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The Effectiveness of Transportable Acquisition Management Lessons

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Barbara Tarker**

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Approved and released by
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13. ABSTRACT (Maximum 200 words) This report documents one phase of a joint services effort--the Guidelines for Transportable Education and Training (GTET) project. The ultimate goal of the GTET project is to provide guidelines for the training manager responsible for converting residential courses into transportable ones. In this report, the authors document the effectiveness of prototype transportable lessons by looking at student performance. The most important finding within the constraints of the study was that transportable courseware is at least as effective as residential courseware in teaching students nontechnical material and is a far more cost-effective approach. <i>Keynote</i>					
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FOREWORD

This report was prepared by the Navy Personnel Research and Development Center (NAVPERSRANDCEN) to document its involvement as principal investigator in the development of the Guidelines for Transportable Education and Training (GTET). The Joint Services Manpower and Training Systems Development Program funded the project through Program Element 0604722A, Work Unit No. 0604722A.00.02.

Other NAVPERSRANDCEN work efforts funded by GTET are described in four additional reports. One addresses lessons learned in converting residential courseware to transportable courseware (NPRDC-TN-90-21). The remaining three are supplements to a user's manual for the CATS program. CATS is an acronym for computer-based instruction authoring tools system, a government-owned set of software tools for constructing and presenting interactive courseware on a personal computer. The three supplemental reports concern lesson presentation (NPRDC-TN-90-28), lesson maintenance (NPRDC-TN-90-30), and a guide for students (NPRDC-TN-90-29).

The ultimate goal of the GTET project is to provide guidelines for the training manager responsible for converting residential courses into transportable ones. In this report, the authors document the effectiveness of prototype transportable lessons by looking at student performance. The most important finding within the constraints of the study is that transportable courseware is at least as effective as residential courseware in teaching students nontechnical material and is a far more cost-effective approach.

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Questions regarding this work can be directed to Dr. Michael R. Flaningam, Principal Investigator, Code 162, Navy Personnel Research and Development Center, San Diego, California 92152- 6800, (619) 553-0554 or AUTOVON 553-0554.

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SUMMARY

PROBLEM

It is becoming increasingly important to the military to develop alternatives to residential classroom instruction, which is expensive, usually unstandardized, group-oriented, and limited to small numbers of students. Transportable courseware is such an alternative.

RESEARCH FOCUS

Many people throughout the Department of Defense need basic information about acquisition management, but the demand for this kind of training is greater than the residential schools can satisfy. To determine if residential courses in acquisition management could be readily converted into transportable ones, the program sponsors selected the Defense System Management College's (DSMC) residential Program Management Course (PMC) to serve as the focus of a research effort.

The objective of this effort was to develop transportable lessons that were as educationally effective as residential lessons and that could serve as an adequate substitute for classroom instruction under the premise that transportable instruction is more economical to use because it can reach far greater numbers of students.

APPROACH

Transportable lessons were developed for one of the seven modules that introduce students at the DSMC to the PMC. The transportable lessons for this module, called Tools for Program Management (TPM), were prepared in both print and computer versions.

The transportable lessons were created using a systems approach (the SEID process or Systems Engineering of Instructional Development process). Lessons were written from a set of lesson specifications and objectives, and test items on the final TPM test reflected those objectives.

To determine whether these transportable lessons could serve as an adequate substitute for the lessons in the residential course, 31 students from DSMC were selected to be members of a control group; they received conventional residential instruction on the TPM module as part of the PMC introduction. Classroom presentation of the TPM material was interspersed over 3 of the 6 weeks of the course. Most of the instruction

was given in a lecture/discussion style. Fifteen students from the Air Force Institute of Technology and 14 from the Systems Acquisition School served as the experimental group, learning about TPM through the newly developed transportable lessons. Half of the students from each experimental site received the print version of the TPM lessons and half received the computer version.

Both groups were given the same final test made up of 55 multiple-choice items. The students in the control group were tested together on the TPM module after the fifth week of the 6-week PMC. The students in the experimental group were tested individually as each finished the lessons.

RESULTS AND DISCUSSION

The key finding was that students who studied with the transportable lessons performed at least as well as students who took the residential classroom lessons. Students who took the transportable lessons actually scored higher than classroom students. But, since the teaching methods used by the instructors may have differed greatly within the control group setting and because control group learning of the TPM module took place within a larger context (i.e., as part of the PMC introduction), these score differences cannot be attributed to the transportable media alone.

There was no significant difference in scores between those students in the experimental group who received the print version and those who received the computer-based version.

CONCLUSIONS

Within the constraints of this study, the authors found that transportable instruction can be as effective as residential classroom instruction in presenting nontechnical information to acquisition management students.

RECOMMENDATIONS

(1) A systematic front-end training analysis can help determine if transportable lessons are an appropriate medium for a given subject matter area.

(2) Since no special educational benefits can be attributed to any one presentation medium, the most cost-effective medium should be chosen to present lessons.

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INTRODUCTION

Problem

The military services, including the reserve community, need to provide quality training in both technical and nontechnical areas to large and varied populations of students at widely distant locations. Of particular concern to the military services is the training developed for those responsible for the acquisition of weapons and other supplies, with the goal that all materiel received performs well and is priced reasonably. Congress has also advocated strengthening acquisition education and has recommended improving defense management, in general, and the acquisition system, in particular (Packard Commission, June 1986). A recent Assistant Secretary of Defense stated that a necessary near-term action is the development of better qualified procurement personnel. He noted too the need to "promote wider use of non-traditional training methods."¹

Residential instruction, however, does not provide all the answers. It has many limitations, among them: (1) lack of uniformity in lesson content (sometimes due to lack of clear training objectives, sometimes due to varying instructor experience, interest and capabilities); (2) lack of a systematic process by which to update and revise course materials so that they are the same for all instructors in all classrooms; (3) nonadaptability to an individual's learning needs; (4) inaccessibility to all students who need or desire the training; and (5) rigid scheduling that requires students to delay training until it is offered in a classroom. Finally, residential training is very expensive.

