Transitioning Learning Strategies Research Into Practice:

Focus on the Student in Technical Training

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Abstract. Applying learning strategies in the context of computer based military technical training requires the solution of a number of research problems. In an on-going, four-year effort to define student learning strategies/skill training needs, instructional procedures, and training products, four major research problems have been addressed. First, how does one go about identifying the types of learning strategies and skill maintenance strategies likely to have the most payoff? Second, what methodologies are appropriate for identifying segments of the student population most in need of specific types of skill training? Third, what are appropriate evaluation criteria and research designs to apply in a military CMI instructional environment where practical benefits are judged in terms of increased student efficiency? Finally, what assumptions can be made about the generalizability of research findings from a military learning strategies/skill training program which emphasizes general conative, affective, and cognitive skills related to effective and efficient learning? Approaches to these problems as derived from research conducted in the context of the Air Force Advanced Instructional System—a large-scale individualized and computer based technical training environment—are described.

The application of cognitive and affective learning strategies in the military has been an area of concern since the late 1970's (O'Neil & Spielberger, 1979). A large part of this concern is based on the fact that the termination of the draft in 1972 has presented the military services with a variety of unique problems. A prevalent and continuing problem, predicted by Vitola and Valentine (1971a, 1971b), is that manpower resources from the higher aptitude levels are more limited and the percentage of high school graduates lower than found during the draft. Not only is it recognized that many recruits possess inadequate basic reading skills (Duffy, 1977; Fletcher, 1977; HumRRO, 1977; Mockovak, 1974; Smith, Note 1; Stolte & Smith, Note 2), but there have been efforts to address other types of cognitive and affective skill deficiencies associated with motivational problems in military students of lower ability and educational level (Jealous, Bialek, Pitpit, & Gordon, 1975; Joyce, Note 3; McCombs & Dobrovolny, Note 4; McCombs, Dobrovolny, & Judd, 1979; O'Neil & Spielberger, 1979).

The problems with student skill deficiencies in the volunteer service in part reflect inadequacies that have been identified in our country's educational system. Our educational system has been criticized for contributing to an increase in the number of students who lack basic reading and mathematical skills and for failing to contribute to students' overall intellectual development and psychological maturity (Sprinthall, 1980). The nature of the skill-deficient recruit's problem is likely to be more comprehensive, then, than the lack of basic reading and cognitive skills. In fact, it has been suggested that in addition to skill deficiencies resulting from inadequacies in our educational system, the skill-deficient trainee may have additional motivational skill deficiencies resulting from a "Me Generation" values orientation (Sheehy, 1979).

Other evidence of the comprehensiveness of skill deficiencies for students of lower ability or lower educational levels is provided by Gade and Peterson (1977). They discuss the fact that students at lower levels of ability—along with possessing poor decision-making and analytic skills—also exhibit low levels of vocational maturity and often lack clear values and goals. In addition, one can speculate that given the age of the average military trainee (between 17 and 20 years), many trainees are experiencing the typical conflicts of their developmental stage (between adolescence and adulthood). These conflicts may lead to other kinds of affective skill deficiencies of an attitudinal or motivational nature.

In general, therefore, skill deficiencies in the military recruit population entering technical training may stem from educational, philosophical, and developmental sources. These deficiencies may encompass skills in both the cognitive and affective domains. Learning strategies research and application in the military student population must address both these skill areas—a position in keeping with that argued early by Piaget (1952) and more recently by Hurst (Note 5) and Zajonc (1980). These researchers have argued that affect and cognition are inseparable yet distinct. Neither process domain should be neglected in remedying the problems of the skill-deficient trainee. This is particularly true when considering that student cognitive and affective problems become even more severe when students are faced with adjusting to a wide variety of new circumstances and requirements.

The learning strategies project described here was undertaken to first identify specific cognitive and affective skill deficiencies—as well as problems in the areas of conation or the will to learn—that are related to ineffective and inefficient military trainee performance in a computer-managed instructional (CMI) technical training environment. Information on specific skill training needs was then used to develop specialized skill training packages that could remedy the particular cognitive, affective, and conative skill deficiencies identified. The following sections describe the context and products developed in an on-going four-year learning strategies research program and discuss four specific research problems that have been addressed in the course of this research program. In the four problem areas, solutions that were attempted are discussed, along with lessons that have been learned.

