DEVELOPMENT OF MULTIVARIATE ANALYSIS
TO IMPROVE THE EFFICIENCY OF
AN IPI LEARNING SYSTEM

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PREFACE

This study was concerned with developing multivariate analysis methodology for the express purpose of improving the efficiency of individually paced instructional systems. Step-wise multiple regression was used to predict both procrastination and individual rate of learning. Canonical analysis was used to identify the relative degree of relationship between each instructional unit and the total efficiency of the course. Canonical analysis was also used to determine the degree of relationship between two separate courses and to identify which instructional units were most responsible for the relationship.

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The persual of this degree and the completion of this study has been a family project. I wish to express my gratitude to my wife, Pam, for her typing ability, and I wish to express my love for her as a friend, woman, and fellow scholar.

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CHAPTER I

INTRODUCTION

Introduction to the Problem

Across the nation there appears to be a growing concern for finding effective means to manage instruction. This concern is probably the result of the resources for education becoming more contingent on accountability (Green, E., 1971; Smith, V., 1972). One way that the concern for effective management of instruction is manifesting itself is by the growing number of educational innovations that emphasize an accountable output that are springing up across the nation.

The effectiveness of an educational innovation is usually determined by comparing a new innovative system of instruction with a system or program that is currently in use. This type of instructional system evaluation may be misleading as the new, innovative program may be unstable in terms of its efficiency. Rarely, if ever, are new instructional systems in their first semester or first year operating at the peak of their efficiency or effectiveness when they are compared to a system currently in use. In fact, computer simulations show that some of the most important effects of educational projects will not manifest themselves for as many as ten years (Pfeiffer, 1968). Nevertheless, most of the educational researcher's time and energy spent in the quest for more effective management of instruction is, in fact, allocated to "old system-new system" comparisons. As a result of this focus of research time and energy, a great deal of research methodology concerning ways and means of comparing instructional systems has been developed. Even with this new and sophisticated methodology, there are still some difficult problems that researchers encounter when comparing large scale instructional systems. The parameters of large scale instructional systems are so ambiguous that one rarely knows if he is comparing instructional systems that are different in name only (Brownell, 1966; Williams, 1965). These hazy parameters usually manifest themselves in a long list of no significant differences which are reported with monotonous regularity (Siegel, 1967). What is lacking now and badly needed is research concerned with ways and means of increasing the efficiency of an existing instructional system, new or old (Kraft and Lotta, 1969).

The Problem and Purpose

The present study is concerned with the above stated need for research which is involved in the efficiency of instructional systems. The purpose of this investigation is to develop, describe, and suggest uses for multivariate analysis techniques that will lead to the discovery and articulation of "key" learner variables and "key" instructional variables. Although attempts at manipulation of these "key" variables are beyond the scope of the present investigation, it is expected that the managers of instructional systems will eventually use the techniques developed in the present study as tools to increase the efficiency of their systems. Specifically, the type of instructional system that this study deals with is an Individually Prescribed Instruction (IPI)-mastery learning mode that features an integrated curriculum. Developed in this proposal is the concept that the key to effective means of increasing the IPI-mastery learning system's efficiency is to be found in the student's behavior within this system.

Theoretical Approach

The "calculus of practice" and "mathemagenic activities" are two concepts that will be used in an attempt to logically catagorize two separate scientific approaches to the management of instruction (Rothkopf, 1968).

The calculus of practice denotes the process of changing or manipulating an instructional system or methodology and is usually ambitious and comprehensive in scope; also, it tends toward an instructional design that determines the exact occurrence of each of many discrete instructional events or episodes. The calculus of practice works on the assumption that one instructional system is superior to another in terms of either economics or student performance or both.

The second concept used is mathemagenic behaviors. Here the emphasis is more on what the student does within a system of instruction and less on the system itself. These include such activities as reading, asking questions, inspecting an object, mentally reviewing a lecture, and engaging in a programmed learning activity. These also include looking out of the classroom window, yawning, day-dreaming in class, and reading a book without comprehension. These examples point out that some mathemagenic behaviors are a hindrance rather than a help to the efficiency of a given calculus of practice. This allows one to classify these behaviors into two broad functions: 1. habilitating (helping) 2. dishabilitating (hindering). Which of the functions a given mathemagenic behavior or set of behaviors is performing is inferred by such measures as achievement, rate of learning, number of attempts to reach a criterion, and persistence.

In the management of mathemagenic behavior, the calculus of practice is accepted as a given; therefore, the educator concentrates on maintaining the habilitating mathemagenic behaviors within the instructional system. He does this largely by managing contingencies, in a statistical sense, between large collections of instructional events and student actions, and also by controlling the consequences of students' activities. This approach calls for the discovery of factors that will shape habilitating mathemagenic behaviors. Ultimately, it calls for control of these factors.

