largest disparity sex-wise is in the quantitative area. This gap (2.8) exists between black males and all males.

Of note also, is that the 1986 matriculants who did not survive the rigor of medical school (within each ethnic group) performed less well than their ethnic counterpart in each area of the MCAT. This was apparent within the minority groups as well as the majority group. This suggests that achievement scores on the MCAT, to some degree, is a predictor of survival in medical school.

The performance scores of medical school matriculants on the MCAT are obviously important because this examination serves as a filtering device that must be understood in order to increase the minority involvement in medicine. Please note that blacks comprise only 3% of the physicians in this country; Hispanics make up 4%, and native Americans make up only .1%, although this latter group is roughly .6% of the total population.

Although blacks, Hispanics and Native Americans are under-represented, in medicine, whites and Asian/Pacific Islanders show higher proportional representation in the physician population. Whites are 83.2% of the total population and 86% of physicians; and Asians/Pacific Islanders are 1.6% of the total population and 10% of the physicians in America.

For whatever reasons, it is clear that the black group and the Hispanic group as a whole have consistently performed below that national average on popular standardized tests in America and as a result, perhaps, they are sorely under-represented in mathematics-based fields.

Certainly, we cannot deny the dearth of representation of these minorities as employed scientists and physicians in America; we cannot deny that these ethnic groups perform below the national average on many popular standardized tests; we cannot deny that differential course-taking in high school is apparent in these ethnic groups; nor can we deny that black students take about one year less of high school mathematics than their peers; nor can we deny that the level of parental education and family income are directly related to academic achievement; nor can we deny that blacks living in the high socio-economic level performed well above the average score on the National Assessment at all age levels; nor can we deny that as the level of advanced mathematics credits increases in high school that the mean tests scores also increases; nor can we deny that when black male students take five credits of mathematics in high school that they perform as well as white male students with the same number of credits on popular standardized tests in mathematics (Jones, 1988). There is sufficient documentation to support otherwise.

The environment in which the black child operates reminds him constantly that the expectations for him to achieve in mathematics are lower than those of the majority student. He and his parents are frequently told of his athletic or dance prowess and his improved time on a given time such as running the 50 yard dash; but they are seldom told how wonderful he could be in mathematics and how he has

improved in translating verbal problems into mathematical statements or using the fundamental theorem of fractions. They are frequently told that he can perform successfully in sports; but seldom told that he can perform successfully in mathematics. Perhaps, if he is encouraged to spend and indeed spends nearly as much time with mathematics as he is encouraged to spend and often spends with athletics, that his performance in mathematics would be outstanding. If he is encouraged to think of good scholarship and achievement in mathematics like he is encouraged to think of good performance in sports, his performance in mathematics would be stellar.

Some colleges and universities in the United States have been responsive to the need to increase minority involvement in science and mathematics. They have already planned and implemented academic intervention programs for school students and their teachers with this goal in mind. Several of these programs have been successful in getting blacks and Hispanics to pursue upper level courses in mathematics and science during their high school years so as to increase their college options and career choices. Several of these programs provide opportunities for students to interact with appropriate role models; and some enhance the mathematics and science experiences of their students with classroom instruction and tutorial assistance. The duration of student involvement in these programs may be as little as five weeks to as long as five years. Examples of these successful programs: "A Summer Program in Mathematics and Computer Science", "The Saturday Academy", and "A Certificate Program for Specialist Teachers of Mathematics at the Elementary Level", at the University of the District of Columbia; The "Mathematics, Engineering and Science Achievement Program", at several universities in California and the "Pre-freshman Engineering Program" at several universities in Texas.

I am sure that we all believe that mathematics is an enabling force and a critical filter. With institutions of higher learning working in concert with school teachers, school students, school administrators, parents, as well as the public and private sectors, we will then upgrade the mathematics education of the minority students.

With sensitive, enthusiastic and competent teachers working co-operatively with parents and administrators to facilitate the maximum achievement for all, we will enhance the performance of minorities on standardized tests and increase their matriculation in upper level mathematics and science courses. Ultimately, we will increase the representation of blacks and Hispanics in mathematics-based fields.

## **The Mathematics, Engineering, Science Achievement (MESA) Program**

Larry Lim  
Director, The MESA Program  
University of Southern California

### **Overview**

MESA ( Mathematics, Engineering, Science Achievement) is a program that works with junior high and high school minority students to motivate and prepare them to pursue math-based college education and careers. MESA's goal is to make students successful who would be unsuccessful without us, and to make successful students better. MESA is a highly academic program with strong enrichment components.

I'll divide this talk into three parts. Firstly, what are MESA's results. Secondly, how does MESA get these results. And thirdly, what is the structure of MESA.

### **MESA's Results**

The MESA program at the University of Southern California currently works at 8 high schools and 3 junior high schools. During the 1987-88 academic year, there were approximately 350 students in USC-MESA. I anticipate that the USC-MESA program will expand into additional high schools and junior high schools next year.

Over the past nine years nearly 650 students have graduated from the USC-MESA program. Nearly 90% have gone on to four-year colleges with 70% of those majoring in a math-based field. Since the class of 1980 of the students we can locate (those for whom we have real information) 58% have graduated or are still in school; with close to 50% of those pursuing a math-based major.

There are similar programs at 16 other universities in California, as well as programs in half a dozen other states. In California alone, MESA works directly with nearly 5000 students in over 150 schools from 60 school districts.

The Statewide California MESA program statistics are: while the national average SAT is just over 700 for Blacks and about 790 for Hispanics, the MESA SAT average is 830 for Blacks and 900 for Hispanics; for the class of '86, 86% enrolled in college, and 90% of those were enrolled in a 4-year college.

## **How Does MESA achieve those numbers? What Does MESA do?**

MESA understands that two things must be recognized. One—students must be motivated to pursue college and math-based majors and two—motivation won't work without adequate academic preparation.

Most MESA programs are located in predominately minority neighborhoods and schools. MESA provides both motivational and academic support for MESA students and the schools as a whole.

### **Atmosphere**

MESA provides students with an atmosphere of academic excellence. It provides students with an academic peer group and a place to go. MESA tells students that there is nothing wrong with reading, studying, and doing math problems.

### **Motivation**

MESA provides engineering/science speakers and role models, field trips to industry and colleges and universities, Incentive Awards (money and prizes for grades and SAT scores-up to a possible \$1200 a year).

### **Academic Activities**

SAT/ACT prep classes; summer and Saturday enrichment programs in math, science, English, computer science, etc.; math, science, and engineering projects and competitions; regional MESA competitions; group study and tutorial programs; special research opportunities with groups such as Earthwatch and the Jet Propulsion Laboratory; and regular weekly meetings for speaker presentations, planning other MESA activities.

### **Services To Students**

MESA provides college information, admissions/financial aid help; tracking of students from the 7th grade through college graduation; and MESA-Minority Engineering Programs to help their college retention. To schools, MESA offers training, recognition, and conferences for teachers, the university, and private industry. MESA has coordinated programs where industry donates equipment and services directly to schools.

### How Does MESA work?

The MESA program is centered at a university, usually at a School of Engineering. The program Director, from the university, takes care of the paperwork, funding, field trips, contests, summer programs, planning for the center organization as a whole.

Each program works with specific students at specific junior and senior high schools in the vicinity of the university. Students are recruited and selected early and remain in the program for three, four, five or more years. To make a significant difference, this long term interaction is a necessity.

One or two math/science teachers at each school are designated as the MESA Advisor and are responsible for the program at the school. The MESA Advisor is responsible for recruiting, counseling, and all the day-to-day interaction with the students. The MESA Advisor is usually given a release period or a stipend or released from other responsibilities so that the MESA work can be accomplished.

MESA activities range in size from one-on-one college advising to classroom science activities to College Day and Math Olympics for 1000 MESA students at a crack.

The MESA program is headquartered at the University of California-Berkeley. Funding comes from private industry and foundations, the state legislature, and the school districts. The linkage between schools, universities, and industry is a key to the success of MESA. Each understands that it both provides and uses the products of the others.

MESA has been around over ten years now. The major factor in its success has been the focus on math and science. This clear concentration on physical science, instead of including pre-med, business, or just getting into college, gives the program a focus and lets MESA students know early on that such concentration is necessary to become an engineer.

Thank you for letting me talk about MESA.

**An Overview of The Saturday Academy-  
A Pre-College Mathematics Based  
Intervention Program**

Winson R. Coleman  
Director, The Saturday Academy  
University of the District of Columbia

**Overview**

In September of 1982 the Saturday Academy began as an academic intervention program housed on the campus of the University of the District of Columbia and supported by the College of Physical Science Engineering and Technology. This pre-engineering program was developed in response to a proposal by Dr. Beverly J. Anderson, then Chairperson of the Department of Mathematics at the University of the District of Columbia. The program was accepted for funding by NASA and has been in existence and growing ever since. In 1982 the program consisted of 60 students and 6 teachers. Presently the program serves 300 students per year using 20 part-time teachers and over 40 teaching assistants who for the most part are program alumni and UDC students.

The program has been designed to meet rather unique needs, and there are many, ranging from single parent families to drug infested neighborhoods, of an urban inner city pre-college population in grades seven through nine. Materials have therefore been designed with this in mind. The actual recruitment of participants has also been geared to this population. Resource persons from the schools, communities and area businesses have graciously accepted our invitation to work in the program. Parents are, by program design, intimately involved from the onset of their child's participation, and are able to take comfort in the fellowship provided by other parents who, in all probability, are going through some of the same problems.

The relative newness of these intervention programs inhibits both the quantity and quality of available research, documenting successes and failures of these approaches. The Saturday Academy began, for example, as a ninth grade program in 1982 and alumni from that period are at best sophomores in colleges throughout the country. Data obviously can not be gathered on the success of this intervention program with regards to college graduation. In a recent study done in partial completion of the requirements for a Doctoral degree at American University, soon to be Dr. Linda Hayden, was able to collect and analyze pertinent data relative to the present performance of Saturday Academy alumni when compared to a peer group. Using a random sample of 38% of the total alumni group involved as participants in the first two sessions of the program as the experimental group and a 37% sample from a like sized peer group, data was collected. Briefly the results indicated that there were indeed significant differences in high school graduate rates, in college enrollments and in the number of students choosing science as a collegiate major.