The Research Context

The context for the learning strategies research program was the Air Force Advanced Instructional System (AIS): a prototype, multimedia, computer based instructional system designed to improve the effectiveness and efficiency of Air Force technical training and to provide an operational research facility for assessing innovations in instructional technology. The system currently supports three technical training courses representative of many cognitive and performance skills required by enlisted Air Force personnel. Military trainees learn their respective course materials via self-paced, individualized, and computer-managed instruction. Within this system, students progress at a rate determined by their individual skills, abilities, and interests.

The new learning requirements of a CMI training environment, encountered by a growing number of military trainees, make the inadequacies of various cognitive and affective skills even more apparent (McCombs et al., 1979). In the CMI environment, students are expected to (a) be attentive and motivated; (b) make learning meaningful by the appropriate use of learning strategies and skills; (c) practice personal responsibility skills required for self-initiated, self-directed, and self-paced learning; (d) interact effectively with both their peers and their instructors; and (e) set appropriate course and life goals.

During the period of the development of the AIS (1973–1977), it became apparent that many students in this instructional environment experience problems exercising the preceding responsibilities. In the Fall of 1976, under the funding auspices of the Defense Advanced Research Projects Agency's (DARPA) Learning Strategies Program, efforts were begun to analyze student learning strategy/skill training needs in this context and to develop products to remedy these needs.

Learning Strategies/Skill Training Products

In the first phase of the program, the objectives were to (a) determine the characteristic problems which students encounter in a CMI environment; (b) identify those strategies which effectively help students cope with these problems; (c) develop and evaluate a small set of self-instructional modules for helping students acquire the skills necessary to adapt and perform in a CMI environment; and (d) investigate procedures for individualizing the assignment of these self-instructional materials so as to minimize training time and cost.

During the second phase of this learning strategies research program, the objectives were to (a) extend the findings of the first phase by identifying additional cognitive, affective, and conative skill deficiencies of students performing unsatisfactorily in technical training; (b) develop and evaluate a set of self-instructional skill training materials for helping students acquire specific skills identified in the cognitive, affective, and conative domains; and (c) develop and evaluate appropriate classes of adaptive decision models and rules for use in the individualized assignment and reassignment of the developed skill training materials.

This learning strategies research program has led to the development of three sets of skill training materials. Two sets of skill training materials were developed in the first phase of the project and a third set was developed in the second phase of the project.

"How does one go about identifying the types of learning strategies and skill maintenance strategies likely to have the most payoff?"

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(1) *Materials for helping students become aware of the requirements of a self-paced, individualized, and computer-managed instructional environment.* These materials include an Orientation to CMI Module and a Time Management Module (Dobrovolny, McCombs, & Judd, 1979; McCombs, et al., 1979). The Orientation Module compares and contrasts the characteristics of a typical CMI environment with those of a conventional lockstep environment and details the behaviors of successful versus unsuccessful CMI students. The module emphasizes that in a CMI environment the student is responsible for learning and that many times negative self-talk is the beginning of a negative attitude/negative performance cycle. The module introduces the concept of time management and its importance in terms of achieving one's goals.

The Time Management Module explains the philosophy, characteristics, and operation of a student progress management component of the AIS. This progress management component calculates individualized course completion predictions for each student based on a battery of individual difference measures, and provides daily student and instructor reports of student progress relative to predicted rates. The Time Management Module also describes basic time management concepts and provides students with an explanation of the Course Completion Map, a charting technique for promoting self-monitoring and self-management of learning progress in a CMI environment.

(2) *Materials for developing active learning strategies and effective study skills.* These materials include a Study Skills Questionnaire (SSQUES), four Study Skills Modules, and an Instructor Orientation and Training program (Dobrovolny, McCombs, & Judd, 1980; McCombs et al., 1979; McCombs & Dobrovolny, Note 4). The SSQUES is designed to evaluate student perceptions of their study skills in the areas of reading comprehension, memorization, test taking, and concentration management via a combination of comparative self-rating items and items which ask students to describe their study habits and skills. The purpose of this measure is to (a) predict student performance on AIS course materials and (b) identify those students in need of specific kinds of study skills remediation.