As was mentioned in the "Problem and Purpose" section, the present study is concerned specifically with an IPI-mastery learning system that features an integrated curriculum. Mastery learning works under the assumption that the degree of learning is a function of the time actually spent on a given subject divided by the time that is needed by the learner to master a subject (Bloom, 1968). This, in essence, means that anyone, with the exceptions of such cases as a learner with organic brain damage, can master any subject if he is given enough time and is so disposed to do so. In practice this amounts to setting objective criteria for mastery performance of a given subject area and then giving each student as much time as he needs to perform to the mastery level. Giving the student time he needs to attain mastery level implies that each student has his own optimal learning rate. This means that a mastery learning system must be self-pacing.

Individually Prescribed Instruction implies that a student takes a pretest on the objectives in a learning sequence; then he enters that sequence at a point that matches his competencies. Another possibility is that there may be several alternate paths through a learning sequence, and the student is prescribed a path based on his abilities and aptitudes.

The first stage of an IPI-mastery learning system's development is concerned with establishing terminal behavioral objectives for each of the courses. This is a very critical point in the development of a calculus of practice that uses a systems approach, for these terminal objectives articulate the purpose of the system and form the key criterion by which the effectiveness is evaluated (Banathy, 1968). Then a task analysis is performed in order to evolve enabling objectives and the sequence (Hierarchy) of these objectives (Gagne, 1970). The purpose of the hierarchy is to arrange student's learning in a logical order which insures that he has all the prerequisite skills necessary to accomplish each new objective or task that he encounters. Next, an attempt to integrate the curriculum is made. This is accomplished by a task analysis of the entire curriculum with the objective being to find prerequisite skills across disciplines. The result is that an attempt is made to collapse all the disciplines into a logical learning order. An example of this integration might be one where a student needs some elementary algebra skills to balance chemical equations. So when this student needs to balance equations, he will have had the algebra necessary from a mathematics course to do so.

Then each student is tested to insure that he has the necessary prerequisite skills to accomplish the first objective in each of the IPI-mastery learning system's courses. If he does not, he is given remedial learning activities, or in some extreme cases, he is sent to a remedial class.

Once the student enters the hierarchy (sequence of objectives), he moves at his own pace toward performance indicative of mastery of the subject. Grades are determined by criterion-referenced grading (progression to a certain point in the hierarchy) rather than by norm-referenced grading (scores on a summative examination). The student is allowed the time he needs to reach whatever grade he desires.

The integrated IPI-mastery learning system (calculus of practice) just described does not operate at 100% efficiency the first semester of its existence; in fact, it will not even approach its peak of efficiency at this time. This is because some students fail to maintain habilitating mathemagenic behaviors, and self-pacing turns into procrastination. Also, some students lack the persistence to attain mastery level and drop out. The system must revise materials and mathemagenic management practices each year in order to move toward the 100% efficiency mark. If the instructional system is to move toward the ideal, every student's rate of learning must be maximized according to his ability; each student will pass each assessment for each objective the first try, and every student must attain mastery level.

This emphasis on rate, error, and mastery means the efficiency of a calculus of practice of the nature of the IPI-mastery learning system can best be judged by the mathemagenic behaviors rate of learning (Ackoff, 1968; Hampton, 1967), number of errors per instructional unit (Markle, 1969), and persistence. The efficiency of the system can be increased by management of these behaviors, but, first, factors related to them must be discovered before the management is possible. A research methodology is needed to discover these factors. The position of the present study is that multivariate analyses of these mathemagenic behaviors should be the first step toward discovery of factors that will lead to their management.

A slightly different methodological position (different from conventional educational research) is implied by not studying the traditional educational dependent variable "end-of-the-course-summative-achievement" and/or grade point average. There are two basic reasons for this position: one is philosophical, and one is statistical. The philosophy of mastery learning denies that the number of right answers in a limited amount of time is all important. What is more important is that every student can score the same on a summative type examination if he is given enough time. The same is true with the grades such as A, B, C, or D. The goal of mastery learning is that everyone makes an A. Grades no longer discriminate mathemagenic behavior; hence, the effectiveness of the mastery learning system must eventually stand on how long it takes a student to master a subject. The position as stated to the student is "Learn for mastery, not grades." It would be inconsistent with this philosophical stance to make grades an important research criterion. The multivariate statistics to be used are correlational in nature. If a potential vast array of scores are collapsed into just a few tied scores (as would be the case with a summative achievement or grades in mastery learning), the statistical phenomenon known as truncation of range occurs. Truncation has the effect of decreasing the size of the correlation coefficients of the dependent variable with any independent variables (Guilford, 1965).

As was mentioned above, the basic reason for this study is that a research problem has arisen because of the need for objective, accurate means of analyzing student mathemagenic behaviors, and the relationships of these behaviors to the IPI-mastery learning calculus. The postulation is that discovery and study of these relationships will lead to increased efficiency of the learning system.