She was also able to demonstrate some rather interesting information relative to gender that was supported through both experimental and control group data. The data supporting our three major contentions was as follows:

| Category                                     | Experimental | Control |
|----------------------------------------------|--------------|---------|
| Participants Completing<br>High School- *    | 98%          | 46%     |
| Participants Entering<br>College -**         | 91%          | 46%     |
| Participants Choosing<br>Science Majors- *** | 45%          | 20%     |

In national comparisons with other pre-college programs aimed towards increasing minority participation in mathematics based fields, we identified two major programs, namely The Mathematics Engineering and Science Achievement (MESA) and The Minority Introduction to Engineering (MITE). MESA is the oldest( founded in 1969) and largest such program of its type being funded by the state of California and the private sector (\$4 million/year). MITE, on the other hand, is a relatively new program sponsored by the state of Florida as part of a ten year plan to increase the number of minorities in scientific technical fields. According to information published in the September, 1987 edition of Black Issues in Education, the following comparisons were made:

| Program                | High School<br>Graduate | In College | Science<br>Major |
|------------------------|-------------------------|------------|------------------|
| SEC-Washington<br>D.C. | 98%                     | 92%        | 45%              |
| MESA-California        | N/A                     | 85%        | 60%              |
| MITE-Florida           | N/A                     | 90%        | 47%              |
| NSF                    |                         |            |                  |
| White                  | 87%                     | 49%        | 36%              |
| Black                  | 78%                     | 48%        | 33%              |

As these programs age more data will be collected and analyzed to further determine the potential of these early interventions in eliminating the waste of minority scientific talent in the public schools throughout our nation. At the present our efforts are only attempts to provide early stimulation in mathematics and the sciences for this population with the hope that this early motivation will allow/cause the young student to remain "turned on" to education and not turn his/her back on the opportunity that it presents.

**The Texas Prefreshman Engineering Program:**  
**A Model For A Statewide Pre-College**  
**Minority Intervention Program**

Manuel P. Berrioza'bal  
Professor of Mathematics  
Coordinator, Texas Prefreshman Engineering Program  
The University of Texas at San Antonio  
San Antonio, Texas 78285

**Abstract**

Since the summer of 1986, the Texas Prefreshman Engineering Program (TexPREP) has been organized and conducted in Texas. TexPREP is the statewide replication of the San Antonio Prefreshmen Engineering Program (PREP) which started in the summer of 1979. It currently operates at institutions of higher education in seven cities.

The purpose of TexPREP is to identify high achieving middle and high school students who are potential engineers or scientists and to give these individuals needed reinforcement to successfully pursue future college engineering and science studies. Women and minority students are special target groups.

The program is an academically intense eight week program which stresses the development of abstract reasoning skills, problem solving skills and career opportunities in engineering and science.

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 75 average or better performance standard during the program. Each student earns a final grade which is reported to his/her school.

Over 2000 students have completed at least one summer in a PREP; 77% have come from minority groups under-represented in science and engineering and 49% of whom have been women.

During the summer of 1987, TexPREP locations conducted a follow-up of former participants. As of fall 1987, 680 former participants were of college age. Responses were received from 584; 416 said they would attend college in the fall of 1987, while 73 had graduated from college. Of this number, 68% indicated that their majors are in science or engineering.

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 has been to identify high achieving middle and high school

students of the Greater San Antonio area who are potential engineers or scientists and to give these individuals needed reinforcement so they can successfully pursue future college engineering and science studies.

## Overview

The program is an academically intense eight week program which stresses the development of abstract reasoning skills, problem solving skills and career opportunities in engineering and science.

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 75 average or better performance standard during the program. Each student earns a final grade which is reported to his/her school.

In the fall of 1985, the Texas Pre-freshman Engineering Program(TexPREP) was organized. Currently TexPREP is a collaborative effort of higher education institutions in Brownsville, Corpus Christi, Denton, Edinburg, Laredo, Lubbock and San Antonio. Each location has its own director and the director of San Antonio PREP serves as TexPREP Coordinator. San Antonio PREP has been replicated in these six more recent locations and the partnership of San Antonio PREP and its benefactors and supporters have been extended to the new locations.

Financial and full-time inkind manpower staff support has come from local, state and national colleges and universities; local school districts; military commands and other government agencies; private industry; along with the Texas Alliance for Minorities in Engineering, Inc. and its local chapters.

In the combined 1987 TexPREP, 841 started the program and 668 successfully completed it. Eighty-six poverty level participants were supported by the local SYETP Programs and each participant earned at least \$700 during the summer. Seventy-seven (77%) of the successful participants were minority while 53% were women.

The combined 1987 staffs include 14 college faculty members, 15 high school instructors, 5 Navy offices, 489 Air Force officers, 2 practicing engineers, 1 graduate student and 44 program assistants.

Each summer TexPREP takes follow-up of former participants. In the fall of 1987, 680 of approximately 2000 former participants were of college age. Responses were received from 584 of whom 445 said they would attend college in the fall of 1987 while 73 had graduated from college. Thus, 88% of the respondents were college undergraduates or college graduates. Of this number, 68% indicated that their majors are in science or engineering. Statistical summaries are presented later in this paper.

Since a significant number of minority students come from low income families, TexPREP charges no tuition or fees. In this way, low income does not become a barrier for application. Also, all PREP's have been designated a Summer Youth Employment and Training Program (SYETP) worksite. Thus, some poverty level participants earn up to \$700 by their work experience in PREP.

In 1980, the population of Texas was approximately 14.2 million, of whom 1.7 million were Black and 3.0 million were Hispanic. Thus, these minorities constituted 33% of the State's population. According to a 1987 study of the Texas Higher Education Coordinating Board, these minorities were awarded only 12% of the 1986 Baccalaureate degrees from public institutions in science and engineering. These figures reflect the serious under-representation of Texas minorities in the sciences and engineering professions.

### **Goals**

The goals of TexPREP are the following:

1. To acquaint these students with professional opportunities in engineering and science;
2. To increase the number of competently prepared minority and women high school students from the TexPREP area who will ultimately pursue engineering or science studies 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; and
4. To increase the retention rate of these students in college.

Over the years significant awards have been achieved by TexPREP and the TexPREP participants. Among the notable awards are the following:

1. **Camille Moody (1981, San Antonio PREP).**

In 1984 Camille was the Grand Prize Winner of the Alamo Regional Science and Engineering Fair. In the same year, she won third place in the Mathematics Division of the International Science and Engineering Fair.

2. **John Gutierrez (1986, 1987 Laredo PREP).**

John was the First Prize Winner in the Geophysics Division of the 1987 International Science and Engineering Fair.

3. **Karl Rodriguez (1984 San Antonio PREP).**

Karl was one of the forty finalists in the 1988 Westinghouse National Science Talent Search.

4. **1986 TexPREP.**

In December 1986, the 1986 TexPREP was designated as exemplary EESA Program by the Department of Education.

5. **San Antonio PREP.**

In March 1987, the United Negro College Fund, Inc. presented the program with the Fred D. Patterson Award for rendering outstanding service in the interest of and the support of the minority community.

6. **TexPREP.**

In April 1987, Texas Senate Resolution No. 480 commended the work of TexPREP.

# 1987 Follow-Up Survey of Former TexPREP

## Participants

During the summer of 1987, the TexPREP locations conducted a follow-up of former PREP participants. Of the 680 former participants who are now college age, responses were received from 584, of whom 445 indicated that they will attend college in the fall of 1987 while 73 have graduated. Summaries of results follow:

**Table I**

| PREP YEAR | NO. OF COLLEGE ELIGIBLE | NUMBER OF REPLIES | ATTENDING COLLEGE |         |       |       | NOT IN COLLEGE | COLLEGE GRADUATES |         |       |       |
|-----------|-------------------------|-------------------|-------------------|---------|-------|-------|----------------|-------------------|---------|-------|-------|
|           |                         |                   | ENGINEERING       | SCIENCE | OTHER | TOTAL |                | ENGINEERING       | SCIENCE | OTHER | TOTAL |
| 1979      | 42                      | 40                | 1                 | 1       | 1     | 3     | 9              | 10                | 9       | 9     | 28    |
| 1980      | 49                      | 40                | 4                 | 4       | 2     | 10    | 4              | 17                | 4       | 5     | 26    |
| 1981      | 64                      | 54                | 14                | 3       | 10    | 27    | 13             | 6                 | 4       | 4     | 14    |
| 1982      | 154                     | 110               | 42                | 29      | 35    | 107   | 28             | 4                 | 1       | 0     | 5     |
| 1983      | 213                     | 186               | 62                | 42      | 75    | 179   | 7              | 0                 | 0       | 0     | 0     |
| 1984      | 96                      | 75                | 33                | 24      | 14    | 71    | 4              | 0                 | 0       | 0     | 0     |
| 1985      | 21                      | 20                | 13                | 3       | 3     | 19    | 1              | 0                 | 0       | 0     | 0     |
| 1986      | 31                      | 29                | 13                | 12      | 4     | 29    | 0              | 0                 | 0       | 0     | 0     |
| TOTALS    | 680                     | 584               | 182               | 118     | 145   | 445   | 66             | 37                | 15      | 19    | 73    |

Table II

University And Major Selections Of In-College  
Former TexPREP Students  
(1987 Survey)

| INSTITUTION             | ENGINEERING | SCIENCE | OTHER | TOTALS |
|-------------------------|-------------|---------|-------|--------|
| Angelo State University | 1           |         | 1     | 2      |
| Austin College          |             | 1       |       |        |
| Baylor University       |             | 2       | 1     | 3      |
| Boston College          | 2           |         |       | 2      |
| Cedar Crest College     |             |         | 1     | 1      |
| Colorado Scho. of Mines | 1           |         |       | 1      |
| Columbia University     | 1           |         |       | 1      |
| Cornell University      | 1           |         |       | 1      |
| Creighton University    |             | 1       |       | 1      |
| Dallas Baptist College  |             | 1       |       | 1      |
| Duke University         |             |         | 1     | 1      |
| Florida College         |             | 1       |       | 1      |
| Hallmark University     |             | 1       |       | 1      |
| Hardings University     |             |         | 1     | 1      |
| Houston Comm. College   |             |         | 1     | 1      |
| Howard University       |             |         | 1     | 1      |
| Illinois Inst. of Tech. | 1           |         |       | 1      |
| Incarnate Word College  | 1           |         | 2     | 3      |
| Laredo Jr. College      | 2           | 1       |       | 3      |
| Lamar University        |             | 1       |       | 1      |