The four Study Skills Modules cover cognitive skill areas identified as troublesome for students in CMI: Reading Comprehension, Memorization, Test Taking, and Concentration Management. The materials in each of these areas are packaged individually so that a student can

receive any or all of the modules as deemed necessary by an instructor or the AIS computer's adaptive assignment capability. The philosophy generally emphasized in the Study Skills Modules is that learning and remembering new information becomes easier if the student changes it in such a way as to make it meaningful to him or her. The Reading Comprehension Module recommends that students ask questions about the main ideas in new technical information, that they draw pictures detailing the relationships between new ideas, or that they use a systematic problem solving procedure to resolve difficult or confusing passages. The Memorization Module describes and exemplifies various elaboration and grouping strategies for remembering information and the Test Taking Module discusses the use of logical reasoning strategies and gives students numerous practice exercises in these techniques. The Concentration Management Module discusses the importance of creating a good mood for efficient and effective study, describes the ways in which negative self-talk can produce feelings of boredom or anxiety while studying, and presents techniques students can use for combating negative self-talk with positive self-talk and for becoming relaxed yet alert while studying.

The purpose of the Instructor Orientation and Training program is to (a) familiarize instructors with the strategies, techniques, and objectives of the study skills materials; (b) provide instructors with an opportunity to practice these techniques; and (c) help instructors implement appropriate counseling and tutorial skills for enhancing individualized assignment and long term student use of strategies and techniques presented in the Study Skills Modules. Three two-hour small group sessions were designed to meet these training goals and to facilitate instructor interaction and discussion of any problems experienced in implementing the Study Skills Modules.

(3) *Materials for developing motivation, personal responsibility, and effective life coping skills through positive self-control strategies.* These materials are designed to address general student skill deficiencies in the conative, affective, and cognitive domains for those students performing unsatisfactorily in technical training (McCombs & Dobrovolny, Note 4). Seven individually packaged, self-instructional modules and an instructor orientation and training package have been developed in this area, under the general heading of "Motivational Strategies for Positive Self-Control and Development." The *Introduction Module* introduces students to the concept of personal responsibility and positive self-control, presents rudimentary techniques for controlling negative attitudes, and describes the purpose of the skill training package. The *Values Clarification Module* explains the role of values and beliefs in our lives and helps students explore their values and beliefs in a number of areas. The *Career Development Module* helps students explore their career interests and make some career goals and plans. The *Goal-Setting Module* presents the purpose of goals as directing human behavior, describes a general model for systematically thinking about and setting personal goals, and helps students work through exercises for setting specific long term and short term goals. The *Effective Communication Module* describes techniques and strategies for effectively communicating feelings, wants, and needs and for dealing with stressful interpersonal situations. The *Stress Management Module* describes the role of perceptions, negative self-talk, and mistaken beliefs in producing stress and presents a number of strategies for reducing stress. Finally, the *Problem Solving Module* provides a summary of the skill training package, as well as a general approach for systematically working through and solving personal and technical training problems.

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Learning Strategies/Skill Training Material Format

All student skill training materials developed in the learning strategies program are in a printed, self-instructional format. The materials are formatted in an easy to read, low density style which includes the use of visuals, where appropriate, as well as periodic embedded questions and practice exercises. Time to complete each module ranges from about 30 minutes to about four hours.

Following the initial self-instructional skill training, students are encouraged to use three basic types of skill maintenance strategies and techniques. First, students are instructed on the use of specific self-monitoring, self-charting, or self-recording techniques. Second, students are taught the importance of rewarding themselves for reaching goals or making desired changes in performance or behavior, and are instructed in the use of various self-reward strategies—from using positive self-talk or self-praise to purchasing desired products or engaging in desired activities. Third, students are encouraged to use their instructor as a learning strategies expert and as someone who can assist them in acquiring and maintaining particular skills. In turn, instructors are trained to perform the role of learning strategies expert.