Definition of Terms

Calculus of practice is the process of changing or manipulating an instructional system. There are two forms of the calculus of practice. In the first form, an effort is made to produce economical learning sequences by manipulating the amount of time spent at various practice tasks and the sequence of these practice maneuvers. In the second form, progression through the learning sequence is made contingent on the achievement of certain performance levels.

This second approach aims toward deciding on what performance criteria must be reached and with what learning sequence these criteria should be accomplished.

Mathemagenic behaviors are student activities or behaviors within a given instructional system. These behaviors are of two forms. In the first form the behaviors contribute to the efficiency of the learning system. These behaviors are called habilitating. In the second form the behaviors are detrimental to the efficiency of the learning system. These behaviors are called dishabilitating.

Instructional units are points along an IPI learning hierarchy which insure that the students are progressing through the hierarchy satisfactorily. They are usually identified by an instructor-administered assessment task which the student completes as he finishes the unit.

Rate of learning is the number of days it takes a student to complete an instructional unit.

Number of errors is the total number of attempts to attain the mastery level criterion of each instructional unit.

Individually Prescribed Instruction (_IPI_) is a procedure that denotes matching a student's competencies with an appropriate position in a learning sequence.

Mastery learning is an instructional philosophy that implies giving a student the time he needs to master a given subject.

Instructional system is a deliberately designed synthetic organism, comprised of interrelated and interacting components which are employed to function in an integrated fashion to attain predetermined educational objectives.

Limitations of the Study

1. Results should not be generalized to instructional systems different from the IPI-mastery learning model described in this study.

2. The results will be correlational in nature; therefore, cause and effect cannot be determined.

Assumptions of the Study

1. The methodology of the study can be generalized to other situations that employ IPI-mastery learning systems.

Research Questions

The first two research questions are generated by the problems of procrastination and persistence in self-pacing systems such as IPI. Whereas previous research indicates that a large percentage of students reach mastery level in a reasonable amount of time (Green, B., 1971), there are those students who procrastinate, fall behind, and eventually drop out (Born and Herbert, 1971). Procrastination is a very serious problem in self-pacing programs. The seriousness of this problem was discussed at length in an address given at a workshop on self-pacing methods

(Leidecker, 1972). Practically the entire content of this speech was devoted to the problem of procrastination.

The first question centers around identifying when a student is proceeding satisfactorialy or when he is procrastinating. The difference between self-pacing at an optimum rate and procrastinating is difficult to discriminate between as students do learn at different rates. If a rate of learning could be predicted for each student, and if a student fell behind his predicted rate, the instructor could contact him for special help. An individually predicted rate would be a superior index as compared to a group average: with only an average rate some students would be misidentified as procrastinators. To call these students in for unneeded help puts an unnecessary burden on instructors; also, students would be misidentified as proceeding satisfactorily when they are actually falling behind. These students need to be identified and helped.

The second research question centers around the students who shall be called the "no-start-procrastinator" (NSP). The NSP is the student who cannot seem to get started working on the instructional objectives. By the third or fourth week the NSP's are far behind the rest of the students, and usually they do not come in until notified by their dean or advisor. Possibly, these students are capable of doing the material, and they, for the most part, have been "lazy" and unable to pace themselves. It is obvious that the procrastinating student needs special treatment. This is a condition where Individually Prescribed Instruction can demonstrate a special feature, for IPI has capability to meet individual student needs (Scanlon, 1970). For example, the NSPs perhaps need someone to "structure" them more. Such an instance of control of mathemagenic behaviors is demonstrated in a study by Whitehill (1972). This study indicates that a "study skills development" program that employs operant methods can be successful in development of effective study skills. Individually Prescribed Instruction has the capability to do just that if that is what is needed to prevent a NSP from falling behind his own capabilities, becoming discouraged, and dropping out. What is needed is a means to identify a potential NSP early in the semester so that preventive measures can be taken.

The third research question arises because of need to evaluate each instructional unit in terms of the overall efficiency of the system. Identification of the units that are and are not contributing to the overall efficiency will be very helpful for any revision of instructional materials.

The fourth and last research question centers around the integrated hierarchy of the IPI-mastery learning system. As was stated, an attempt was made to design the sequences so that there are linkages across disciplines and those linkages are so sequenced that the student always has the prerequisite skill he needs. That is the attempt, but are linkages where they are thought to be, if they exist at all?