Transportable education addresses many of the limitations of residential training and has proven to be more cost-efficient. It does not require sending personnel away from the work site for training. Lessons are standardized, which means that everyone taking the course will receive the same message. Ultimately, many more people can be trained for fewer dollars (Locatis, 1987).

Transportable education permits more timely training; courses can be available for presentation whenever the student or supervisor determines they are needed. These courses can also be used as cost-efficient refreshers for people who need to be brought up to date on a particular topic. If carefully designed, transportable lessons can provide other time efficiencies because they can be structured to take advantage of each student's skill and knowledge and permit students to choose the amount and kind of instruction they wish to receive.

Although the need for transportable education in professional management programs is well documented, there are few guidelines on how to develop computer-based lessons in nontechnical areas.

¹William Taft, 19 August 1985, in a Memorandum to the Service Secretaries and Assistant Secretaries of Defense.

Research Focus

Earlier research funded by the Naval Air Systems Command (NAVAIR) explored the feasibility of transporting residential acquisition management instruction. To determine if residential courses in acquisition management could be converted into transportable ones, NAVAIR, the Defense Systems Management College (DSMC), and the Navy Personnel Research and Development Center (NAVPERSRANDCEN) selected the residential Program Management Course (PMC) at the Defense Systems Management College (DSMC) to serve as the focus of this research effort.²

Much of the material presented in the PMC is similar to material in courses provided at other locations, such as those provided by the Air Force Institute of Technology (AFIT) and the Systems Acquisition School (SAS) of the Air Force Systems Command (AFSC). Since transportable training can be broken up into modules and used in a wide variety of settings, it was reasoned that portions of the transportable materials could substitute for some lessons from these other courses, making the lessons useful to an even wider population.

Personnel from the three agencies noted above proposed to provide students with a significant portion (approximately 7 days) of the PMC material in a transportable instructional package. Two versions of the transportable material would be created: a print version and a computer-based version.

Hypotheses

Course developers predicted that transportable instructional materials would provide nonresidential education that was at least equal in value to that of its parallel residential course in terms of student performance. The objective of the project was to create transportable courseware that could substitute, not surpass, classroom training. Course developers also hypothesized that there would be no differences between the transportable print and computer courseware, since the computer lessons paralleled the print lessons in every way--content, organization, and format. For the print version, one turns a page; for the computer version, one presses a spacebar to move from screen to screen. Meta-analyses by both Clark (1985) and Kulik (Kulik, Kulik, & Cohen, 1980) indicate that most performance differences that have been found between classroom and computer-based versions of instruction are due to variables such as instructional methods rather than to instructional *delivery* methods. Since the print and computer lessons were basically the same, no differences were anticipated between these two versions.

²Another product of this present effort is a set of Guidelines for Transportable Education and Training (GTET), guidelines that project managers can use to help develop and implement transportable instructional packages. These guidelines are in the process of being developed and are based, in part, on the lessons learned from this effort (Tarker, Rybowskiak, Flaningam, & Hulton, 1990).

APPROACH

Materials

Analysis and Design of Materials

A training needs analysis was conducted that resulted in three products: (a) a topical outline that provided course objectives for several lessons; (b) lesson specifications that evolved from the topical outline and that were used to guide the design and development of the prototype course materials; and (c) tradeoff analyses that determined appropriate training media, including hardware and software for both courseware authoring and development and for lesson presentation.

Courseware Development

Systems Engineering of Instructional Development (SEID) technology and computer-based authoring systems were used as tools in the design, development, and presentation of transportable education lessons (Instructional Science and Development, Inc., 1987).³ For this project, a transportable print version and a computer version were used to present the courseware to students.

Development of the courseware was based on lesson specifications. The lessons were produced iteratively to maintain quality and cost controls. They were produced by teams of contract and government personnel, with subject matter expert review and input by DSMC personnel. All activities were closely monitored to ensure the correct application of systematic instructional technology methods.

The courseware was designed to help students spend their time more efficiently (e.g., to spend more time on areas that are causing them the greatest difficulty). The materials were designed so that students with higher aptitudes or greater experience were able to proceed

³SEID evolved from the Instructional Systems Development (ISD) approach that was formalized in the late 1960s and early 1970s. SEID is similar to ISD in the use of a systematic approach to all phases of instructional development, ranging from analysis, design, development, and implementation through evaluation and management. The SEID differs in the sense that it was designed for nontechnical training, such as acquisition management education, while ISD was designed for use with highly technical courses, such as those that teach how to operate or repair machinery.

through the course material quickly, while those with lower aptitudes or less experience were able to receive additional assistance as needed.

A formative evaluation of the materials was conducted. Both students and teachers who used the materials provided the feedback. Some of the lessons were extensively revised as a result of this evaluation, and many other format and content recommendations were incorporated into the final materials.

Further details on courseware design and development are provided in a related report entitled *Lessons Learned in Converting Residential Courseware to Transportable Courseware* (Tarker et al., 1990).

Transportable Lessons

The transportable lessons consisted of seven lessons from one module of the Introductory PMC (PMC (I)) course--Tools for Program Management (TPM). In the classroom setting, the content of these lessons was presented over a 6-week period. (See Appendix A for a description of the PMC(I)) modules and the TPM module that was converted into transportable lessons.)

Two versions of each transportable lesson were developed: a self-paced print version and a self-paced computer version. Both versions were designed to be used by individuals at or near their workplaces.

Each student received either a print version or a computer version of each of the seven lessons. Both modes were designed to require minimal interaction with an instructor, needing only a facilitator who would be available to answer questions. The facilitator was either present during all lessons or was available by phone. Students planned their own time, working on the lessons as time permitted. Both versions contained the same content material and only differed in presentation method. All lessons included a pre-quiz and post-quiz, an introduction and a list of lesson objectives, content information, a summary, and practice questions. Some lessons also contained supplementary information and examples.

Each print-version lesson consisted of a printed booklet (8 1/2" by 11") that contained all of the instructional materials. Each computer version lesson consisted of a student disk and a set of 5-1/4" floppy disks. Each student received his/her own floppy disk that stored the student's test results and tracked the student's completion of lesson sections. All of the students using the computer version received a printed user's guide for each lesson that contained: (1) instructions for installing and using the computer lessons, and (2) a variety of appendices with printed pages of some of the lesson content. All material in the computer lesson appendices was also part of the print lessons.