The choice of the format and instructional approach to use in the student skill training products was determined both by an extensive review of relevant literature and by the empirical process of seeing what worked best in particular skill areas. The documented literature review can be found in McCombs and Dobrovolny (Note 4). A discussion of research issues and problems that led to the selection of particular methodologies and approaches in this learning strategies research program is presented in the following sections and in the article by Dobrovolny in this issue.

Research Problems, Issues, and Approaches

Four specific research problems that have been addressed in the course of this learning strategies program will be discussed along with various approaches that were taken to these problems and lessons that were learned.

Research Problem 1: *How does one go about identifying the types of learning strategies and skill maintenance strategies likely to have the most payoff in military technical training?*

The approach taken in this program was

to first analyze where learning strategies problems are being reflected in technical training. This analysis led to the selection of four criterion measures which were open to further analysis in determining the types of learning strategies likely to have the most payoff in this military training environment. The criterion measures were (a) attrition rates (percentage of students dropped from a particular technical training course); (b) times-to-complete (the training times for various units of instruction, such as a block or a course); (c) criterion test scores (scores obtained on tests administered at the end of various units of instruction, such as lessons and blocks); and (d) test failure rates (percentage of students failing a given test).

The second step used in identifying the types of learning strategies likely to have payoff in this environment was to analyze relevant sources of information to generally determine the types of skill deficiencies likely to lead to learning problems. These relevant sources of information included the educational and psychological literature, individual difference and performance data available from the AIS computer, personal observations and experience with students in this military CMI environment, and discussions with instructors and students in the AIS courses. Integrating information from these sources, we determined that theoretical frameworks from developmental psychology could be particularly helpful in forming an overall picture of student learning strategies and skill training needs, as well as helping to isolate potential skill training area needs within the cognitive, affective, and conative domains. At this early stage of the program it became apparent that some percentage of the students had maturity-related problems, values and needs conflicts, an absence of self-directed learning skills, inadequate problem solving abilities, deficiencies in positive self-control skills for dealing with such problems as anxiety or stress, and problems related to inabilities to engage in self-motivation strategies.

Following the analysis of relevant information and the formation of a preliminary list of potentially beneficial skill training/learning strategies areas, the percentage of students having problems in each area was determined. This was done in order to determine if the sample size was adequate for statistical methodologies that could describe the specific learning needs of students with learning problems, as well as identify specific students who would benefit from skill training. At this stage—using information from attrition rates, training times, test scores, and test failure rates—we determined that at least one-fourth of the students in the AIS technical training courses were performing unsatisfactorily. That is, this percentage included those students who either were dropped from the course (2% to 15%), students who took longer than the established course time (10% to 20%), and students with low test scores or who took consistently more than one attempt to reach criterion (10% to 20%). Because these student groups were overlapping, but could generally be defined by looking at the lowest quartile on performance measures, it was decided to describe the characteristics of students in this bottom quartile by statistical analyses which discriminate these unsatisfactorily performing students from the remaining 75% of the students in the course. From these analyses, we learned that, in comparison to satisfactorily performing students, students performing unsatisfactorily:

(a) had low general interest, as measured by the Ontario Test of Intrinsic Motivation (Day, Note 6) and low motivation to learn the course materials, as measured by the State Epistemic Curiosity Scale (McCombs-Leherissey, Note 7);

(b) experienced high levels of test-taking anxiety, as measured by the Test Anxiety Inventory (Spielberger, Gonzalez, Taylor, Anton, Algaze, Ross, & Westberry, 1980) and high levels of anxiety about learning the course materials, as measured by the state anxiety subscale of the State-Trait Anxiety Inventory (Spielberger, Gorsuch, & Lushene, 1970);

(c) had poor logical reasoning skills, as measured by the Logical Reasoning Test (Hertzka & Guilford, 1955), low reading comprehension ability, as measured by the Reading Skills Scale (McCombs, Note 8), and poor study skills, as measured by the Study Skills Questionnaire (McCombs & Dobrovolny, Note 9); and

(d) were generally younger students with less educational experience, as indicated in biographical data collected by the AIS.

These findings confirmed information we had obtained from the literature, our observations and experience with AIS students, and discussions with AIS students and instructors regarding student learning strategies/skill training needs. But we needed to know more in order to define specific skill training packages and student populations in need of those packages. That led us to seek answers to the next question.