Table II(Continued)  
University and Major Selections Of In-College  
Former TexPREP Students  
(1987 Study)

| INSTITUTION                 | ENGINEERING | SCIENCE | OTHER | TOTALS |
|-----------------------------|-------------|---------|-------|--------|
| Mass. Inst. of Tech.        | 3           |         |       | 3      |
| New Mexico Mil. Inst.       |             | 1       |       | 1      |
| North Texas St. Univ.       |             | 1       |       | 1      |
| Norwich University          | 1           |         |       | 1      |
| Our Lady of the Lake Univ.  | 2           | 1       | 5     | 8      |
| Palo Alto College           |             |         | 1     | 1      |
| Pan American University     |             | 2       | 2     | 4      |
| Penn. State University      | 1           | 1       |       | 2      |
| Prairie View A&M Univ.      | 2           | 1       | 3     | 6      |
| Princeton University        |             | 1       |       | 1      |
| Rice University             | 3           | 1       |       | 4      |
| San Antonio College         | 7           | 10      | 6     | 23     |
| Southern Methodist Univ.    | 3           |         | 1     | 4      |
| Southwest Texas St. Univ.   |             |         | 1     | 1      |
| Stanford University         | 3           | 1       |       | 4      |
| St. Edward's Univ.          |             |         | 1     | 1      |
| Stephen F. Austin St. Univ. |             |         | 1     | 1      |
| St. John's College          | 1           |         |       | 1      |

|                       |   |    |    |    |
|-----------------------|---|----|----|----|
| St. Mary's University | 3 | 10 | 16 | 29 |
|-----------------------|---|----|----|----|

Table II(Continued)  
University And Major Selections Of In-College  
Former TexPREP Students  
(1987 Survey Cont'd.)

| INSTITUTIONS                    | ENGINEERING | SCIENCE | OTHER | TOTALS |
|---------------------------------|-------------|---------|-------|--------|
| St. Phillip's College           | 1           |         | 4     | 5      |
| Texas A & I University          | 2           |         | 1     | 3      |
| Texas A&M University            | 54          | 17      | 10    | 81     |
| Texas Christian Univ.           |             | 1       | 1     | 2      |
| Texas Lutheran College          |             |         | 1     | 1      |
| Texas Tech. University          | 2           | 2       | 3     | 7      |
| Trinity University              | 2           | 5       | 2     | 9      |
| University of Alabama           | 1           |         |       | 1      |
| University of Colorado          |             | 2       |       | 2      |
| University of Dallas            |             | 1       |       | 1      |
| University of Houston           |             | 1       |       | 1      |
| University of Miami             |             | 1       |       | 1      |
| University of New Mexico        | 1           |         |       | 1      |
| University of Notre Dame        | 1           | 1       | 2     | 4      |
| University of Pennsylvania      | 1           | 1       | 1     | 3      |
| University of Texas-Austin      | 51          | 19      | 24    | 94     |
| University of Texas-El Paso     |             |         | 1     | 1      |
| University of Texas-San Antonio | 26          | 22      | 43    | 91     |
| U.S. Air Force Academy          | 2           | 1       |       | 3      |
| U.S. Military Academy           |             |         | 1     | 1      |
| U. S. Naval Academy             | 3           | 1       |       | 4      |
| Wilson College                  | 1           |         |       | 1      |
| Yale University                 |             | 1       |       | 1      |
| Undecided                       |             | 1       | 2     | 3      |
| TOTALS                          | 184         | 117     | 144   | 445    |

TABLE 3  
DISTRIBUTION OF COLLEGE GRADUATED FORMER PREP PARTICIPANTS (1987 SURVEY)

| MAJOR INSTITUTIONS                                                                                                                                                   | ENGINEERING     |       |       |          |                | SCIENCE |                 |       |       |          | OTHER          |       |                 |       |       | TOTALS   |                |       |   |   |    |   |    |   |    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------|-------|----------|----------------|---------|-----------------|-------|-------|----------|----------------|-------|-----------------|-------|-------|----------|----------------|-------|---|---|----|---|----|---|----|
|                                                                                                                                                                      |                 |       |       |          |                |         |                 |       |       |          |                |       |                 |       |       |          |                |       |   |   |    |   |    |   |    |
|                                                                                                                                                                      | AMERICAN INDIAN | ANGLO | BLACK | HISPANIC | ASIAN ORIENTAL | TOTAL   | AMERICAN INDIAN | ANGLO | BLACK | HISPANIC | ASIAN ORIENTAL | TOTAL | AMERICAN INDIAN | ANGLO | BLACK | HISPANIC | ASIAN ORIENTAL | TOTAL |   |   |    |   |    |   |    |
| BRANDEIS UNIV.<br>COLUMBIA UNIV.<br>M.I.T.<br>PRINCETON UNIV.<br>RICE UNIV.<br>S.M.U.<br>ST. MART'S UNIV.<br>TEXAS A & M UNIV.<br>TEXAS A & M UNIV.<br>TRINITY UNIV. | M               | F     | M     | F        | M              | F       | M               | F     | M     | F        | M              | F     | M               | F     | M     | F        | M              | F     | M | F | M  | F | M  | F |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 0              | 0       | 0               | 1     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 1  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 2        | 0              | 2       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 2 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 1              | 1       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 1              | 1       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 1              | 1       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 1        | 0              | 1       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 1        | 0              | 1       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 1        | 0              | 1       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 1        | 0              | 1       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
| U.S.A.F. ACADEMY<br>UNIV. OF DENVER<br>UNIV. OF HOUSTON<br>U.T. AUSTIN<br>U.T.M.S.C.A.<br>U.T.S.A.                                                                   | 0               | 0     | 0     | 0        | 0              | 0       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 0              | 0       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 0              | 0       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 0              | 0       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 0              | 0       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 0              | 0       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 0              | 0       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 0              | 0       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 0              | 0       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
|                                                                                                                                                                      | 0               | 0     | 0     | 0        | 0              | 0       | 0               | 0     | 0     | 0        | 0              | 0     | 0               | 0     | 0     | 0        | 0              | 0     | 0 | 0 | 0  | 0 | 0  | 1 |    |
| TOTALS                                                                                                                                                               | 0               | 4     | 2     | 1        | 0              | 19      | 0               | 2     | 1     | 2        | 0              | 14    | 0               | 1     | 2     | 0        | 1              | 7     | 0 | 0 | 10 | 3 | 17 | 3 | 48 |

Table III:

Distribution of College Graduated  
Former PREP Participants  
(1987 Survey)

Summary  
1987 Texas PreFreshman Engineering Program

1. PERIOD OF OPERATION: June 8-July 31,1987
2. DISTRIBUTION OF GRADUATING PARTICIPANTS:  
 ( BY GRADES)

|                | 5TH      | 6TH       | 7TH        | 8TH        | 9TH        | 10TH      | 11TH      | TOTALS     |
|----------------|----------|-----------|------------|------------|------------|-----------|-----------|------------|
| Brownsville    |          |           |            | 7          | 9          | 7         | 5         | 28         |
| Corpus Christi |          |           |            | 14         | 13         | 9         | 15        | 51         |
| Denton         |          |           | 1          | 16         | 10         | 4         | 4         | 35         |
| Edinburg       |          |           |            | 31         | 10         | 12        | 9         | 62         |
| Laredo         |          |           |            | 16         | 10         | 15        | 6         | 47         |
| Lubbock        |          |           |            | 9          | 10         | 4         | 2         | 25         |
| San Antonio    | 1        | 89        | 105        | 114        | 60         | 46        | 5         | 420        |
| <b>TOTAL</b>   | <b>1</b> | <b>89</b> | <b>106</b> | <b>207</b> | <b>122</b> | <b>97</b> | <b>46</b> | <b>668</b> |

Minority Representation: 77%      Women Representation: 53%

3. **SCHOOL DISTRICTS:**

All School Districts (Public, Private, Parochial) in the Greater Metropolitan Areas of Brownsville, Corpus Christi, Denton, Edinburg, Laredo, Lubbock and San Antonio.

4. **PROGRAM:**

- . Logic and Its Application to Mathematics (1st year students)
- . Algebraic Structures (2nd year students)
- . Vector Algebra and Vector Geometry (3rd year students)
- . Introduction to Engineering
- . Introduction to Computer Science
- . Problem Solving Seminars
- . Practice SAT Examinations
- . Guest Speakers
- . Field Trips

5. **ADMINISTRATIVE STAFF:**

San Antonio Director and TexPREP Coordinator:

Dr. Manual P. Berrioza'bal

UTSA Co-Director:

Dr. Darwin Peek

Palo Alto Directors:

Mr. Leandro Esparza

Captain Robert Wallin

Brownsville Director:

Dr. Erasmo Saenz

Corpus Christi Director:

Dr. William Mareth

Denton Director:

Dr. Rose Marie Smith

Edinburg Director:

Mr. William Shockley

Laredo Director:

Dr. Ramon Alaniz

Lubbock Director:

Dr. Derald Walling

6. **INSTRUCTIONAL STAFF:**

14 College Faculty Members  
12 High School Teachers  
2 Practicing Engineers  
48 U.S. Air Force Officers  
5 U.S. Navy Officers  
1 Graduate Student  
44 Program Assistants

7. **INSTITUTIONAL FACILITIES:**

|                 |                                                                                   |
|-----------------|-----------------------------------------------------------------------------------|
| Brownsville:    | Pan American University<br>Texas Southmost College                                |
| Corpus Christi: | Del Mar College                                                                   |
| Denton:         | Texas Women's University                                                          |
| Edinburg:       | Pan American University                                                           |
| Laredo:         | Laredo State University                                                           |
| Lubbock:        | Texas Tech University                                                             |
| San Antonio:    | The University of Texas at San Antonio<br>Palo Alto College<br>Trinity University |

8. **PROGRAM COSTS:**

Approximately \$ 600,000

The total support for 1987 TexPREP includes financial (\$250,000) and inkind (\$350,000) contributions from local, state, and national colleges and universities; private industry; military commands and other government agencies; professional organizations; local school districts; and JTPA Summer Youth Employment and Training Programs.

9. **Recommendations and Accountability in Science-Oriented Minority Intervention Programs:**

See "Summary" Section

## The Master of Science in Teaching Elementary Mathematics

Carrie M. Kendrick  
Department of Mathematics  
Co-Director of the Certificate Program  
For Elementary Mathematics Teachers  
The University of the District of Columbia

According to several teacher education sources, prior to the 1950's very little preparation in mathematics was required or recommended for prospective elementary teachers beyond the general college-wide requirement.

Through the joint efforts of the Committee on Undergraduate Programs in Mathematics (CUPM) of the Mathematical Association of America, the National Council of Teachers of Mathematics and other mathematics interest groups, it became evident that elementary teachers needed training in both content and pedagogy based on the mathematics taught at the elementary level. (Kendrick and Anderson, 1984).