CHAPTER II

A REVIEW OF RELATED LITERATURE

Introduction

The review of the related literature in Chapter II is for the express purpose of developing and justifying four research hypotheses which have been formed from each of the research questions developed in Chapter I. As was mentioned on page two of the present document, there is a lack of and a need for research in the area of analyses of efficiency factors in learning systems. The same phenomenon that created the need for the present study manifests itself two ways in Chapter II. First, since there has been little research, there is little related literature; therefore, Chapter II is relatively short. Secondly, because new multivariate statistical techniques are being tried, there is need to justify why certain statistical procedures have been chosen; therefore, the reader will encounter some material he might expect to see in Chapter III, "Design and Methodology."

Research Question Number One

Research question number one centers around predicting rate of learning. Students do learn at different rates and this rate is related to factors such as aptitude (Block, 1971; Carroll and Spearitt, 1967; Sjogren, 1971) and perhaps performance (rate) on prior units; therefore, an attempt will be made to use aptitudes, prior performance, and some selected "personality" variables to predict rate of learning. The aptitude measures that will be used for analyses are the Act scales, the Nelson-Denny Reading Test scales, and Cooperative Algebra Test and Cooperative Trigonometry Test scores. The ACT is a measure of general aptitude in that it stresses primarily problem solving exercises and proportionately few measures of narrow skills (ACT Technical Report, 1965, pp. 4-5); therefore, it is expected that the ACT scales and Composite ACT scores will display at least a moderate correlation with rate of learning. The English ACT scale should serve as a specific measure of aptitude for an English course. Previously, research has shown reading skills to be correlated with rate of learning in self-pacing programs (Noble, 1968). In light of Noble's findings, it is expected that reading skills scores as measured by the Nelson-Denny Reading Test will be related to rate of learning. The Cooperative Algebra Test is a measure of specific mathematical aptitudes, particularly the ability to apply mathematical ideas to new situations (Buros, 1965). The Cooperative Trigonometry Test is designed as a sample of performance related to skills in trigonometry (Buros, 1972). Both the Cooperative Algebra

Test and the Cooperative Trigonometry Test should serve as specific measures of mathematical aptitude and should correlate highly with rate of learning in mathematics courses. Prior performance measures to be used are high school class percentile rank (class rank/ class size) as reported by the student. Prior research indicates that student self-reported measures of past performance are valid predictors of academic success (Hanna, Bligh, and Lenke, 1970). Rate of learning on preceding units of instruction is also included as a measure of past performance. The selected personality variables are the scales on the Brown-Holtzman Survey of Study Habits and Attitudes (SSHA), and the student's achievement discrepancy scores. The SSHA has been successful at predicting school achievement (Buros, 1959), and it may well be indicative of rate of learning. Of particular interest is the Study Habits Scale which is reported to be predictive of procrastination and use of effective study methods (test manual). The students' achievement discrepancy scores compose a variable derived by subtracting each student's predicted achievement score from his actual achievement score. Robert Thorndike (1967) has defined discrepancy scores such as these as being useful measures of underachievement and overachievement. Discrepancy scores are a measure of what the student has done as compared to what he should be able to do based on the performance of other students having a similar ability level. Discrepancy scores such as these have been used as a measure indicative of a motivational type of personality variable (Hummel and Sprinthall, 1965). It is possible that if a student has been an underachiever in the past, he will continue to be one in the present. If underachievement is indeed indicative of low motivation for academics, these discrepancy scores may be related to procrastination and rate of learning. Both a high school percentile rank discrepancy score and a Composite ACT discrepancy score will be included as predictors of rate of learning. The rate of learning for each unit will be predicted separately. This is because each unit may require slightly different skills (Smith and Eaton, 1939; Wang, 1971); because each student has a different level of skills, his rate of learning may change drastically as he moves from unit to unit. A second benefit derivable from this procedure is an insight into the skills required for accomplishment of the unit. Examination of the dependent variable correlations from the multiple regression will allow for study of the relationship between the skills (aptitudes) and the student's rate of learning. The hypothesis that is generated from the first question is: There will be a statistically significant relationship between the independent variables-aptitude, prior performance, and personality variables and the dependent variable-rate of learning. Also, this significant relationship will generate a linear combination of predictors to rate of learning.

Research Question Number Two

The second research question is concerned with predicting the "no-start-procrastinator" (NSP). The independent variables used for this question will be the same as were used for the first question with the exception of one prior performance measure. Rate of learning on preceding units will not be included as an independent variable for this question. The reason for this is that the NSP is to be predicted at the beginning of a course before the student has performed in an instructional unit. Research question number two generates the following hypothesis: There will be a statistically significant relationship between the independent variables-aptitude, prior performance, and personality variables and the dichotomous dependent variable-"no-start-procrastination population" versus "normal population." Also, this significant relationship will generate a linear combination of predictors to the dichotomous dependent variable.