> "The Introductory Module introduces students to the concept of personal responsibility and positive self-control, presents rudimentary techniques for controlling negative attitudes, and describes the purpose of the skill training package."

Research Problem 2: *What methodologies are appropriate for identifying segments of the student population most in need of specific types of skill training?*

Some potentially effective methodologies for identifying the types of students most in need of skill training in the cognitive, affective, and conative areas identified had been disclosed in answering the first question—by the analysis of relevant literature, discussions with students and instructors, and analysis of available empirical data. These approaches were also judged as appropriate for further defining the student in need of skill training. In the first phase of this learning strategies program, discussions with students and instructors formed the primary method by which skill training needs in the area of an orientation to CMI, time management skills, and study skills training needs were identified. The training packages developed in these areas filled a pressing need, but did not solve all the learning problems of that one quarter of the trainee population that was still performing unsatisfactorily. Further definition of this population was undertaken by conducting student and instructor interviews—interviews which yielded further information that could be used in designing a set of individual difference measures.

Interviews with students and instructors were conducted in three AIS courses. The major purpose of the interviews was to ascertain instructors' perceptions of the characteristics which distinguish students

performing well versus poorly in their courses and to solicit suggestions on the types of skill training they felt would be most beneficial. The major purpose of the student interviews was to (a) obtain additional information—from students classified into "good," "average," or "poor" performance categories on the basis of instructor and supervisor recommendations—on students' perceptions of their problems with the course and their strategies for coping with these problems; and (b) determine whether this information differed for good versus poor students. Both instructor and student interviews indicated that the kinds of students having the most difficulty successfully completing their course were those who exhibited the following characteristics (which distinguished them from students who had less difficulty):

"Students performing unsatisfactorily had low general interest,...experienced high levels of test-taking anxiety,...had poor logical reasoning skills,...and were generally younger."

(a) In the conative domain, the poorer students consistently were those with low motivation to learn, with few military or personal goals, and who could be classified as being low in maturity, with little self-discipline or the ability to take responsibility for their own learning.

(b) In the affective domain, the poorer students were generally those with high levels of anxiety toward learning and toward taking tests, and who lacked effective skills for coping with the demands of technical training.

(c) In the cognitive domain, the poorer students were generally those with poor reasoning and comprehension skills, and/or those who lacked decision-making or problem solving skills in technical or personal areas.

Based on this information and the information from the data analyses, a set of individual difference measures was selected from available measures or designed by us in the case where existing measures that tapped particular student variables of interest could not be located. In general, this battery of measures assesses students' (a) personal values and goals; (b) emotional or psychological and vocational maturity; (c) self-concept or self-esteem; (d) expectations about the demands of the military, technical training, or being able to take responsibility for their own learning; (e) perceptions of their ability to deal with various sources of stress; (f) ability to make responsible decisions; (g) achievement motivation or fear of failure; (h) success/failure attributions; (i) learning-related self-verbalizations; and (j) problem solving or critical thinking skills.

The battery of items in these areas was subjected to a validation process for the purpose of identifying the smallest set of items which (a) could reliably discriminate satisfactory and unsatisfactory performance groups in two AIS courses; and (b) could define particular skill training strategies or treatments for those students performing unsatisfactorily. In general, the evaluation of the original set of 140 items produced a reduced subset (30 factors) that are reliable (internally consistent) and predictive measures of the kinds of students performing satisfactorily versus unsatisfactorily in a CMI military technical training environment. The battery also formed theoretically and conceptually meaningful constructs suggestive of skill training deficiencies and needs—a set of variables that might have both predictive and diagnostic utility in terms of identifying students in need of particular kinds of skill training in the conative, affective, and cognitive skills domains.

The question of whether this approach and methodologies involved are appropriate for identifying segments of the student population most in need of specific types of skill training still remains to be demonstrated. Reduction of DARPA's funding in the learning strategies area has forced us to delay answering this question until other funding sources can be obtained for investigating individualization parameters in this motivational precourse skill training area. In the meantime, there are other research issues and problems in the area of the training materials themselves—one of the most important of which is addressed by the following question.