The microcomputers used to present the computer courseware were off-the-shelf systems (Zenith 248s) that already existed at the students' work sites or at a training location nearby.

Evaluation Materials

All students who used the transportable lessons also received a feedback form packet that asked questions about the lessons. A list of the feedback questions, including questions soliciting demographic information, is included in Appendix B.

Demographic information was gathered from each student. Questions covered previous education, military rank or civilian grade, and work-related experience in the systems acquisition field. After the students finished all of the lessons, they were asked about their previous experience with the content presented in each of the lessons. Attitudes toward the lessons were assessed through the use of four basic ranking questions about each lesson, with space provided for written comments. Students were also asked to record the number of minutes it took them to complete each lesson.

Coordinator Materials

A coordinator at each testing site was also provided with: (1) a description of the purpose of the evaluation, (2) directions for protecting the identity of the students, (3) a list of materials for each student, (4) a description of the students' need of a content-knowledgeable facilitator (this was usually the coordinator) who could answer questions about subject matter, and (5) directions for how and when to return the materials. A copy of the instructions to coordinators is provided in Appendix C. Coordinators were also provided with the final examination and instructed to monitor its use.

Procedures

All materials were mailed to the coordinators at the training/evaluation sites. The final results and feedback were returned as the materials were completed, about 4 months later. The coordinators were responsible for identifying and eliciting the cooperation of representative volunteer students to receive the transportable instruction. Coordinators were also tasked with: (1) distributing and collecting the materials, (2) explaining to the students the importance of doing the lessons and providing feedback, (3) tracking the materials with identification numbers to preserve participant anonymity, and (4) determining how to present the computer lessons (see below).

Each training site set up its own delivery and installation system for the computer lessons. At SAS, the computer lessons were installed on computers by the coordinator, not the students. At AFTT, the coordinator distributed the computer disks to the students, who then installed them on their own computers and completed the lessons at their own work sites.

The instructions recommended that students devote no more than 2 hours at a time to the coursework, for both print and for computer versions. Of course, it was left up to the individual students whether or not to follow these recommendations.

Half of the students at each experimental site used the computer version and half used the print version.

Subjects

Personnel from three sites participated in the evaluation. DSMC provided 31 students from one of its regional centers to receive conventional residential instruction and to serve as the control group. AFIT provided 15 students and SAS provided 14 students to receive the transportable instruction.

The students who received the residential classroom instruction were students at DSMC. They were given the introductory portion of PMC over a 6-week period at DSMC's regional center in Huntsville, Alabama.

The two Air Force sites were selected because their students represent the ultimate target population in terms of education and experience. These students were *potential* candidates for the PMC in that they met DSMC's experience and educational requirements. Students at both sites were volunteers. One site offered course credit for participation.

Demographic information on all subjects is presented in Table 1. The experimental groups were mainly Air Force students (with AFIT having two non-Air Force students). The control group (Huntsville) was more heterogeneous; the largest single group represented was from the Army (54.8%). The majority of the Huntsville students (51.6%) and AFIT students (53.3%) were civilians at the GS-11 level and above. The SAS students formed a more homogeneous group in terms of service and grade, with all students being Air Force military personnel, primarily with an "O1 to O3" rank (85.7%). The remainder of the SAS students (2) were ranked "O4 and up" (14.3%).

No student at either of the experimental sites had previously attended the introductory PMC course. Six (42.9%) of the SAS students were instructors; none of the students from Huntsville or AFIT functioned as teachers.

Data on degree, years of acquisition experience, years of program office experience, and years of military/federal service were only collected for the two experimental sites. All the students at both experimental sites had college degrees. AFIT students reported either a bachelor's or a master's degree as their highest degree obtained, and one student reported another type of degree as the highest obtained. A majority of SAS students had a bachelor's degree (64.3%), with 5 of the 14 students having a master's degree (35.7%).

Table 1
Demographic Information--Rank and Education

Variable	Test Site			Totals
	Huntsville (n = 31)	Air Force Institute of Technology (AFIT) (n = 15)	Systems Acquisition School (SAS) (n = 14)	
Service				
Air Force	5	13	14	32
Army	17	0	0	17
Marine	0	1	0	1
Navy	4	0	0	4
FAA	3	0	0	3
Industry	1	0	0	1
SAF	1	0	0	1
Other	0	1	0	1
Grade				
01-03	3	4	12	19
04 & up	11	2	2	15
GS-1--GS-10	0	1	0	1
GS-11 & up	16	8	0	24
N/A	1	0	0	1
Degree				
None	NA	0	0	0
Bachelor	NA	7	9	16
Master	NA	7	5	12
Other	NA	1	0	1

In terms of years of acquisition experience, AFIT students had fewer years (with a mean of 3.37 years or $\bar{M} = 3.37$) than SAS students ($\bar{M} = 6.41$), but the years spanned a wider range (with a standard deviation of 6.03 or $SD = 6.03$) (Table 2). A majority of the AFIT students had no acquisition experience (60%), although the range extended to one student having 18 years' experience. Acquisition experience for SAS students was distributed a bit more evenly, with the highest number of years being 14.

Table 2
Demographic Information--Work Experience

Variable	Test Site			Totals
	Huntsville (n = 31)	AFIT (n = 15)	SAS (n = 14)	
PMC Experience				
None	0	15	14	29
PMC 1	31	0	0	31
PMC 1 & 2	0	0	0	0
Years Acquisition Experience				
M	NA	3.37	6.41	
SD	NA	6.03	4.17	
Years Program Office Experience				
M	NA	1.33	3.52	
SD	NA	2.25	3.63	
Years Military or Federal Service				
M	NA	11.47	7.95	
SD	NA	6.65	5.31	

Note. NA = Data not available.