In spite of the recommendations of Professional Mathematics Organizations, only a very small number of colleges and universities offer mathematics courses designed specifically for elementary pre-service or in-service teachers, and when offered, courses in mathematics were generally taught by professors in the department of education; only in very rare instances, were these courses taught by professors in the department of mathematics. According to one report many educators felt that courses offered in the department of mathematics would suffer from low enrollment since elementary teachers believe that "arithmetic" in the department of mathematics would contain "too much mathematics".

In 1983, a report entitled, "Education of Americans for the 21st Century" prepared by the National Science Board's Commission on Pre-college Education in Mathematics, Science and Technology, provisions for a "plan of action for improving mathematics, science and technology for all American elementary and secondary students.." included the recommendation that elementary teachers of mathematics should have college training in mathematics sufficient for understanding functions, elementary probability and statistics and the relationship between algebra and geometry; elementary teachers should be computer literate and that State Certification Boards should adopt certification standards that would reflect the requirements previously indicated.

### Closer to Home

At a symposium on "The Shortage of Certified Mathematics Teachers in the District of Columbia Schools, February 5, 1983 sponsored by the District of Columbia Public Schools, The University of the District of Columbia and Howard University, the problem was addressed by local educators from both the private and public sectors.

The following priority recommendations were advanced:

1. There should be certified mathematics teachers for Grades 3-6 in the D.C. public schools and
2. The local universities should design a graduate level Elementary Mathematics Resource Teacher Preparation Program.

A subsequent survey in 1983 conducted by the Department of Mathematics of the District of Columbia Public Schools revealed that approximately one hundred of the one hundred-forty individuals in elementary mathematics resource teacher positions, had not met certification requirements. This meant that approximately 71% of that 1983 population responsible for the development of future mathematics enrollees were not adequately prepared in the content area to teach the subject. The positive evidence revealed by the survey was the fact that a vast majority of these teachers were willing to participate in courses designed specifically for them.

Stop for a minute and reflect on the fact that the first six years of a student's formal education in mathematics is spent with the elementary teacher. By age nine, a student should recognize the relevance of mathematics to the individual and society. If the elementary teacher has the responsibility for this development, the elementary teacher could be the key to the development and appreciation of the efficiency, elegance, and the practicability of mathematics. These attitudinal goals are especially important during the early school years since they are likely to influence the voluntary participation (beyond that which is merely required) by students in mathematics during the high school and early college years.

In spite of the important role of the elementary teacher in the development of interest in and appreciation of mathematics, this is an area that has not been given adequate attention. Even more alarming is the fact that many students are being taught by some teachers who are inadequately prepared in the content, but in addition, also suffer from mathematics anxiety.

It was within the previously described atmosphere that the Departments of Mathematics at the University of the District of Columbia and the District of Columbia Public Schools joined forces to focus on the preparation of the elementary mathematics resource teachers. The Elementary Mathematics Specialist Program represents the dynamics of the Department of Mathematics at the University of the District of Columbia and the Mathematics Department of the District of Columbia Public Schools in responding to the needs of elementary school teachers of mathematics in the D.C. Schools.

### Objectives

The condensed objectives of the program are:

1. To develop competence in mathematics content needed to teach effectively from kindergarten through Grade 6 level;

2. To develop the computer techniques needed by modern elementary mathematics teachers;
3. To develop competence in writing, selecting and solving word problems;
4. To develop skills in designing learning sequences and selecting strategies appropriate for mathematics from kindergarten through Grade 6;
5. To develop skills in coordinating learning styles and teaching strategies;
6. To reduce mathematics anxiety;
7. To provide course-work necessary for certification as an Elementary Mathematics Resource Teacher in the District of Columbia Public Schools;
8. To develop skills in the design of assessment tasks, instructional activities, and materials and;
9. To develop skills in leading in-service workshops for classroom teachers.

The specific objectives (too numerous to delineate here) are based on the objectives delineated by the National Council for Accreditation of Teacher Education (NCATE).

### **Master of Science in Teaching (MST) Program**

Teachers participate in the MST Program for several reasons:

1. Meet content certification requirements for elementary mathematics resource teachers in the District of Columbia Public Schools.
2. Maintain and improve content and pedagogical competence in elementary mathematics
3. Earn graduate credits toward the MST degree

A certificate component of the MST Program has been implemented by University of the District of Columbia and funded by a District of Columbia Higher Education Grant under the Education for Economic Security Act (EESA), Title 11, The University of the District of Columbia and the District of Columbia Public Schools since 1986.

The Certificate Program may be completed in one calendar year. Teachers enrolled in this program must complete a minimum

of 15 semester hours of courses selected from the planned MST Program:

1. Fundamentals of Mathematics I
2. Fundamentals of Mathematics II (Algebra)
3. Geometry for Elementary Teachers
4. Probability & Statistics for Elementary Teachers (usually offered as a Summer Institute) and
5. Problem Solving for Elementary Teachers

The MST Program for elementary teachers will include a total of 21 semester hours of mathematics and 9 hours of graduate level education courses. The additional courses designed specifically for elementary mathematics teachers include the following:

- . Using the Computer in Elementary School Mathematics
- . Methods for Elementary Mathematics Specialist Research Seminar

Teachers may also enroll in courses selected from the secondary MST Program. Highly recommended:

- . History of Mathematics

MST participants will be required to complete a comprehensive examination and meet the certification requirements for the mathematics resource teachers in the District of Columbia Public Schools.

### **The Support Services**

All participants in the Certificate Program must participate in a unique component of this program—the support seminars. The support seminars consist of meetings designed to reinforce the utilization of content and the development of strategies for use in the classroom. These seminars mesh content, strategies and materials related to the real world of the classroom. In addition to teaching techniques, these seminars allow the teachers an opportunity to voice needs, ask questions and share ideas as well as serve as confidence building sessions.

The establishment of a MST program for elementary teachers in the Department of Mathematics at The University of the District of Columbia sets a mandate for other colleges and universities to offer a program in mathematics for elementary teachers. This is a program whose time has come.

The project has shown two very successful periods of operation. The program has not only provided the participants with an opportunity to participate in a

unique program of courses, workshops and seminars but in addition we have had an opportunity to recommend thirty-seven participants for unconditional content certification and at least six others for temporary certification.

It is interesting to note that initial enrollment was composed of more experienced teachers average age 41 years; however, more recently, interest is being shown by a younger population. Some of these teachers could meet the certification requirements as a mathematics specialist as soon as they meet the service requirement of 3 years. This indicates that this phenomenon could benefit the school system's quest for continued improvement in mathematics achievement for present and future pupils for many years to come. With the national development of programs of this type, many of the problems of early mathematics education could be greatly alleviated. This program provides a model for the development of excellent elementary teachers in the District of Columbia, the surrounding areas and the nation.

## The Role Of A Summer Program In Attracting Blacks And Hispanics Into Mathematics-Based Fields

Beverly J. Anderson  
Professor of Mathematics and Director  
A Summer Program in Mathematics and Computer Science  
University of the District of Columbia

### Background

Although institutions in America have devised programs to encourage non-Asian minorities to seek careers in mathematics-based fields, many of these institutions start too late-their programs usually consist of academic intervention on the senior high or college level. By this time, a significant number of the brighter non-Asian minority students have not been channeled into the introductory (algebra and geometry) or intermediate (intermediate algebra) calculus track courses, and they do not benefit optimally from the programs. Hence, many of these students have been virtually eliminated from careers in the sciences because they were not exposed to the calculus-track courses in high school.

As a result, blacks and Hispanics are sorely under-represented in careers in the sciences and mathematics. Although the black minority comprises roughly 12% of the total population in America, this ethnic group represents only 2% of the employed scientists and engineers in this country. Equally distressing is that the Hispanic population which comprises roughly 6% of the total population represents roughly 1.5% of the employed scientists and engineers in America ( Employed Scientists and Engineers in the U.S. National Science Foundation, 1985).

In recognition of the under-representation of blacks and Hispanics in mathematics and mathematic-based fields, and the apparent need to provide appropriate counseling to some of these students, the Department of Mathematics and the Department of Electrical Engineering and Computer Science at the University of the District of Columbia have come together to implement several academic intervention programs, mainly for **junior high school students**, designed to stimulate their interest in mathematics and to enrich their experiences in mathematics and mathematics-based fields. The departments realize the need to provide opportunities to intrigue capable students while exposing them to career opportunities in engineering and other mathematics-based fields.

Since the summer of 1982, two hundred sixty-eight (268) junior high school students participated in a program entitled, **A Summer Program in Mathematics and Computer Science for Academically Oriented Students**. This program has been funded by the Office of Naval Research, Department of the United States Navy since 1982 and has been awarded approximately \$500,000 over that period.

### **Program Goals**

The goals of the program have been developed in response to the need to increase minority representation in the sciences and mathematics. The four major goals of the program are (1) to stimulate interest in mathematics and mathematics-based fields; (2) to encourage students to pursue the more rigorous mathematics courses in their remaining high school years; (3) to allow students an opportunity to become aware of the role of mathematics as the invisible filter; and (4) to improve the reasoning skills of students and equip them with facilitative strategies to learn concepts and solve problems in mathematics.

### **Program Components**

This five-week summer program, meeting from 9:00 AM until 2:30 PM, Monday through Friday, has two major program components: (1) the instructional component in three content areas-General Mathematics, Computer Science, and Statistics, designed to intrigue students and improve their reasoning skills; and (2) the career education component, designed to provide participants with an opportunity to see "mathematics at work" in everyday life and allow them an opportunity to interact with appropriate role models in the sciences and mathematics.

### **Program Objectives**

The instructional objectives of the program serve as a guide for developing lessons and selecting films. The six instructional objectives are for students to (1) demonstrate increased facility in the technical language of mathematics, computer science, statistics and operations research; (2) formulate problems; (3) evaluate ways to solve problems; (4) apply basic knowledge to the solutions of the problems in the three content areas; (5) draw valid conclusions from data given; and (6) create an appropriate computer program for a problem from a word statement. These instructional objectives are supplemented by two major career education objectives. Students are expected to (1) name at least ten mathematics-based fields wherein blacks and Hispanics are under-represented; and 2) communicate how they can become better prepared in high school, especially in the area of mathematics, to increase their college and career options by the time they reach college.

### **Program Personnel**

The program staff consists of four (4) members of the University of the District of Columbia faculty-two from the Department of Mathematics and two from the Department of Electrical Engineering and Computer Science, one administrative assistant and two teaching assistants whose services are employed mainly in the computer laboratory. The program director and associate director handle the administrative duties as well as teach the mathematics course and chaperone all field trips.