Research Problem 3: *What are appropriate evaluation criteria and research designs to apply in this military CMI instructional context where practical benefits are judged in terms of increased student efficiency?*

There are four major types of evaluation criteria that can potentially be used to assess the benefits of learning strategies/skill training materials in this context. First, one can measure any changes or improvements in the skills that the training addresses. Second, one can observe changes in behaviors that are associated with the skills the training addresses. Third, changes in attitudes or interests in learning as a result of the skill training can be assessed. Finally, changes in learning performance in courses which require these skills can be measured.

Directly measuring changes in the skills addressed in a particular learning strategies/skill training package—whether these be cognitive, affective, or conative skills—is a difficult task at best. This task becomes even more complex when the skills addressed are of the general and global nature of those in this learning strategies program. Although it is certainly possible, and perhaps desirable, to analyze and define the underlying processes and skills necessary in areas such as time management, study skills, career development, values clarification, goal setting, effective communication, stress management, or problem solving—this was clearly an effort that has not been adequately completed to-date and one that was beyond the scope of our contracted research program. It could also be argued that given the research goal of producing skill training materials that result in improvements in student learning efficiency in the operational training environment, changes or improvements in particular skills are not the appropriate evaluation criteria. We thus considered other kinds of measures by which we could evaluate the cost-effectiveness or practical benefits of a skill training program that was aimed at remedying general kinds of skill deficiencies present in student populations performing unsatisfactorily in military technical training.

Observing changes in the behaviors associated with the skills addressed by a particular training package is also difficult and beset with numerous methodological problems. First, observing behavior relies on subjectively gathered information which can only be recorded in a semi-objective format. Second, it requires a careful and time-consuming analysis of the behaviors one would expect to be demonstrated as a result of the acquisition of particular skills. Third, it requires the use of a number of

trained observers who can devote substantial amounts of their time observing student behaviors in the classroom. These considerations made the value and feasibility of using observations of changes in behaviors questionable, and it was decided not to use this type of evaluation criteria in assessing the practical benefits of the developed skill training materials. It was also decided, however, that other types of subjective and anecdotal information from instructor observations of student behavior following skill training provided a valuable source of information that could supplement other sources chosen to address the practical benefits of the skill training.

Assessing changes in student attitudes or interests in learning or performing well in technical training can be accomplished by objectively scored paper and pencil measures. This information can also be obtained from instructor observations or discussions with students. In analyzing the relationships of this attitudinal information to the type of skill training packages developed in this learning strategies program, it can be argued that they provide an important source of information about predicted affective outcomes. For example, goals theoretically motivate performance, and effective management of stress theoretically eliminates or reduces negative effects of anxiety on performance. For this reason and because improved attitudes toward performing well in technical training is a variable of potential interest for demonstrating practical benefits in a military technical training environment—this evaluation criterion variable was deemed appropriate and feasible. General classes of attitudinal variables considered important include student attitudes toward the learning situation, toward performing well, and toward themselves as responsible and able to achieve in a self-directed learning environment.

Measuring changes in student performance (times-to-complete, test scores, failure rates, attrition rates) as a result of the skill training appeared to be the most easily obtained and potentially appropriate measure of practical benefits. This measure is not without its problems, however, one of which is the nature and strength of the relationship between the acquisition of particular skills, such as goal setting skills or stress management skills, and performance as measured by times-to-completion or criterion test scores. In addition, there is the problem of controlling for other sources or factors that might be responsible for positive changes in performance—sources or factors that must be controlled in order to reach any valid conclusions about the practical benefits of this type of skill training.

Along with the concern over appropriate evaluation criteria comes the concern for appropriate research designs that can be applied to an operational military training context. In this regard, two critical issues are the (a) feasibility of research design implementation and (b) user acceptance of any conditions imposed on the instructional environment by the research design. In the course of our four-year learning strategies program, these two issues were taken into consideration in determining appropriate research designs, and three designs have been identified as having varying degrees of appropriateness.