Research Question Number Three

The third research question arises because of a need to determine the effectiveness of each unit of instruction in terms of the overall efficiency of the calculus (instructional system). As was mentioned on page eight of the present study, the efficiency of the calculus is best determined by the set of variables-rate of learning and number of errors (attempts at the terminal objective of each unit). This set of variables can be termed the "efficiency domain" of the IPI-mastery learning calculus of practice. If each unit of instruction is considered a variable, either in terms of rate of learning or number of errors, then all of the units form a set of variables that can be termed the "instructional domain." The degree of relationship (correlation coefficient) between the two sets of variables or domains will be indicative of the effectiveness of the instructional system in terms of its units. A method that will correlate the two domains is canonical correlation (Hope, 1968; Kelly, Boggs, and McNeil, 1969). Not only does the canonical correlation indicate the linear correlation between the sets, it also evolves a regression coefficient for each variable that indicates its linear contribution to the canonical correlation (Morrison, 1967). Using the canonical multivariate correlational technique to answer this research question allows for the third hypothesis: There will be a statistically significant relationship between the instructional domain and the efficiency domain. Also, each instructional unit will make a differential contribution to the relationship between domains. A "differential contribution" implies that the variables in a set contribute differing amounts of variance to the relationship between sets. The regression coefficient associated with each variable is a measure of the amount of a variable's contribution.

Research Question Number Four

The fourth and final research question centers around the need to evaluate the integrated curriculum feature of the IPI-mastery learning system. If the disciplines are reinforcing (in a non-Skinnerian sense) each other as is planned in the design of the course, there should be a relationship between the courses. Once again, canonical correlations can be used to find the relationship between the courses. The regression coefficients associated with each instructional unit will indicate the major linkages between disciplines. For example, if unit three in English and unit five in mathematics are weighted the heaviest by the regression coefficient, then the nature of the inter-discipline linkage is to be found in those two units. Careful study of the nature of the units, the aptitude and personality correlates of the units from research question number one, and the sequencing should provide valuable insight for subsequent adjustment of the hierarchies and rewriting the learning activities in the units. This last research question generates the fourth hypothesis: There will be a statistically significant relationship between discipline domains, and each unit of instruction will make a differential contribution to that relationship.

CHAPTER III

DESIGN AND METHODOLOGY

Introduction

A "new" calculus of practice has been implemented at a large southwestern university. It consists of approximately 40 hours of mathematics, chemistry, physics, computer science, speech, and English. This new system of instruction blends the two educational concepts, "Mastery Learning" and "Individually Prescribed Instruction." It also features an integrated curriculum. The instructional system has been designed so that it is of the integrated, IPI-mastery learning variety such as has been described through out the first two chapters of the present study. This instructional system shall hereafter be designated as the ML-IPI system. It is within this system that this investigation will be conducted.

Subjects

There are two basic populations that evolved during summer orientation, 1971, and fall enrollment, 1971.

For the purposes of the present study, the two populations will be called "group one" and "group two."

Group one was formed by using a table of random numbers to select students from a pool of eligible students that formed each day throughout the 1971 summer freshman orientation program. To be eligible for selection to group one, a student must have declared a desire to be either a mathematics, physics, chemistry, or engineering major. This declaration was made during the morning of the student's first day of the orientation. If the student was randomly selected for group one the second morning of orientation, his advisor informed him that he was eligible for the ML-IPI instructional system's courses. The advisor explained the nature of the courses to the student, and while doing so, tried to avoid giving the student the impression that he was to be an experimental subject. If the student decided that he did not want to enroll in these courses, he was allowed to enroll in the conventional courses. There were three students who decided to go into the conventional system. At the end of the summer orientation program, there were 110 group one students randomly selected and pre-enrolled in the ML-IPI instructional system. All of these students were enrolled in at least two courses within this instructional system, and some were enrolled in as many as four.

Group two consists of students taking one or more of the ML-IPI system's courses. Their enrollment into the courses was through normal advisor channels and was not experimentally controlled in any way. Group two consisted of 113 students.

Seventy-four of the 110 randomly selected group one students actually enrolled at the university for the fall semester. These 74 students comprised the population for hypothesis number two.

By the end of February 1972, all remaining group one students had completed their ML-IPI system courses. There were 68 of these students remaining in the system. These 68 students comprise the population for hypothesis number one.

All of the group one and group two students that finished the courses of interest comprise the population for hypothesis number three and number four.

Instrumentation

American College Test ACT

The American College Testing Program was initiated in 1959 and in its first year of operation was administered to approximately 120,000 high school seniors. The results of the 1959 testing were reported to 368 participating colleges (plus over 600 other colleges) in 19 states. During the school year 1962-1963, over 350,000 students completed the tests and reported their scores to 725 colleges or universities requiring or recommending the tests (Buros, 1965, p. 2).