## **Program Participants**

The program is designed for "academically oriented" black and Hispanic students rising to the ninth or tenth grade. For the purpose of this program, "academically oriented" students are those identified by their teachers to be "good" or "outstanding" on sixteen (16) characteristics, such as achievement, attitude and interest in school work. Some students not satisfying the racial and grade classifications have been accepted into the program. However, from 1982-1987, over 95% have been black or Hispanic.

## **The Instructional Component**

The instructional component of the program consists of three courses of study: General Mathematics, Computer Science, and Statistics. Both the Computer Science and Statistics courses meet for one hour and fifteen minutes each morning and the mathematics course meets for one and one half hours each afternoon, except on Friday. The computer classes are held in the computer laboratory (a classroom with twenty terminals) three days a week, and the statistics classes are held in that laboratory two days a week.

An interdisciplinary approach is used to reinforce learning in the three courses, as similar topics are covered in each course. The goals of the courses follow:

### **General Mathematics**

- . to improve the students skills in recognizing patterns and drawing conclusions;
- . to improve the students' facility with the technical language of mathematics;
- . to improve the students' knowledge of the structural nature of mathematics; and
- . to improve the students' techniques in formulating and solving problems.

### **Computer Science**

- . to prepare the students to become literate in computer science and knowledgeable of the hardware;
- . to prepare the students to construct flowcharts for algorithmic development; and
- . to prepare the students to construct and debug programs in the BASIC language using control statements; string variables and arrays, data files and graphic techniques.

## Statistics and Operations Research

- to expose students to probability theory
- to enable the students to transfer the skills developed in their computer course into problem solving tools in statistics; and
- to expose students to some of the significant mathematical models underlying statistics.

### The Career Education Component

This component of the program provides the students with an opportunity to see mathematics employed in everyday life and to interact with some professionals engaged in mathematics-based fields. The major aspects of this components are field trips, videos, films and a forum. Although career education in the sciences and mathematics is an inherent part of the program and teachers encourage the students to remain in the calculus tract so that they will have more career options when they reach college, the time specifically designated for career education is on Friday afternoons. The field trips generally include a tour of the Naval Research Laboratory in Washington, D.C. and a tour of the David Taylor Naval Ship Research and Development Center in Caderock, Maryland where students get to meet personally with physicists, mathematicians, statisticians, and other scientists.

In addition to the tours, the students view several video tapes and films. The tapes "Mathematics at Work in Society", developed through a grant awarded to the Mathematics Association of America, show many mathematics-based career opportunities and role models; and the tapes "Challenge of the Unknown", developed through a grant to the American Association for the Advancement of Science, show the role of mathematics in solving many problems in everyday life. The students also have enjoyed the film, "Donald in Mathemagic Land" which shows how mathematics grows from simple ideas; heroes in mathematics of African Heritage; and the applicability of mathematics.

The career education component also includes a career awareness forum, which has been a highlight of the program. This forum provides an opportunity to bring a special group of professionals to the university and to hear them speak to the amount of mathematics needed in preparing for their careers and the use of mathematics in carrying out their jobs. This program has included a black female oceanographer, a black male mathematician, a black female engineer, a black female meteorologist, a white male meteorologist, a white female meteorologist, a black female physician, a black male professor of mathematics and a black male statistician. During this one and half hour program followed by a reception, students and their parents exchange ideas with these professionals.

Unscheduled guest presentations have been provided by officials from the Office of Naval Research and the University of the District of Columbia.

## **Program Evaluation**

Students are encouraged to provide formative evaluations daily in some classes and/or after each unit of study in other classes. The techniques used in evaluation include worksheets, tests, informal observations, discussions and anecdotal records. Summative evaluations are submitted by students at the end of the program.

The formative evaluations have been used as a basis for refining the curriculum and teaching strategies. The summative evaluations have been used to further refine the curriculum and for making recommendations regarding the continuation programs.

The faculty engaged in the program meet periodically throughout the summer program to discuss the progress of the students, their readiness for the instructional material, their motivation, attendance, skills attained and program effectiveness. Summative evaluations also are submitted by faculty at the end of the program.

## **Follow-up**

A follow-up study is conducted every two years on all of the students who participated in the program up to that time. The last follow-up study was to determine the effect of the five-week intervention program on its participants. Specifically, we were interested in the level of student enrollment in mathematics courses; their interest in mathematics-based fields as career goals; the effect of the program on their preparing for and/or majoring in mathematics-based fields; and their perception of the value of the program.

A ten-item questionnaire was mailed to the home addresses on file for the 151 students served by the program from the summer of 1982 through the summer of 1985; 135 were deliverable.

The study revealed that the respondents generally enroll or have enrolled in mathematics courses during each year of high school following their participation in the program and that they intend to take courses in mathematics through the calculus while in college; that the vast majority of the respondents plan to attend college and major in a mathematics-based field; and that the vast majority would be willing to participate in a similar program and would recommend the University of the District of Columbia-Navy program to a friend.

## **The Student**

Of the 151 students served by the program prior to the spring of 1986, 65 responded to the questionnaire. This number reflects nearly 50% of the 133 students whose mailings were not returned to the university. A breakdown of the number and percent of respondents from each of the summer programs appears in Table 1. Of note is that there is a direct relationship between the number of respondents and the recentness of the program. That is, 31% of the 1982 students responded, whereas 55% of the 1985 students completed their questionnaires.

Table 1

Number and Percent of Students Responding to the Questionnaire  
In the Follow-up Study

| Year Of<br>Program | Total No.<br>In Program | Number<br>Responding | Percent<br>Responding |
|--------------------|-------------------------|----------------------|-----------------------|
| 1982               | 32                      | 10                   | 31%                   |
| 1983               | 40                      | 14                   | 35%                   |
| 1984               | 39                      | 19                   | 49%                   |
| 1985               | 40                      | 22                   | 55%                   |

Interest in Mathematics

The interest in mathematics was measured by the extent to which the students enrolled in mathematics courses in high school and the extent to which they enroll or intend to enroll in mathematics courses in college. The report revealed that 77% have taken or intend to take at least one course in mathematics during each high school year. Also, 94% plan to take at least Calculus I in college. Of note is that 37% plan to take at least one course in mathematics above Calculus III.

### Interest in Mathematics-Based Fields

Although roughly 12% of the students did not express an intended occupation, 80% of the respondents (91% of those expressing an intended occupation) indicated a mathematics-based field. The most popular areas mentioned were engineering (34%), medicine (23%), computer science (8%), and mathematics (8%).

### Affective and Cognitive Effects

Three items on the questionnaire were related to the affective and cognitive effects of the program. The fact that 97% of the respondents would recommend the program to a friend and 89% would participate in the program again reflects to us that the program had a positive effect, at least affectively, on the students. The cognitive effect of the program in the follow-up was measured in terms of how the students perceived of the cognitive gains. The study revealed that 81% of the respondents felt that the program improved their reasoning skill or strengthened their background in mathematics.

### Unsolicited Comments from the Students

The many warm expressions sent by the students provided the program administrators with the desire to continue this program and perhaps have reach a greater number of students. Many of the students expressed gratitude for having participated in the program. Additionally, students freely commented on some other effects of the program.

Several of the students claimed that they initially became interested in computers, in the summer program and that they have pursued that interest ever since their summer session. Other students commented on the career awareness aspect of the program contending that the program lead to a heightened awareness of many fields of engineering and other areas in science; and still other students addressed the friendships made during their session-friendships which appear to be important to them.

### Summary

From all indication, the participants who responded seemed to have had a wonderful learning experience in the summer program. We are pleased that the goals of the program have been attained; that is, students are taking courses in mathematic throughout their high school years and a large percentage of our students are planning to seek or are currently seeking careers in mathematics-based fields. Since this study was conducted, some 117 students have participated in the summer program. We plan to implement a similar study on the entire group of 268

students in 1988.

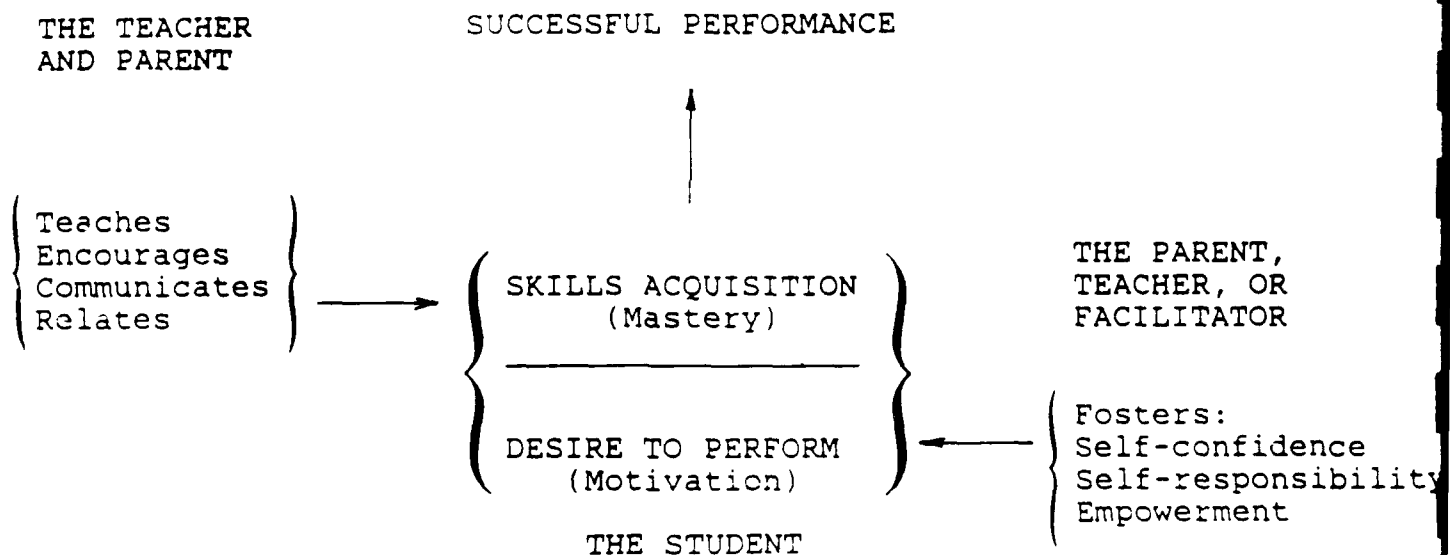
**For Further Information Contact:**

- Beverly J. Anderson, Director  
A Summer Program in Mathematics and Computer Science  
University of the District of Columbia  
Department of Mathematics  
Washington, D.C. 20008  
  
Telephone: (202) 282-3171
  
- Bernis Barnes, Associate Director  
A Summer Program in Mathematics and Computer Science  
University of the District of Columbia  
Department of Mathematics  
  
Telephone: (202) 282-3171

Innovations In Education  
"An Impacting Intervention Program"

William Guillory  
President, Center of Creative Inquiry  
Midvale, Utah

An underlying assumption of these intervention program is that successful performance is based upon two major factors: motivation to succeed and skills development and mastery. More specifically, that skills development programs are necessary, but not sufficient for success. Therefore, these intervention programs are designed to address the area of performance or motivation, as illustrated in the diagram below:



The most important aspect to understanding and influencing the performance of others, is that motivation to perform ultimately comes from within. At some point, for whatever reasons or circumstances each student is faced with, that student has to make a decision to perform at whatever level is dictated by the requirements of the course of study they have accepted.