A similar profile was found for the experimental sites with regard to the number of years students recorded for program office experience, with SAS students having a higher mean number of years' experience ($M = 3.52$). The majority of AFIT students (nine) did not have any program office experience (60%). However, AFIT students had more years of military/federal service ($M = 11.47$) than had SAS students ($M = 7.95$).

Training Conditions

Control Group Conditions

The students in the control group (Huntsville, AL) were DSMC students taking the 6-week PMC(I) course. DSMC assumed that these students spent between 15 and 75 minutes of preparation time for each hour of residential classroom instruction. The classroom presentation of the TPM material (the same material that was taught in the transported lessons) was interspersed over 3 of the 6 weeks of the course. Most of the instruction was given in a lecture/discussion style to a class of 31 students. No homework was given other than the preparation readings.

Experimental Group Conditions

No additional time was required of the students beyond that used in studying the transportable lesson materials. Students worked individually and at their own pace. Some students did the lessons at their own work sites and others did them at computer work stations close to their work sites. Because of this flexibility, they were able to coordinate the lesson sessions with their regular work schedules.

Final Testing Conditions

A final test was given to all students in both the control and experimental groups. The test items were developed by both DSMC subject matter experts and by instructional designers at NAVPERSRANDCEN. The 55 multiple-choice items were based on lesson objectives. Longer lessons with more objectives required more questions than shorter lessons.

The students who received the residential classroom instruction were tested in the fifth week of the 6-week course after the seven TPM lessons had been presented. The TPM lessons were interspersed with lessons in other topic areas throughout the 5 weeks. Students who received the transportable materials were given only the TPM lessons. They were tested individually after they finished the seven lessons. These students did not receive any other training modules.

RESULTS

All analyses were conducted using the BMDP statistical software package (Dixon, 1988). Means and standard deviations for the total number correct on the final test for the control (Huntsville) and experimental groups (AFIT and SAS) are presented in Table 3. A one-way analysis of variance was conducted on the total number correct to test for differences between the means of all three groups.

Table 3
Means and Standard Deviations for
Final Test Scores by Site
(Number Correct Out of 55 Items)

Measure	Test Site		
	Huntsville ($n = 31$)	AFIT ($n = 15$)	SAS ($n = 14$)
<u>M</u>	33.19	40.80	39.64
<u>SD</u>	6.43	6.33	6.36

Results of the analysis of variance yielded significant differences ($F(2,57) = 9.24, p < .01$). Although sample sizes for the groups differed, the Levene test for equal variances indicated no significant difference between variances. The Scheffe pairwise comparison test indicated that the mean total score for AFIT ($M = 40.80$) was significantly higher than the mean total score for Huntsville ($M = 33.19$) at the $p < .01$ level. The Scheffe test also indicated a higher mean score for SAS ($M = 39.64$) over the mean score for Huntsville at the $p < .05$ level. The Scheffe test yielded no significant differences between AFIT and SAS, indicating no performance differences on the final test between the two experimental sites.

The mean final test scores and standard deviations for the residential, transportable print, and transportable computer courses are presented in Table 4. Results of the analysis of variance comparing the mean final total scores were significant ($F(2,57) = 9.83, p < .01$). The Scheffe test indicated that the mean total score for the transportable print version of the course ($M = 38.85$) was significantly higher than mean final score for the residential course ($M = 33.19$) at the $p < .05$ level. The mean final score for the transportable computer course ($M = 41.38$) was also significantly higher than that of the residential course at the $p < .01$ level. No significant differences were found between the print and computer versions of the course.

Table 4
Means and Standard Deviations for
Final Test Scores by Course
(Number Correct Out of 55 Items)

Measure	Course		
	Residential (N = 31)	Print (n = 13)	Computer (n = 16)
M	33.19	38.85	41.38
SD	6.43	6.50	6.01

The means, standard deviations, and ranges of times for completion of each lesson were recorded for the experimental groups only. Results are presented in Table 5. Times to complete the lessons varied considerably from lesson to lesson and from student to student. Coordinators reported that few students had questions about the content of the materials. Separate t-tests assessing differences between the two experimental sites indicated only one statistically significant result. Students at AFIT took significantly longer (87 minutes) than SAS students (54.50 minutes) to complete TPM 3.

T-tests assessing differences between print and computer versions on time to complete lessons yielded no significant differences.

Separate t-tests were also performed on the attitude assessment items for the experimental groups to measure differences between their responses. The students ranked four 10-scale items (see Appendix B, Overall Lesson Feedback Form). The first item addressed the issue of "beneficial" learning versus "waste of time"; the second item concerned the relative difficulty or ease with which the student was able to follow the lessons; the third item concerned the degree to which the student found the material to be motivating; the fourth item addressed perceived mastery of the content. The means and standard deviations for the four items for both experimental groups were calculated. Those tests that resulted in significant differences are presented in Table 6. If the Levene test for differences between variances was significant, a separate variance estimate was used. If the Levene test did not indicate significant differences, the pooled variance estimate was used.

Table 5
Means and Standard Deviations for Time Required by
Experimental Groups (AFIT and SAS) to Complete TPM Lessons
(Minutes)

TPM Lesson Number ^a	Experimental Group		
	AFIT	SAS	Combined
1. TPM 1			
<u>M</u>	113.33	96.43	105.17
<u>SD</u>	88.32	24.72	62.25
2. TPM 2			
<u>M</u>	119.07	112.71	116.00
<u>SD</u>	58.20	33.06	47.03
3. TPM 3			
<u>M</u>	87.00	54.50	71.31
<u>SD</u>	47.50	21.00	40.08
4. TPM 4			
<u>M</u>	65.00	41.15	53.93
<u>SD</u>	46.48	25.33	39.40
5. TPM 5/6			
<u>M</u>	190.13	148.71	170.14
<u>SD</u>	111.11	50.12	88.22
6. TPM 7			
<u>M</u>	151.33	66.79	110.52
<u>SD</u>	166.09	37.85	127.70
7. TPM 8			
<u>M</u>	106.36	72.67	90.81
<u>SD</u>	76.23	44.75	64.78

^aEarly in the design of the lessons, developers created eight lessons, but later merged the content of Lessons 5 and 6. Lessons 5 and 6 subsequently became known as TPM 5/6, with TPM 7 and 8 retaining their original numbers.