The ACT test consists of four parts: English Usage, Mathematics Usage, Social Studies Reading, and Natural Sciences Reading. Standard scores ranging from one to thirty-six are obtained for each subtest plus a composite score. The English Usage examination is an 80 item, 50 minute test that measures the student's understanding and use of the basic elements in correct and effective writing such as punctuation, capitalization, usage, phraseology, style, and organization.

The Mathematics Usage test is a 40 item, 50 minute examination that measures the student's mathematical reasoning ability. This test emphasizes the solution of practical quantitative problems which are encountered in many college curricula. It also includes a sampling of mathematical techniques covered in high school courses.

The Social Studies Reading examination is a 52 item, 40 minute test that measures the evaluative reasoning and problem-solving skills required in the social studies. It measures the student's comprehension of reading passages taken from typical social studies materials. It also contains a few items that test his understanding of basic concepts, knowledge of sources of information, and knowledge of special study skills needed in college work in the social studies.

The Natural Sciences Reading examination is a 52 item, 40 minute test that measures the critical reasoning and problem-solving skills required in the natural sciences. Emphasis is placed on the formulation and testing of hypotheses and the evaluation of reports of scientific experiments (ACT Technical Report, 1965).

The basic idea underlying development of the four tests is that the best way to predict success in college is to measure as directly as possible the abilities the student will have to apply in his college work. This means the tasks presented in the tests must be representative of scholastic tasks. The validity of this kind of reasoning in test construction has been amply supported by research. The result today is that nearly all of the most widely used tests of academic potential consist largely of two kinds of exercises: 1. the comprehension of reading passages and 2. the solution of functional and practical problems involving quantitative reasoning (ACT Technical Report, 1965, p. 3).

The ACT test differs from other widely used tests of scholastic potential primarily in the degree to which this practice is followed. The ACT tests contain a large proportion of complex problem-solving exercises and proportionately few measures of narrow skills (ACT Technical Report, 1965, pp. 4-5).

A review reported in Buros' Sixth Mental Measurements Yearbook reported on the reliability of the ACT form-AC, for a sample of 990 high school seniors. The odd-even reliability coeficients were English Usage=.90, Mathematics Usage=.89, Social Studies Reading=.86, and Natural Sciences Reading=.95 (Buros, 1965, p. 4).

The ACT is administered under the direction of the American College Testing Program, Inc. The ACT is given five times each year at testing centers throughout the United States and Canada to those students in their senior year of high school who are planning to attend an institution of higher learning. The scores are reported to three institutions designated by the student as those institutions he is considering attending.

<u>Nelson-Denny Reading Test NDRT</u>

The Nelson-Denny Reading Test is a 30 minute test which contains a 100 item vocabulary subscale, a 36 item reading comprehension subscale, and a 639 total words reading rate subscale. The comprehension and vocabulary subscales are combined to create a total score.

The NDRT was designed for use in grades nine through sixteen, and norms have been established for each grade level. Reviewers of the NDRT (Buros, 1965) report that internal reliability has been estimated by part-whole correlations. These internal reliability estimates range from 0.38 to 0.47. The reviewers also report alternate forms reliability coefficients that range from 0.81 to 0.93, and they report validity coefficients with school achievement that range from 0.40 to 0.60. Garrett (1949) found the NDRT demonstrated a correlation coefficient of 0.67 with academic performance.

Cooperative Algebra Test CAT

The Cooperative Algebra Test was developed by the Educational Testing Service to measure a student's comprehension of the basic concepts, techniques, and unifying principles of elementary algebra. The CAT consists of multiple choice items that are arranged in the order of least difficult to most difficult. Emphasis is given to the ability to apply mathematical ideas to new situations and to reason with insight while factual recall and computations are minimized. According to reviewers (Buros, 1965), the development of the CAT followed currently accepted practices with respect to curricular validation, preliminary tryout, and item analysis. Bowers (1956) found a correlation of 0.58 between the CAT and grade point average. Reviewers (Buros, 1972) report that the CAT correlates 0.60 with the Cooperative School and College Ability Tests. Also, these same reviewers report that the CAT demonstrates K-R 20 (Kuder-Richardson) reliability coefficients of 0.80 to 0.84.

Cooperative Trigonometry Test CTT

The Cooperative Trigonometry Test was developed by the Educational Testing Service in 1961, 1962, and 1963. It is a 40 item examination which is designed as sample of performance related to skills in trigonometry. The test has a broad scope; it has questions on radians, inverse functions solving triangles and graphs. The emphasis of this test seems to be on the results of a trigonometric formula and not derivations or applications of such a formula. The test has excellent face validity but seems to be lacking in predictive or concurrent validity (Buros, 1972). Reviewers in the Seventh Mental Measurements Yearbook report K-R 20 reliability coefficients of 0.80.