If a student is not self-motivated to succeed, then that student may be influenced by parents, teachers, or someone who facilitates a special intervention program. In situations where parents are unable or unwilling to teach, encourage,

communicate, and relate to their children, the teacher assumes these responsibilities; with varying degrees of commitment and corresponding success.

Where both the parent and the teacher are unable (because of responsibilities) or unwilling to influence the desire to perform, then a special intervention program is required for the student who is not self-motivated to succeed. That is specifically what the Innovations programs are designed to address.

When we first designed this program several years ago, it was easy, because it simply involved reflecting on my personal career. I am a product of the New Orleans public school system, a graduate of Dillard University, and a graduate of the Ph.D. program in physical chemistry at the University of California at Berkeley.

As I considered my own career, I discovered that an essential key to my success was the sense of self-worth and self-confidence, coupled with a demand for responsibility and accountability in my studies, that I acquired from Dillard University as an integral part of the curriculum. I can also see, in retrospect, how valuable the Vesper services (they forced us to go to) were. We had weekly speakers constantly fostering and enforcing that sense of personhood; beyond racial pride.

These led, over a four year period, to an ingrained sense of ableness and capableness, which is the essence of an empowered individual. Empowerment, for us at Innovations, is the essence of education. What we have come to learn, as a result of the refinement of our programs, is that not only the choice, but the selection of mathematics-based fields requires and demands this type of discipline for success.

In my opinion, it is the desire to perform (motivation) which is not being acquired by minorities, either formally or informally, that has led to the reduction in minority advanced degrees in mathematics-based fields. As a result, we designed a program specifically to deal with this missing element, essential for success. We initially began presenting this program in Utah to middle and senior high school students titled, "Innovations in Education." This program was presented to regular students, as well as students in STEP programs with astounding success. The program was then expanded to college

level students at the University of Utah, Atlanta University Center, Howard University, and Jackson State University. Again, with very positive results.

What we have come to learn is that a significant, permanent change can be made on a group of young people which can have a decided impact upon their commitment to success in life. This impact can be made in a relatively short period of time, depending on the design of the program and the individuals facilitating the process. That is, it's very difficult, if not impossible, to facilitate in an individual what one has not experienced himself or herself.

The underlying assumption of our programs is that every participant is fully able, capable, and esteemed. They are however, by accomplishments, not fully confident and we agree with Dr. Maxwell Maltz (author of Psycho-Cybernetics) that performance is related to one's self-concept or self-image. We are not certain which comes first, achievement or the sense of capableness through the attitude "I can perform." Certainly they are related.

Underlying every subject of our programs is the sense of self-responsibility for the results in one's life; given the external environment as it is. What ultimately has to be addressed are the beliefs we have about ourselves and the extent to which we sabotage and contribute to our own demise.

The essence of the process is experimental learning by students simultaneously with their student peers.

#### **Experiential learning:**

1. A person learns best when he or she is involved in the learning experience.
2. Knowledge has to be discovered individually if it is to mean anything or is to make a difference in behavior.
3. A commitment to learning is highest when a person is free to set his or her own learning goals and actively pursue those goals within a given framework.
4. Learning is achieved most productively within groups where people interact and reflect on their mutual experiences.

Our experience with Youth programs over the past six years have in essence, proven what the various Youth: 200 forums across the nation have concluded:

“ Solutions should be sources in the development of the total person in terms of ‘empowerment’, ‘self-responsibility’, ‘transformation’, ‘self-awareness’, and a ‘holistic approach’.”

We recently facilitated a program titled “Achieving Excellence in Education”, A Break-through Weekend, for the New Orleans Public School system in a retreat environment. The program was conducted from Friday noon to Sunday noon for eighth grade students.

The mission statement of the program was the following:

### **Mission Statement**

It is becoming increasing evident to more and more people that the difference between success and failure on the part of the individual student is the student's attitude toward school and life itself. It is also becoming evident that one's outlook on life, one's world map, one's attitude or perspective, however, you want to define it, can be positively modified and can be done so over a short as period of time as a weekend.

Based on this premise, the school system is planning a “Break-through Weekend” for students who are just approaching adolescence and who are making personal choices about how they relate to the rest of the world. The purpose of the weekend is not to inculcate the students with a specific set of values, but rather to call to their attention the decisions that are unconsciously being made and acted out and to get them in touch with the fact that they can make a difference in how life turns out. In other words, its a way for them to discover that they individually are responsible for the results produced in their lives.

### **Program**

- . Responsibility for the Educational Process
- . Self-esteem, Self-worth, and Self-growth

- . Development of Interpersonal Skills-  
Communication and Interpersonal Relationships
- . An Outdoors Experience-Self-confidence  
and Team Building
- . Commitment to Success-Setting and  
Accomplishing Goals

### **Pre-Workshop Questionnaires**

The Nowicki-Strickland Internal/External Questionnaire is a measure of the extent a student feels in control, or not in control, of his or her life.

The Education Attitude Determination Questionnaire was designed (over a five year period) to determine beliefs and attitudes the participating students had about their educational experience, its value, and their personal commitment to success in life.

On the basis of these pre-workshop instruments, the specific focus of the program was designed.

### **Workshop Evaluation**

(The student evaluations at the completion of the weekend were exceptional.)

### **Post-Workshop Evaluation**

(Subsequent student evaluations three months later proved that the workshop/retreat had a permanent impact on the students.)

Teacher feedback about the program was also extremely encouraging and positive about the permanent changes they have observed in these students.

This summer, in Utah, we will be conducting a six-day "Youth Leadership Training Program: for Economically Disadvantaged Youth sponsored by the Davis County Job Training Partnership Act for sixteen to eighteen year old high school students.

The objectives of the program are:

1. To help young people to become self-sufficient adults; both socially and economically.
2. To adopt a strong sense of self-responsibility and accountability for the circumstances and results in their lives.
3. To develop a strong sense of self-worth, self-esteem, and self-respect.
4. The development of human and life skills- interpersonal relationships, communication, and problem solving.
5. To serve as peer leaders in encouraging their peers in responsible decision-making.
6. To foster self-confidence, constructive risking, leadership, and exceeding self-imposed limitations.
7. Experiential learning of the qualities of leadership.
8. To establish goals and learn the process of goal setting, and the successful achievement of goals.

The program will involve the following subjects:

- . Self-Responsibility and Accountability
- . Development of Interpersonal Skills-Communication, Interpersonal Relationships, Problem-Solving, Decision-Making, and Goal Setting.
- . An Outdoors Ropes Course

- . Transcending Personal Barriers; Sex, Race, etc.- A Group Experiential Process
- . The Integrated Person-The Development of Self-Esteem and Self-Worth
- . An Outdoors Hiking Experience
- . Leadership Skills-Personal Empowerment

Based on our six year experience with Innovations programs and my twenty year experience at three universities as a Professor of Chemistry, I am confident that the components of an ideal intervention program designed to significantly increase minority participation in Mathematics-based fields are the following:

**Opportunities For Success In Mathematics-Based Fields**  
**" An Intervention Program For Minority Students"**

1. Self-Responsibility and Accountability in Academic Achievement.
2. Opportunities in Mathematics-Based Fields.
3. The Development of Self-Worth, Self-Esteem, and Self-Growth.
4. An Outdoors Experience in Team-Building, Leadership, and Exceeding Self-Imposed Limitations.
5. The Identification and Elimination of Negative Cultural Conditioning That Serve As Self-Imposed Limitations (Transcending Barriers of Race and Sex).
6. Goal Setting and Strategies for Successfully Achieving Established Goals.

This program will make a significant impact on the number of students successfully choosing mathematics-based professions and being successful, both at the undergraduate and high school levels.

## Summary

The Symposium brought together a wide range of professionals from across the country to address a problem with national implications: The Problem of the Under-achievement and Under-representation of blacks and Hispanics in Mathematics and Science.

It was fitting that we met in the nation's capital, the seat of government, the home of several private and public agencies that have acknowledged for years that there has been a problem with the achievement of blacks and Hispanics in science and mathematics. The seriousness with which professionals from these and other agencies, institutions and organizations addressed the topic of the symposium was impressive.

In summary, the program participants presented, erudite papers with thoughtful insights for increasing minority representation in science and mathematics; and those joining in the symposium contributed to the development of numerous recommendations to upgrade the mathematics education of minorities and enhance their experiences in mathematics and science. The symposium program consisted of three groups of panelists—one focusing on sociological and psychological factors, another on academic intervention programs and the third on funding sources, followed by a brief question-answer period; a keynote speaker, a special presentation from a director of a non-academic intervention program and two worksessions.

The first panel, consisting of Claude Mayberry, Edgar Epps, Lois Powell and John McAdoo, addressed the psychological and sociological issues that impact achievement and representation. From this panel, the symposium participants were given a clear picture of the learner and his environment.

The second group of panelists, consisting of program directors Manuel Berrioza'bal, Carrie Kendrick, Winson Coleman, Larry Lim and Beverly Anderson as well as the special presentation by William Guillory presented varied intervention programs aimed at increasing the involvement of blacks and Hispanics in upper level mathematics and science courses in high school and encouraging these students to pursue careers in science, engineering, and mathematics. These program directors told of their joys and pains as leaders of successful intervention programs. They also shared their program goals; the successes of their students and their methods of tracking students.

The keynote address delivered by Barbara Sizemore on the "Algebra of Academic Achievement" intrigued the participants at the luncheon, as she provided statistics on the performance of students in some predominately black schools in the United States. Dr. Sizemore's research supports that some predominately black schools are the leading schools in the country in terms of student performance in mathematics on several widely used standardized tests in the United States. She suggested that the approaches used in those schools should be replicated in other schools serving the black minority student.