Table 6
Means and Standard Deviations for Attitude Assessment Items
(Experimental Group Only)

	Measure	AFIT	SAS	t	df
Beneficial vs. Waste of Time					
TPM 7	<u>M</u>	3.93	6.64	-2.96*	27.0
	<u>SD</u>	2.34	2.59		
Motivating vs. Just More Work					
TPM 8	<u>M</u>	3.86	6.00	-2.55*	24.0
	<u>SD</u>	1.88	2.41		
Mastery vs. Uncertainty					
TPM 1	<u>M</u>	1.73	3.93	-2.61*	14.3
	<u>SD</u>	.70	3.08		
TPM 2	<u>M</u>	2.20	5.07	-3.30**	15.6
	<u>SD</u>	1.01	3.10		
TPM 8	<u>M</u>	2.93	5.08	-2.23*	14.7
	<u>SD</u>	1.38	3.09		

Notes: * $p < .05$.
** $p < .01$.

A significant difference was found for the student's perception of mastery on TPM 1, TPM 2, and TPM 8 between the two experimental groups, indicating the AFIT students felt that they mastered the content of the lessons better than did SAS students.

AFIT students found TPM 7 more beneficial ($M = 3.93$) than did SAS students ($M = 6.64$); no other significant differences existed between the groups with regard to perceived benefits derived from the other lessons. AFIT students ($M = 3.86$) found TPM 8 to be significantly more motivating than did the SAS students ($M = 6.00$).

No significant differences were found between AFIT and SAS regarding the degree of difficulty involved in following the lessons.

No significant differences were found when the four attitude items were analyzed by course for the two experimental groups. Print versions and computer versions did not yield any significant differences across lessons for any of the attitude assessment questions.

Through written comments, we learned that the coordinator at one experimental site initially had some difficulty persuading people to use the computer version. People seemed to lack confidence with computers or computer techniques. Yet, by the end of the evaluation period, all of the computer volunteers were positive about using the computerized lessons and felt that they had learned something. This group suggested providing a print copy of the materials to supplement the computer version to reinforce what they learned on line and to keep for future reference.

T-tests conducted to assess the differences between mean years of acquisition experience, program office experience, and military/federal service indicated no significant differences between subjects at AFIT and SAS.

DISCUSSION

The transportable courseware yielded higher scores on the final test than did the residential courseware, supporting the hypothesis that the transportable courseware would at least yield equivalent results on an objective test.

There were no significant test score differences between students who received the print version and those who received the computer version, supporting the hypothesis that the computer version would produce the same results as the print version. Also, since no differences were found between performance scores from the two experimental sites, it is possible that having computerized transportable materials available at a shared computer near the work site is just as effective as having them available at individual work sites.

There may be several reasons why the transportable courses yielded higher test results. The classroom students were tested after receiving instruction not only on the seven TPM lessons, but also after instruction on other topics. The students receiving the transportable courseware completed only the TPM lessons, then received the TPM final test. Interspersing the

TPM lessons with other types of lessons may have reduced the residential group's performance on the final TPM test because of additional information that had to be considered and learned. Conversely, it could be argued that the additional lessons have the potential to reinforce the TPM lesson material, since the TPM lessons contain the tools (such as basic math operations) that program managers use throughout other phases of program management and apply to other lessons.

Another reason why the transportable lessons resulted in higher final test scores may be that classroom instructors used different instructional methods than those used in transportable materials. Clark (1985) suggests that many studies that compare media do not distinguish the medium from the instructional method. He reports that characteristics typically found in computer-based instruction are not generally found in classroom lectures, such as examples matched with non-examples that illustrate the lesson objective, individualized pacing, a correspondence between instruction and test items, and corrective feedback after responses.

The transportable lessons for this project were designed and developed using a systematic method (the SEID process). The lessons were written from a set of lesson specifications and lesson objectives, and the test items on the final TPM test reflected those objectives. At Huntsville, the five instructors may have focused on issues other than those represented by the lesson objectives. The instructors may or may not have covered material that appeared on the final test. Because the teaching methods used by the instructors may have differed greatly within the control group setting and because control group learning of the TPM module took place within a larger context (i.e., as part of the PMC introduction), these score differences cannot be attributed to the transportable media alone.

In addition, the self-paced nature of the transportable materials could have affected the test scores. Students in the experimental groups could complete all or parts of a section of a lesson, could review materials at any time, or perform the practice and test items more than once. Students attending lectures at the residential school might have found it more difficult to review materials. For example, if questions could not be answered during the scheduled lecture, it may have been difficult to talk with the instructor outside of class time. Also, the self-paced students might have chosen to study the materials when they were most alert and best able to attend to new information.

The transportable lessons were designed to be interactive. All students were expected to respond to a variety of scenarios and answer many questions during the lessons. In typical classrooms, often only a few students participate in discussions. Perhaps the transportable lessons stimulated more active learning by all the students.

CONCLUSIONS AND RECOMMENDATIONS

The goal of this project was to design, develop, test, and evaluate a set of transportable training materials that introduce program management concepts to acquisition managers. It was hypothesized that these training materials would result in performance gains that were at least equal to those obtained by students who received residential instruction. The goal was achieved and the hypothesis was confirmed. In fact, students who used transportable courseware performed better on the final test than did the residential students.

We did not hypothesize that the transportable lessons would result in instruction superior to conventional classroom instruction. The purpose of this investigation was to determine if the transportable courseware could serve as an adequate substitute for classroom instruction under the premises that transportable instruction is more economical to produce and can reach far greater numbers of students. Transportable instruction was viewed as a vehicle for alleviating high student demand, inadequate facilities for meeting this demand, and the travel costs associated with attending residential classroom instruction.

When developing future courses, it remains important to determine which skills are best taught via transportable lessons using the GTET guidelines. It is probably inappropriate to develop transportable courseware for every lesson in a residential program. Some skills may be more readily taught within a classroom setting and may be more amenable to group discussion and exchange.