The Survey of Study Habits and Attitudes SSHA

The Survey of Study Habits and Attutudes is a 100 item self-rating inventory designed to measure a student's scholastic motivation in terms of his behavior and attitudes. Each item of the SSHA is answered by the student's completing one of five choices on a five point continuum of "rarely" to "almost always." The SSHA yields separate study habit and study attitude scores.

Specific definitions for the individual scales and subscales are as follow:

SSHA Delay Avoidance Subscale DA measures one's promptness in completing academic assignments, one's lack of procrastination, and one's freedom from wasteful delay and distraction.

SSHA Work Methods Subscale WM measures one's use of effective study procedures, one's efficiency in doing academic assignments, and one's how-to-study skill.

SSHA Study Habits Skill SH combines the DA and WM subscales to provide an overall measure of one's scholastic behavior.

SSHA Teacher Approval Subscale TA measures one's opinion of teachers and their classroom behavior and methods.

SSHA Education Acceptance Subscale EA measures one's approval of educational objectives, practices, and requirements.

SSHA Study Attitudes Scale SA combines the TA and EA subscales to provide an overall measure of one's academic beliefs.

SSHA Study Orientation Score SO combines the SA and SH scales to provide a single measure of one's study habits and attitudes.

Validity and reliability findings are provided by the test manual (1967). Correlation coefficients of the SO scale with grade point average with aptitude as measured by the Scholastic Aptitude Test partialed out range from 0.20 to 0.32. The KR-8 reliability coefficient is 0.89 for the DA subscale, 0.87 for the WM subscale, 0.87 for the TA subscale and 0.87 for the EA subscale. The 14 week test-retest reliability coefficient for the DA subscale is 0.88, 0.86 for the WM subscale, 0.83 for the TA subscale, 0.85 for the EA subscale and 0.88 for the SO scale. Reviewers (Buros, 1959) report validity coefficients with grade point average that range from 0.27 to 0.66, and they report test-retest reliability coefficients that range from 0.79 to 0.95.

Procedures

Hypothesis Number One

Hypothesis number one stated in the alternate form reads: There will be a statistically significant relationship between the independent (predictor) variables-aptitude, prior performance, and personality and the dependent variable-rate of learning. Also, this statistically significant relationship will generate a linear combination of predictors to rate of learning for each unit of instruction.

The aptitude variables consist of the ACT subscales--mathematics, English, social science, and natural science; the Composite ACT scores; the Nelson-Denny subscales--vocabulary, reading comprehension, and reading rate; the Nelson-Denny total score; the Cooperative Algebra Test; and the Cooperative Trigonometry Test. These measures of aptitude were administered to the subjects by testing professionals of the University Tests and Measurement Bureau during summer freshmen orientation, summer of 1971.

The prior performance variables consist of rate of learning in preceding units and a class percentile rank as reported by the student. Each subject reported his high school graduating class size and his rank in class. The class size was divided into the rank to obtain the class percentile rank. Within one given class, this measure is an ordinal number. For the purposes of this study, the class percentile ranks between subjects (who for the most part graduated from different high schools) will be assumed to be an interval level measurement; therefore, the class percentile rank will be used in conjunction with parametric statistical procedures such as the Pearson product moment correlation coefficient.

The personality variables consist of the Brown-Holtzman Survey of Study Habits and Attitudes (SSHA) scales which are the study habits scale, the study attitudes scale, and the study orientation scale; also included in the personality variables are the ACT discrepancy score (ADS) and the class percentile rank discrepancy score (CDS). The SSHA was administered to the subjects by testing professionals of the University Tests and Measurements Bureau during the summer orientation, summer of 1971.

The ADS was formed by first computing a multiple regression of Composite ACT on the following predictors: mathematics ACT scale; English ACT scale; natural sciences ACT scale; social sciences ACT scale; the SH, SA, and SO scales from the SSHA; the vocabulary, reading comprehension, reading rate, and total score scales from the Nelson-Denny Reading Test; Cooperative Algebra Test; Cooperative Trigonometry Test; and the class percentile rank. The multiple regression procedure generated regression coefficients for each predictor that made a statistically significant (0.05 level) contribution to the regression equation; also a multiple correlation coefficient of 0.815 and a multiple standard error of the estimate of 1.871 were computed. The regression coefficients were used to predict a Composite ACT score for each subject. Next, the subject's actual Composite ACT score was compared to the predicted one. All of those subjects whose actual Composite ACT score fell one-half a standard error of the estimate below (less than) the predicted Composite ACT was classified as an "underachiever" (UADS). The rest of the subjects, all those not classified as an underachiever, were classified as "satisfactory achievers" (SADS). These classifications of UADS and SADS formed the basis for the binary predictor variable "ACT discrepancy score"; this binary variable was quantified by assigning a 0.0 to those subjects classified as UADS and a 1.0 to those subjects classified as a SADS.