The first and most desirable design from the standpoint of statistical control is a Simultaneous Matched Control Group design. In this research design, experimental and control groups—composed of students identified as likely to benefit from the skill training and randomly assigned to these two groups—are exposed or not exposed to the skill training materials, respectively. For this design to work most effectively, however, it is necessary to have large numbers of students who can be classified as skill deficient within the same course—making the use of this design feasible only in courses with a large student flow. In addition, it is desirable that experimental and control group students are not exposed to the same instructors, in that instructors associated with experimental students have been given specialized training as learning strategies experts. Meeting these two requirements is often difficult, if not impossible, in the operational military technical training environment.

A second possible design which avoids some of the problems associated with the first design is a Sequential Matched Control Group design. In this research design, experimental group students are compared with a matched group of students who progress through the course during an earlier or later time period. This procedure avoids the need for large numbers of students classified as skill deficient and the problem of exposing experimental and control students to different instructors. It necessitates, however, the use of sophisticated and sometimes questionable procedures for statistically controlling for differences between the groups that are not due to the treatment—such as differences in ability or educational level. In addition, it requires controlling for other time-related changes such as changes in course materials and procedures.

The third possible design which avoids problems in both the first and second design, but which has other problems of its own, is the Within-Student Control design. In this research design, each experimental student serves as his or her own control, and treatment effectiveness is measured by changes in the student's performances before and after skill training, relative to average changes in performance for other students in the course for the same units of instruction. The major problem with this design is that it necessitates waiting to administer the skill training treatment until a sufficient baseline performance level has been obtained—restricting the amount of time that performance changes can be observed, and potentially attenuating results.

> "We thus considered other kinds of measures by which we could evaluate the cost-effectiveness or practical benefits of a skill training program that was aimed at remedying general kinds of skill deficiencies present in student populations performing unsatisfactorily in military technical training."

To date, we have not been successful in resolving the problems associated with selecting appropriate evaluation criteria and research designs. The fact that this is true in this context and other applied research contexts points to a need for reconceptualizing what is appropriate given the goals of learning strategies or skill training research in an applied setting. These problems notwithstanding, it has to-date been possible with the use of each of the foregoing evaluation criteria and research designs in the context of the AIS learning strategies research program to demonstrate performance gains in the areas of training time, test scores, and student and instructor attitudes following skill

training in time management techniques and study skills strategies for becoming actively involved in the material to be learned (McCombs et al., 1979). That brings us to our next research problem.

Research Problem 4: *What assumptions can be made about the generalizability of research findings from a military learning strategies/skill training program which emphasizes general conative, affective, and cognitive skills related to effective and efficient learning?*

In addressing this question, additional assumptions need to be made about the "real" effectiveness of the materials which have been at least partially evaluated in this program (the Time Management Module, the Study Skills Package) and the "expected" effectiveness of materials that are currently undergoing an evaluation (the pre-course motivational package which includes the Introduction through Problem Solving Modules). That is, assuming that these materials do in fact lead to demonstrable and consistent improvements in student performance or attitudes, one can then go on to speculate about the potential generalizability of these materials to other student populations.

A factor which suggests that the materials will generalize to non-military students at similar ages and stages of development is the treatment of relatively well-established student needs that have been addressed in these skill training materials. Given that these developmental needs are not unique to students in military technical training, it would be expected that similar age students in civilian educational settings could also benefit from this type of skill training—particularly if the educational setting is one that emphasizes self-directed learning skills.

An additional consideration in addressing the generalizability issue is that the training materials developed in this program—although designed to be used in an individualized, self-paced, and computer-managed environment—are based on theoretical assumptions regarding the active role the student plays in the learning process. To the extent that the student is an active learner in every instructional context, the skills and strategies presented and taught in these self-instructional modules would be expected to be of some benefit.

Arriving at the answer as to whether the products produced in this research effort will generalize in terms of their effectiveness to other student populations and instructional contexts requires an empirical test. In addition to tailoring the examples and perhaps the format of these skill training materials to other student populations—tailoring of the goals and objectives and the benefits expected from this type of skill training have yet to be accomplished. The question is not one of whether there is a need for and a benefit from this type of learning strategies/skill training research in applied settings. The question is how are we going to measure it and under what conditions.

> "To date, we have not been successful in resolving the problems associated with selecting appropriate evaluation criteria and research designs."

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