Because use of the print and computer versions of the lessons did not result in any differences in student performance, it may be more efficient to develop only print versions if economy is important. We suggest this because: (1) print materials are generally less costly and less time-consuming to develop and produce than computer media; (2) print materials are more portable; (3) there are no hardware requirements; and (4) recent analysis indicates that a specific medium will not provide learning benefits unattainable from other media (Clark & Sugrue, in press; Levie & Dickie, 1973; Schramm, 1977).

Recent research supports the idea that while new electronic media (such as computers and videodiscs) may not provide psychological advantages in learning, they may provide economic advantages when compared with residential instruction in terms of expended resources and speed of learning (Clark & Sugrue, in press). These findings are consistent with this effort's purpose of developing the transportable lessons to help ease the costs of attending residential courses and to allow students to complete courses at their own pace.

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APPENDIX A
TPM LESSON OVERVIEWS

TOOLS FOR PROGRAM MANAGEMENT (TPM) LESSON OVERVIEW

The introductory component of the Defense Systems Management College's Program Management Course (PMC (I)) is designed to cover basic topics in defense acquisition. It contains seven modules of instruction. The Tools for Program Management (TPM) lesson fits into PMC (I) as highlighted below:

PMC (I) MODULES

1. Defense Acquisition Environment and Process (DAEP)
2. Tools for Program Management (TPM)
3. Program Planning and Control (PPC)
4. Resource Estimation and Management (REM)
5. Government/Contractor Relationship (GCR)
6. System/Product Definition (SPD)
7. Executive Skills Development (ESD)

The TPM module consists of seven lessons:¹

TPM LESSONS

- | | |
|-----------|-------------------------------------|
| TPM 01 | Mathematics for Resource Estimation |
| TPM 02 | Economic Analysis |
| TPM 03 | Work Planning and Definition |
| TPM 04 | System Effectiveness |
| TPM 05/06 | Quantitative Decision Making |
| TPM 07 | Non-Quantitative Decision Making |
| TPM 08 | Trade-off Analysis |

¹Early in the design of the lessons, developers created eight lessons, but later merged the content of Lessons 5 and 6. Lessons 5 and 6 subsequently became known as TPM 5/6, with TPM 7 and 8 retaining their original numbers.

TPM 01
MATHEMATICS FOR RESOURCE ESTIMATION

Prerequisites

None

Lesson Introduction

This lesson covers the mathematics you will need to understand learning curve analysis, which is taught in FM 010 (the first lesson of the Funds Management module). Each segment will cover skills relevant to learning curve analysis, in which you predict production costs for future lots based on data from previous lots.

Lesson Objectives

At the end of this lesson you will be able to:

1. Plot data points on coordinate graph paper and log-log paper.
2. Forecast the value of y given a value of x and data that is already plotted.
3. Solve for y in an equation when given a value for x .
4. Solve for x and y in simultaneous equations.
5. Use a calculator with a y^x key to solve equations with either positive or negative exponents.
6. Use logarithms to solve equations.
7. Explain the components of the mathematical equation for a straight line: $y = mx + b$ and the learning curve: $y = ax^b$.
8. Determine the equation of a line, given data points (x,y) or a plotted linear graph.
9. Solve for y , given data points (x,y) or a learning curve plotted on a graph and values of x .
10. Describe the use of the visual method of regression analysis to determine whether your data is accurate, sufficient and linear, or curvilinear.
11. Describe the use of the least squares method of linear regression analysis.
12. Describe how to conduct regression analysis on data that is curvilinear.
13. Use the three measures of goodness of fit (standard error of the estimate (SEE), correlation coefficient, and coefficient of determination) to determine how well the independent variable predicts the dependent variable.

Required Resources

You will need a calculator with a y^x key for this lesson.

TPM 02 ECONOMIC ANALYSIS

Prerequisites

None

Lesson Introduction

As a program manager, you should be aware of how companies that you work with operate--their motivation, their risks, and how they make investment decisions. In this lesson, economic analysis, you will learn about basic economic principles and how to apply analysis techniques to make investment decisions yourself.

Lesson Objectives

At the end of this lesson you will be able to:

1. Explain what is meant by the time value of money.
2. Determine the investment that yields the greatest future value.
3. Determine the best investment opportunity by discounting future value to present value.
4. Explain the relationship between time value of money, interest rate, and investor risk.
5. Explain the seven risk factors associated with interest rates.
6. Define economic terms relating to the use of capital.
7. Define economic analysis.
8. Explain reasons for using Economic Analysis in DoD systems acquisition.
9. Describe economic profit and return on investment.
10. Explain the role of cost of capital in evaluating investment techniques.
11. Calculate the payback period to determine the best project to invest in.
12. Calculate the Net Present Value.
13. Calculate the Internal Rate of Return.

Required Resources

You will need a calculator with a y^x key for this lesson.

TPM 03

WORK PLANNING AND DEFINITION

Prerequisites

None

Lesson Introduction

One of the most useful tools for program/project managers, in both the Department of Defense (DoD) and industry, is the work breakdown structure (WBS). The WBS, in its several forms, is extremely valuable as managers engage in planning, defining, and controlling their work.

A WBS, if well written, defines the program/project's total objectives; it relates the various work efforts (parts) to the overall product or end objective (whole) and provides a framework for the required budgeting and managing of resources.

This lesson presents an overview of work breakdown structures. Many terms are introduced in this lesson. The terms are defined throughout the lesson and are in accordance with MIL-STD-881A, Work Breakdown Structures for Defense Materiel Items.

Lesson Objectives

At the end of this lesson you will be able to:

1. Explain the purpose and importance of the WBS.
2. Define the following terms:
 - Tree diagram
 - WBS elements
 - WBS levels
 - Numbering system
 - Work package
 - WBS dictionary
3. Explain the four types of WBSs, including the purpose and the timing of each in the acquisition process.
4. Use MIL-STD-881A to prepare a Project Summary WBS, including numbering, given a list of 15-20 WBS elements.

Required Resources

You will need a copy of MIL-STD-881A for this lesson.