The third and last group of panelists consisted of program officers from funding agencies. This group, comprised of Ted Reid from the Career Access Programs at the National Science Foundation, Lewin Warren of the Office of Equal Opportunities Program at the National Aeronautics and Space Administration, Neil Gerr of the Mathematical Sciences Division of the Office of Naval Research and Jean Green of the Office of Postsecondary Education, Research and Assistance of the District of Columbia Office of Postsecondary Education, allowed the audience to become more aware of the capabilities of their funding agencies and their willingness to support programs designed to abate the problem of under-representation.

In the worksessions, facilitated and recorded by Bernis Barnes, Mary Johnson, Genevieve Knight, Gordon Lewis, Ruth Lucas, Ura Jean Oyemade, Melvin Thompson, Flavia Walton and Lewin Warren, the symposium participants identified strategies and resources for successful intervention program and made numerous recommendations on how the university, school, government and community could respond to improving achievement of minorities and increasing their representation in mathematics-based fields. There was an air of optimism expressed in the worksessions that the United States of America will upgrade the education of minorities in science and mathematics; stimulate student interest in these subject areas and ultimately increase their representation in the employment force as scientists, engineers, and physicians.

### **RECOMMENDATIONS**

Worksession I: To make recommendations, outline proposals, and identify strategies and resources for successful intervention programs:

1. **A Systemic Approach:**

A Systemic Approach is needed for successful intervention programs. Recognition was given to the exciting models of local and regional intervention programs. There was, however, a consensus that there must be a comprehensive plan involving governmental agencies at the federal, state and local levels; educational and academic institutions and businesses, if the nation is going to have successful intervention programs.

2. **Infrastructure:**

The challenges and opportunities that face minorities seeking mathematics-based careers requires an effective educational infrastructure for grades K-12, undergraduate and professional or graduate education. Educational planners and managers must strengthen the quality of education to ensure the success of minorities in scientific, technical and engineering programs.

3. **Research:**

It was recommended that more educational and social science research be conducted to determine improved methods and techniques for educating minority inner-city youth in preparing for mathematics-based careers and opportunities.

4. Communicating the Value of Mathematics to the Minority Community:

A comprehensive effort is needed using a multimedia approach to focus on the increased opportunities available to students with appreciably developed analytical and mathematical skills. An effort is needed to reach minority community leaders so that they communicate the value of skills, and competence with mathematics as a base for economic development, career mobility, and economic security.

5. Linkages:

There should be a partnership with government, business, churches, academia, and professional organizations in the planning and implementation of successful intervention programs. Specifically, capable young college graduates should be trained to teach mathematics and science to elementary school students in a "Teacher Peace Corp", financially supported by the federal government. These young people could serve in the elementary school and the community in skill building in mathematics and science. Also, community resources could augment what is taught in the schools.

6. Information Dissemination:

There is a need to utilize community centers, churches, libraries, etc., as resource facilities for clearinghouses. Also, there is a need to market mathematics/science education programs to the general population. **These programs must become more attractive.**

7. Volunteers:

There is a need to involve community volunteers such as parents, retired professional, etc., in community service projects to address the under-achievement and under-representation of minorities in science and mathematics

Worksession II.

To make recommendations on what could be done by the university, school, government and the community in response to the under-representation and underachievement of blacks and Hispanics in mathematics and mathematics-based fields.

The University:

1. College and Universities should develop/adopt a mission statement for educating minorities in science and mathematics.
2. The University should retrain interested senior personnel from industry and government to support school programs in mathematics and science.
3. College and universities should attempt to work with intervention programs especially teachers to support students at the elementary and secondary levels, keeping in mind that early intervention is the key.

4. College faculty and students should work closely with local schools to ensure that pre-collegiate education meets the level of preparation required for higher education.
5. The University should provide mentor and support services for undergraduates to encourage students to enter graduate programs. There should be careful watch at each juncture.
6. The University should engage in intervention with school counseling programs to ensure that students are appropriately advised.
7. The University should generate a resource packet for interested agencies, persons, and foundations. The University should also make available a pool of proposal reviewers and editors to assist in the writing of proposals aimed at the minority population in minority settings.
8. The University should be committed to successful minority recruitment and retention programs.
9. There should be an exemplary tracking program associated with college/university-based intervention programs.
10. The University should re-examine its teacher education programs at all levels. There is a need to develop specialist teachers of mathematics at the elementary, junior and senior high levels.
11. Teacher training is needed which not only addresses competence in mathematics content but also develops an attitude of commitment and caring for students.

#### The Schools:

1. The schools must instill in their students a sense of "agency"; that is, the student must develop to see himself as the significant agent in what happens to him. He must be encouraged to believe that there is nothing wrong with reading, studying, and doing mathematics.
2. School counselors should assist students to see the relationship between a good foundation in mathematics and science, and college and career choices.
3. The schools should offer higher level mathematics courses on a regular basis and encourage the students to enroll in these courses.
4. There is a need for small groups of students to be instructed at one time in mathematics to allow for optimal interaction with the teacher and constant feedback on performance.
5. The schools should evaluate their programs to determine which ones are more effective for their students.
6. The schools should require their teachers to attend staff development courses, workshops and professional meetings.

7. The schools should improve the quality of mathematics education at all levels. Too much time is spent teaching lower level skills.
8. The schools should ensure that classroom tests measure computational and analytical skills.
9. The schools should set up programs to improve the standardize test scores of minority students.
10. Teachers should strive to move from the more intuitive to the more abstract in mathematics.
11. Teachers of mathematics/science should become actively involved with their professional organizations. They should encourage their professional organizations to focus on community service projects aimed at addressing the problem of minority achievement in mathematics and science.
12. Curriculum materials in mathematics in the schools should address the gaps that exist in learning the subject matter:
  - a) the transition from intuitive to abstract;
  - b) the transition from arithmetic to algebra and;
  - c) the transition of learning mathematics by way of reading proofs to learning mathematics by writing proofs.

#### The Government:

1. There should be an advisory committee in the federal agencies, such as the Department of Education, Department of Labor, Housing and Urban Development, etc., on minorities in mathematics and science. Also, a portion of the resources from these agencies should be set aside for these groups.
2. There should be more government funding for programs aimed at stimulating the interest of minorities in mathematics and science.
3. The government at the federal, state and municipal levels should study and respond to the Report on, Women, Minorities and the Handicapped in science and technology. They should also use the report as a basis for funding.
4. The agencies of the government should include more blacks and Hispanics on planning and review panels and task forces. Training of all participants on these panels is necessary so that they will understand the present and future needs of this country in science and mathematics.

5. The government has to realize the urgency of preparing minorities to solve problems of national security, the environment, medicine, transportation, etc., as blacks and Hispanics make up a large percentage of the population and are projected to be an even greater percentage in the near future.

The Community:

1. The community should encourage the media to present the schools in a better light. Perhaps, there should be a liaison person from the press to present positive press from the university, school and community related to mathematics and science education.
2. The community should speak out about the decline of academic standards in the schools and require a specific level of expectation. It should demand high quality education from competent teachers.
3. The community should encourage agencies at the federal, state and municipal levels to promote mathematics and science education programs.
4. The community should encourage students to become competent in mathematics and science in school, and it should characterize these studies as meaningful to the resolution of serious social problems.
5. The family and/or community should a.) help minority children to follow verbal directions; b.) encourage them to read books and magazines; c.) encourage them to spend time with mathematics and problem solving; d.) instill in these children that there is something very positive about engaging in these activities; and e) monitor homework assignments daily.
6. The community should assume a more caring role; it should re-establish an acceptable code of behavior; communicate this code to the children and help the children understand that they must follow it.
7. There should be more home/community-based programs.
8. Appropriate education is a function of society. Hence, society must become aware of the factors that impact the education of its children.
9. There is a need for more parental involvement in the schools.
10. There is a need for the involvement of local businesses in the implementation of intervention programs.
11. The community should speak to the need of minorities to take more mathematics and science courses in high school.
12. The community should take a fresh look at those blacks and Hispanics already in the pipeline and ensure, to some degree, that they receive appropriate support and encouragement.
13. The community has to push for a better information system so that the public will become more aware of the academic needs of minority youth in science and mathematics, and programs designed to meet those needs.

14. Professional organizations in mathematics and science should become more involved in upgrading the mathematics/science education of all students, especially the minority student.
15. There is a need to bridge the gap between the hard sciences and the social sciences.
16. Community organizations such as fraternities, sororities, churches, the Urban League, the NAACP, etc., should provide minorities with career information and educational advice.
17. There should be a pool of proposal reviewers in the community.
18. Teaching enhancement projects are a concern of several funding agencies; however, projects which are funded usually do not go beyond bringing teachers up-to-date in content. There also is a need for projects to address the social setting of the students.

**Additional Recommendations for Addressing and Solving  
the Problem of Minority Under-representation in Science  
and Engineering through Intervention Programs**

Manuel P. Berrioza'bal  
Professor of Mathematics  
Coordinator, Texas Pre-Freshman Engineering Program  
The University of Texas at San Antonio  
San Antonio, Texas 78285

**Intervention Program Features**

1. Organize intervention programs for elementary, middle and high school students, six to eight weeks in length during the summer, stressing academic enrichment and which have high expectations of 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 for to intervention program participants who qualify for school district free lunch and reduced cost lunch program but do not qualify for a JTPA program. Offer small stipends (determined by a point system based on academic performance) to those participants (i.e., the better the performance, the higher the stipend).
5. Require strong accountability and reporting components which 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, go to college, 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 constantly have to spend an unreasonable portion of his/her time in money raising activities.

**Linkages**

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 inkind manpower support to a summer intervention program; then in a subsequent summer 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 prep schools interested in recruit-

ment of 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 skills of these individuals might be used most effectively in summer intervention programs. These officers serve as strong role models for the program students and it would be a very inexpensive contribution of the military services to the development of our human resources.
4. Develop linkages between local Job Training Partnership Act (JTPA) Sponsors and intervention programs so that poverty level students can participate in summer intervention programs and have this experience 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, hold another orientation for parents of selected applicants; at the end of the program, hold a closing day assembly to which participant's 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 P.R. 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.

## **Accountability In Science-Oriented Minority Intervention Programs**

Currently, 5% of the annual output of baccalaureate degrees in science and engineering are being awarded to students who come from minority groups traditionally under-represented in the science and engineering professions. The 5% figure is at best one-third of parity. An effective means for getting minority students into the pipeline for college science and engineering studies is through precollege intervention programs. Consequently, many of the successful intervention programs in this country which are dedicated to rectifying this inequity deserve to receive adequate support for continuation, expansion, and replication.

The funders of all intervention programs have an obligation to their constituencies and to this nation to demand an accounting, specifically requiring documented evidence of the success in producing minority college graduates in engineering and science. The successful programs should be supported and enhanced while the unsuccessful programs discontinued.

In the future funding of all programs, it is recommended that a component of accountability be required. The objectives of all these programs should be to show an increase in the number of minorities who receive baccalaureate degrees in science and engineering.

Some aspects of accountability should include the following:

1. An intervention program should include a tracking and reporting mechanism for its minority participants specifically covering the following:
  - a. college admission
  - b. choice of college majors
  - c. college graduation
  - d. college major at the time of graduation
2. All public and private funding agencies should require annual reporting from the programs which they are supporting and should have the prerogative to audit these reports.
3. The Mathematical Association of America, Mathematics community and the Science and Engineering community in general, should formulate guidelines for accrediting successful intervention programs. These accreditations could be used by the recognized intervention programs to gain needed financial support to maintain, expand or disseminate information about the program.

## **Appendix:**

- Participants
- References
- Bibliography

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## Symposium on Intervention Programs

### Directory of Participants

1. John W. Alexander, Jr.  
Wentworth Institute of Technology  
550 Huntington Avenue  
Boston, Massachusetts 02115
2. Nancy Arnez, Ed.D.  
Howard University  
3122 Cherry Road, NE  
Washington, D.C. 20018
3. Beverly J. Anderson, Ph.D.  
University of the District of Columbia  
Building 42, Room 213  
Washington, D.C. 20008
4. Bernis Barnes, M.S.  
University of the District of Columbia  
Building 42, Room 213  
Washington, D.C. 20008
5. Laverne Blagmon-Earl, M.S.  
University of the District of Columbia  
4402 21st Avenue  
Temple Hills, Maryland 20748
6. Sandra Bovain, M.A.  
Cumberland County College  
P.O. Box 517  
Vineland, New Jersey 08360

7. Phillip Brach, Ph.D., P.E.  
University of the District of Columbia  
Building 32, Room B06  
Washington, D.C. 20008
8. Herman Brown, Ph.D.  
University of the District of Columbia  
Building 39, Room 202  
Washington, D.C. 20008
9. Manuel P. Berrioza'bal, Ph.D.  
Director  
San Antonio Pre-Freshman Engineering Program  
PREP Office  
University of Texas  
San Antonio, Texas 78285
10. Rodney M. Burton, Ph.D.  
University of Michigan  
4320 Ord Street, NE  
Washington, D.C. 20019
11. Bettye M. Clark, Ph.D.  
Chairperson  
Department of Mathematics-Computer Science  
Clark College  
240 James P. Brawley Drive, SW  
Atlanta, Georgia 30314
12. Winson Coleman, Ed.D.  
Director  
The Saturday Academy  
University of the District of Columbia  
Building 42, Room 213  
Washington, D.C. 20008
13. Rafael Cortada, Ph.D.  
President  
University of the District of Columbia  
Washington, D.C. 20008

14. Edgar Epps, Ph.D.  
Professor of Urban Education  
Department of Education  
University of Chicago  
5835 South Kimbark Avenue  
Chicago, Illinois 60637
15. Mary DePuew Freedman, M.S.  
North Carolina State University  
College of Engineering  
NCSU-COE, Box 7904  
Raleigh, North Carolina 27695-7904
16. Neil Gerr, Ph.D.  
Scientific Officer  
Code 1111SP  
Mathematical Sciences Division  
Office of Naval Research  
800 North Quincy  
Arlington, VA 22217-5000
17. John N. Glover, M.B.A.  
Golden Spiral Institute  
P.O. Box 6682  
McLean, Virginia 22106
18. Mary W. Gray, Ph.D.  
Department of Math/STAT  
American University  
Washington, D.C. 20016
19. Mrs. Jean Green  
Education Planner  
Office of Postsecondary Education  
Research and Assistance Section  
D.C. Office of Human Services  
1331 H Street, NW- Suite 600  
Washington, D.C. 20005

20. William Guillory, Ph.D.  
President  
Center of Creative Inquiry  
1225 East Fort Union Boulevard-Suite 200  
Midvale, Utah 84047
21. Rose Gunn, B.A.  
University of the District of Columbia  
6008 7th Place, NW  
Washington, D.C. 20011
22. Marilyn Hala, M.Ed.  
National Council of Teachers of Mathematics  
1906 Association Drive  
Reston, Virginia 22091
23. Deborah Hale, M.S.  
Thomas Nelson Community College  
P.O. Box 9407  
Hampton, Virginia 23670
24. William Hawkins, Ph.D.  
University of the District of Columbia  
3046 Nash Place, SE  
Washington, D.C. 20020
25. Linda Hayden, Ph.D.  
American University  
4607 Connecticut Avenue, NW  
Apartment 105  
Washington, D.C. 20008
26. Joy Jackson, Ph.D.  
New Jersey Department of Higher Education  
20 West State Street, Commerce Building  
Trenton, New Jersey 08626

27. Mary Johnson, Ph.D.  
Director  
Mathematics Science Initiative Program, D.C.P.S.  
Langdon Elementary School  
20th and Franklin Street, NW  
Washington, D.C. 20018
28. Silvia T. Johnson, Ph.D.  
Howard University  
301 Gilsan Court  
Silver Spring, Maryland 20900
29. Myrtle Jonas, Ed.D.  
University of the District of Columbia  
Building 41, Room 501-101  
Washington, D.C. 20008
30. Phyllis Katz  
Director  
Hands on Science Program  
4910 Macon Drive  
Rockville, Maryland 20852
31. Carrie Kendrick, Ed.D.  
Co-Director  
A Certificate Program for Elementary Mathematics Specialists  
University of the District of Columbia  
Building 42, Room 213  
Washington, D.C. 20008
32. Genevieve Knight, Ph.D.  
Professor of Mathematics  
Coppin State University  
7314 Kerry Hill Court  
Columbia, Maryland 21045

33. Gerald Kulm, Ed.D.  
American Association for the Advancement of Science  
1333 H Street, NW  
Washington, D.C. 20005
34. Gordon Lewis  
Supervising Director of Mathematics  
District of Columbia Public Schools  
Langdon Elementary School  
20th and Franklin Street, NW  
Washington, D.C. 20018
35. Rhett Lewis  
National Urban Coalition  
1120 G Street, NW  
Washington, D.C. 20005
36. Larry Lim  
Project Director  
The Mathematics, Science, Engineering Program  
School of Engineering  
OHE 104  
University of Southern California  
Los Angeles, California 90089-1455
37. Colonel Ruth Lucas  
Assitant to the Dean  
College of Physical Science, Engineering and Technology  
University of the District of Columbia  
Building 32, Room B06  
Washington, D.C. 20008
38. John McAdoo, Ph.D.  
Associate Professor  
School of Social Work  
University of Maryland  
3034 Chestnut Street, NW  
Washington, D.C. 20015

39. Claude Mayberry. Ph.D.  
President  
"Science Weekly"  
4450 South Park Avenue  
Chevy Chase, Maryland 20815
40. Cecilia Ottinger, M.P.A.  
Children's Defense Fund  
122 C Street, NW  
Washington, D.C. 20001
41. Ura Jean Oyemade, Ph.D.  
Associate Professor and Chairman  
Department of Human Development  
School of Human Ecology  
Howard University  
Washington, D.C. 20059
42. Clarence A. Porter, Ph.D.  
Montgomery College  
Takoma Park, Maryland 20912
43. Lois Powell, Ph.D.  
Professor of Psychology  
University of the District of Columbia  
Washington, D.C. 20008
44. Edward N. Prather, M.A.  
Stevens Institute of Technology  
119 Holland Road  
South Orange, New Jersey 07079
45. Louise Raphael, Ph.D.  
The National Science Foundation  
NSF/DMS-339  
Howard University (After August)  
Washington

46. Ted Reid, Ph.D.  
Program Director  
Career Access Program  
Room 639  
The National Science Foundation  
Washington, D.C. 20550
47. Linda P. Rosen, Ph.D.  
Program Officer  
Mathematical Sciences Education Board  
818 Connecticut Avenue-Suite 500  
Washington, D.C. 20006
48. Deborah Schifter, Ph.D.  
Summermath, Shattuck Hall  
Mount Holyoke College  
South Hadley, Massachusetts 01075
49. Mohamed Sesay  
University of the District of Columbia  
Building 42, Room 213  
Washington, D.C. 20008
50. Thomasine Sidewater  
Teacher  
The District of Columbia Public Schools  
18th and Perry Street, NE  
Washington, D.C. 20018
51. Barbara Sizemore, Ed.D  
Professor of Education  
University of Pittsburgh  
3510 Iowa Street  
Pittsburgh, Pennsylvania 15219
52. Marcia P. Sward, Ph.D.  
Mathematical Sciences Education Board  
818 Connecticut Avenue-Suite 500  
Washington, D.C. 20006

53. Melvin Thompson  
Director  
Institute for Science, Space and Technology  
Howard University  
Washington, D.C. 20059
54. Ressie M. Walker, B.A.  
AAUW Educational Foundation  
2401 Virginia Avenue, NW  
Washington, D.C. 20037
55. Flavia Walton, Ph.D.  
Project Director  
Project LEAD: High Expectations  
Links Foundation, Incorporated  
1200 Massachusetts Avenue, NW  
Washington, D.C. 20005
56. Lewin Warren  
Deputy Assistant Administrator  
Office of Equal Opportunities Program  
NASA Headquarters  
Code U  
400 Maryland Avenue, SW  
Washington, D.C. 20546
57. Bonita Washington-Lacey, B.A.  
Earlham College  
Box 2  
Richmond, Indiana 47374
58. Nat W. Woodrick  
Department of Physics  
Howard University  
Washington, D.C. 20059

59. Carolyn Young, M.S.  
Golden Spiral Institute  
3224 19th Street, NW  
Washington, D.C. 20010
60. John F. Young, M.A.T.  
Woodson Junior High School (D.C.P.S.)  
1216 Owen Place, NE  
Washington, D.C. 20002
61. Yingying Zhou  
Student  
University of the District of Columbia  
1021 Arlington Boulevard -No. 314  
Arlington, Virginia 22209

Overview  
References

Beverly J. Anderson  
Professor of Mathematics  
University of the District of Columbia

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Edgar G. Epps  
Marshall Field IV Professor of Urban Education  
The University of Chicago

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John L. McAdoo  
Associate Professor  
School of Social Work-University of Maryland

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In Mathematics and Science  
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Lois Powell  
Professor of Psychology  
University of the District of Columbia

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