TPM 04

SYSTEM EFFECTIVENESS

Prerequisites

None

Lesson Introduction

This lesson presents an overview of system effectiveness. Every system is designed to respond to a stated need or requirement.

System effectiveness may be defined as the measure of the extent to which a system may be expected to achieve a set of specific mission requirements.

System effectiveness may be thought of as a function of availability, dependability, capability, and other variables. Our discussion will define those terms necessary to understand the concept of system effectiveness. The definitions we provide in this lesson are appropriate for either civilian or military System Effectiveness discussions.

Lesson Objectives

At the end of this lesson you will be able to:

1. Define the following terms: availability, dependability, capability.
2. Explain the relationship of the four types of models used to evaluate system effectiveness.
 - Time line model
 - Deterministic model
 - Probabilistic model
 - Relational (Interface) model
3. Explain when utility theory should be applied to determine system effectiveness.

Required Resources

None

TPM 05/06
QUANTITATIVE DECISION MAKING

Prerequisites

None

Lesson Introduction

Decision making is probably one of the most difficult and complex tasks program managers face. It is also one of the most important aspects of the job. Three lessons in the TPM series present the following decision-making techniques to help you in your role as decision maker: quantitative decision making, non-quantitative decision making, and trade-off analyses.

This lesson presents a quantitative decision-making technique called decision tree analysis (or expected value analysis) which is based on the application of expected value. Quantitative decision making involves the estimation and use of probabilities to draw inferences about potential outcomes.

Lesson Objectives

At the end of this lesson you will be able to:

Segment 1

1. Use your knowledge of probability to predict the chance of an event occurring (when outcomes are equally probable).
2. Identify the characteristics of the different types of distributions used to model data.
3. Determine the measures of central tendency and measures of dispersion of a probability distribution.
4. Predict or estimate the chance of an event occurring if you know the mean and standard deviation of a distribution (and can assume a normal distribution).

Segment 2

1. Identify when it is appropriate to use decision tree/expected value analysis.
2. Describe the following components of a decision tree:
Nodes: act node, event node
Elements: action (choice), event, probability, outcome
3. Calculate the expected value of each action.

Segment 3

1. Make a decision based on expected value analysis, when given a decision tree.

Segment 4

1. Explain how the following techniques relate to decision tree analysis: sensitivity analysis, uncertainty analysis, risk analysis.
2. Explain how the point of indifference can be used in decision tree analysis to determine the sensitivity of a decision.
3. Use a decision tree to calculate the point of indifference.
4. Evaluate your decision using the point of indifference.

Required Resources

You will need a calculator for this lesson.

TPM 07
NON-QUANTITATIVE DECISION MAKING

Prerequisites

None

Lesson Introduction

There are several well-known formal approaches to non-quantitative decision making, including the Kepner-Tregoe (K-T) approach and the creative problem solving (CPS) approach. This lesson introduces the Kepner-Tregoe approach to illustrate the advantages of a formal non-quantitative approach.

Even a one-week workshop on the K-T or CPS approach is only a starting point, so this lesson is not intended to teach you to be proficient in applying the K-T techniques. Instead, the purpose is to increase your awareness of your own decision-making process and to present ideas that you may be able to incorporate into your own process.

Lesson Objectives

At the end of this lesson you will be able to:

1. Identify the four basic processes of the Kepner-Tregoe approach.
2. Explain the stages used in the situation appraisal process.
3. Explain the main steps in problem analysis and apply the steps to a case study.
4. Explain the main steps in decision analysis.
5. Explain the main steps in developing an implementation plan using potential problem analysis.

Required Resources

None

TPM 08 TRADE-OFF ANALYSIS

Prerequisites

It is recommended that you complete TPM 01, Mathematics for Resource Estimation, and TPM 05/06, Quantitative Decision Making, before starting this lesson.

Lesson Introduction

It is appropriate to use a formal decision analysis method when: (1) a problem is complex, (2) a problem is important, and/or (3) you must document and communicate your rationale for a course of action to a final decision maker.

The formal methods for decision making and problem solving are either quantitative or non-quantitative. Trade-off analysis is a quantitative method, as is expected value analysis (discussed in TPM 05.) The Kepner-Tregoe method (discussed in TPM 07) is one of many non-quantitative methods.

This lesson presents an overview of a generic trade-off analysis method, which is a formal decision making method for evaluating a set of alternative concepts or designs. It is beyond the scope of this lesson to teach all the details and levels of complexity of the method.

Lesson Objectives

At the end of this lesson you will be able to:

1. Identify when to use the expected value vs. the trade-off analysis method.
2. Explain the six steps for conducting a trade-off analysis.
3. Perform Step 5, Evaluating Alternatives, of trade-off analysis.
4. Perform Step 6, Conducting Sensitivity Analysis, of trade-off analysis.

Required Resources

You will need a calculator for this lesson.

APPENDIX B

LESSON FEEDBACK AND DEMOGRAPHIC SURVEY ITEMS

DEFENSE SYSTEMS MANAGEMENT COLLEGE

Program Management Course, Part I (PMC (I))

FEEDBACK FORM PACKET

We are exploring the conversion of parts of the PMC(I) Course to a self-study option. We are evaluating the first lessons converted to this self-study format. We are interested not only in testing your knowledge of the subject matter, but also how well the materials teach. The feedback you provide on these lessons will help us improve the instruction for these and other lessons in the acquisition field.

1. Name or ID Number (ask your evaluation coordinator):

2. Job title:_____

3. Organization:_____

Work address:_____

4. Work phone:_____

5. Job supervisor name:_____

6. Are you a PMC student?___Yes___No

7. Have you been a PMC student in the past?___Yes___No

If YES, what class were you in?_____

8. Please complete the following background information.

Military or Civilian Grade_____

Military Organization_____

Specialty or Occupational Code_____

What formal training have you had in Systems Acquisition?

Total Military or Federal Service____years

Highest Academic Degree_____

Military Schools (C/S)_____(SSC)_____

Last or Current Job Assignment_____

Projected Next Assignment_____

Experience in Systems Acquisition____years

Experience in a Program Office____years

OVERALL LESSON FEEDBACK FORM

Lesson: **TPM 01** COMPUTER VERSION _____ (or) PRINT VERSION _____

How much time did it take to complete this lesson? _____ min.

Date _____

Please circle a number for each item that you feel best describes the lesson. Then write comments or suggestions for each item.

1. **Beneficial**

Waste of time

1-----2-----3-----4-----5-----6-----7-----8-----9-----10

Comments:

2. **Difficult to follow**

Easy to follow

1-----2-----3-----4-----5-----6-----7-----8-----9-----10

Comments:

3. **Motivating**

Just more work

1-----2-----3-----4-----5-----6-----7-----8-----9-----10

Comments:

4. **Feel I've mastered the content**

Not sure what it taught

1-----2-----3-----4-----5-----6-----7-----8-----9-----10

Comments:

5. **Do you still have any unanswered questions?** ____ Yes ____ No
If yes, what are they?

These items are to be completed AFTER you have completed all of the lessons assigned to you.

6. Which self-study lesson(s) did you take? Circle all that apply.

Print Version

TPM 01 02 03 04 05/06 07 08

Computer Version

TPM 01 02 03 04 05/06 07 08

Have you ever taken Mathematics for Resource Estimation (TPM 01) or studied the content? _____ Yes _____ No
If YES, please explain when and where.

Have you ever taken Economic Analysis (TPM 02) or studied the content? _____ Yes _____ No
If YES, please explain when and where.

Have you ever taken Work Planning and Definition (TPM 03) or studied the content? _____ Yes _____ No
If YES, please explain when and where.

Have you ever taken System Effectiveness (TPM 04) or studied the content? _____ Yes _____ No
If YES, please explain when and where.

Have you ever taken Quantitative Decision Making (TPM 05/06) or studied the content? _____ Yes _____ No
If YES, please explain when and where.

Have you ever taken Non-Quantitative Decision Making (TPM 07) or studied the content? _____ Yes _____ No
If YES, please explain when and where.

Have you ever taken Trade-Off Analysis (TPM 08) or studied the content? _____ Yes _____ No
If YES, please explain when and where.

OVERALL COMMENTS OR SUGGESTIONS ABOUT ANY ASPECT OF THE LESSON(S)
For example, what would you like to see changed in this lesson?
(Please continue on other side, if needed.)

APPENDIX C
INSTRUCTIONS TO EXPERIMENTAL SITE COORDINATORS

EVALUATION COORDINATOR INFORMATION

The goal of the evaluation is to obtain feedback from participants on questions such as:

- What resources are required to support the lesson materials?
- How long does it take each participant to accomplish each lesson?
- How well does each participant perform on the assessments?

A feedback form packet will be provided to each participant to gather: 1) information on some key background questions and 2) their comments on the lesson materials. The evaluation coordinator will complete a worksheet for each participant to help organize the administration and management of the lessons.

As a reminder, please do not alter any of the training materials. Present them to the participants just as they are given to you.

For the Spring, 1989 evaluation, it would be best to have at least 10 participants complete each print/hardcopy version of the lessons and 10 participants complete each computer lesson.

FACILITATOR HELP

Each participant must have someone who can serve as a facilitator to help with the lesson content, someone they can call with questions or clarifications. Facilitators should have completed the PMC or its equivalent or should have had at least five years of experience in acquisition management. It is assumed that, at some sites, the coordinator will meet these requirements and also serve as the facilitator. It is the coordinator's responsibility to make sure all the forms in this packet and in the student feedback packets are completed either by the coordinator or by the facilitator.

The facilitator would be the first person to whom the participant would direct questions. The students need to know how to contact the facilitator and exactly when the facilitator will be available for consultation. The facilitator also needs to keep track of the time that he/she spends helping the participants.

If more information is needed, the facilitator can direct (or have participants do so) questions to the Evaluation Coordinator. The Evaluation Coordinator can contact NPRDC for information: Barbara Tarker AV 553-7975, Mike Flaningam AV 553-7964, or Vel Hulton AV 553-7958.

TASKS FOR EVALUATION COORDINATORS

OBTAIN OR PREPARE SUFFICIENT MATERIALS

EACH participant will need:

- 1 Evaluation Coordinator Worksheet (participant information, to be filled out by the evaluation coordinator)
- 1 Participant Feedback Form packet per lesson (participant feedback from lessons, to be filled out by the participant)
- For TPM01 and TPM02, each participant will need a calculator with a y^x function key feature. TPM07 and TPM08 require a calculator.
- For TPM03, a copy of MIL-STD-881A should be available.

Each HARDCOPY/PRINT participant will need 1 Lesson Booklet per lesson.

Each COMPUTER participant will need:

- 1 Computer User's Guide per lesson,
- A computer loaded with the training materials, OR a set of floppy disks so they can load the materials before beginning,
- A schedule when this computer is available for his/her use,
- 1 Student Disk for EACH lesson to be done (have the participants label their disks with their ID numbers and the lesson numbers).

It would be helpful to label each set of lesson materials with an identification number unique to each participant (and let the participant know his/her identification number), so all materials can be easily identified.

Since the lessons need to be completed and delivered to the evaluation coordinator on schedule, some way of checking on participant progress might be necessary.

COLLECTION OF MATERIALS

After the participants have completed the lessons, the materials will be collected and mailed to the GTET office in San Diego. You may use the mailing labels supplied to you. Materials to return include:

- print/hardcopy lessons,
- all floppy disks,
- feedback form packets (please verify that all forms have been completed)
- tests and answer sheets
- evaluation coordinator worksheets
- and any other materials on which participants have written comments

Please mail completed materials as they are returned to you. We suggest that you send a packet of completed materials at the end of each week. **THE FINAL DEADLINE FOR ALL MATERIALS** to be returned to the evaluation coordinator is 01 AUGUST, 1989.

Some things to check for computer administration:

- Location of computer. (For example, are the computers available to the students during the hours when students can use them? Is the computer area quiet and free of distractions?)**
- Is the computer set up and loaded (by you or by one of the participants)?**
- Is the schedule for computer usage time posted?**

DISTRIBUTION LIST

Distribution:

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