The procedure for forming the CDS variable was basically the same that was used to form the ADS. First, a multiple regression of class percentile rank on the following predictors was computed: the ACT scales including Composite ACT, the SSHA scales, the Nelson-Denny scales, the Cooperative Trigonometry Test, and the Cooperative Algebra Test. The procedure derived a regression coefficient for each predictor making a statistically significant (0.05 level) contribution to the regression equation. A multiple correlation of 0.269 and a multiple standard error of the estimate of 30.701 was computed. The CDS like the ADS is a binary prediction variable. All of those subjects whose actual percentile class rank was one-half a standard error of the estimate less than their predicted class percentile rank was classified as an "overachiever" (SCDS) and was assigned a score of 1.0 on the CDS variable. All the rest of the subjects were classified as "normal" (UCDS) and were assigned a score of 0.0 on the CDS variable.

Many of the subjects enrolled in analytical geometry were also enrolled in trigonometry; most of these subjects completed trigonometry before starting analytic geometry. An extra independent variable was added to the multiple regression equation on the first unit of analytic geometry. This variable was formed by assigning a 1.0 to those subjects that were enrolled in both courses and a 0.0 was assigned to those enrolled only in analytical geometry. This procedure should partial out the effect of the simultaneous enrollment on rate of learning in the first unit of analytical geometry.

The dependent variable "rate of learning" was formed by recording the date that a subject started and completed his first unit of instruction. From that point on, the date of completion of each unit was recorded and was also used as the date of starting for the next unit in the instructional sequence. These date-to-date recordings formed the data necessary to compute the total number of days it took each subject to complete each instructional unit; weekends were included. The period of December 23, 1971, to January 16, 1972, (Christmas vacation) was not included in any given unit nor was it included in the total number of days to complete the course.

The courses freshman trigonometry, freshman English, and freshman analytical geometry were chosen to test hypothesis number one. The reasons for choosing these three courses were administrative in nature; namely, they were cooperation of the instructors and accessibility to the rate of learning data.

Hypothesis number one was tested separately three times, once for each course. The population for each test consisted of all the group one subjects that finished the particular course under study. There were 47 subjects that completed the trigonometry course. Fifty-nine subjects completed the English course, and 36 subjects completed the analytical geometry course.

Hypothesis Number Two

Hypothesis number two stated in the alternate form reads: There will be a statistically significant (0.05 level) relationship between the independent (predictor) variables-aptitude, prior performance and personality and the binary dependent variable--"procrastination." Also, this statistically significant relationship will generate a linear combination of predictors to the dependent variable.

The predictor variables used for hypothesis number two are: aptitude--as measured by the ACT scales, the Nelson-Denny scales, the Cooperative Algebra Test, and Cooperative Trigonometry Test; prior performance as measured by class percentile rank; personality--as measured by the SSHA, ADS, and CDS. These are the same predictors as were used for hypothesis number one with exception of the variable-"rate of learning on prior units."

The dependent variable is a binary variable that has two classifications: 1. No-Start Procrastination (NSP) 2. Satisfactory Progression (SP). Any subject that had a grade of D or F at midterm was classified as a NSP and given a score of 0.0. All the subjects with a grade of C or better were classified as a SP and were given a score of 1.0. The criterion for being awarded an F at midterm was that a subject had done nothing in the course by midway through the semester. The criterion for a D was that the subject had done some work but had lagged far behind the rest of the students. These D subjects, for the most part, had done nothing until just before midterm; then in an effort to avoid an F, they accomplished just a few units of instruction. Almost without exception, if a subject was procrastinating in one of his ML-IPI courses, he was procrastinating in all of them.

The population used to test hypothesis number two consists of the entire experimental group--group one. Twenty-eight of the subjects of group one were classified as NSP and 46 as SP.

Hypothesis Number Three

Hypothesis number three stated in the alternate form reads: There will be a statistically significant relationship between the instructional domain and the efficiency domain. Also, each instructional unit will make a differential contribution to the relationship between domains.

The instructional domain is a set of variables which consists of the instructional units of a course. The efficiency domain is a set of two variables: 1. total time to complete the course 2. total number of errors made while completing the course.

The variables (instructional units) in the instructional domain are formulated in two modalities. One modality is rate of learning. In this modality, each variable is formed by obtaining each student's rate of learning for each unit. The procedure for obtaining the rate of learning is the same as was outlined for hypothesis number one. The second modality is an error mode. In this modality, each variable is formed by obtaining the number of attempts at the terminal objectives of each unit. In the freshman trigonometry course, many of the subjects made several attempts at each unit; these attempts were recorded and are used as interval level data. In the freshman analytical geometry and English courses, the attempt rate was extremely low. Only one or two subjects per unit would have more than two attempts at the terminal objectives of the unit; therefore, the error mode variables for the English and the analytical geometry instructional domains are binary variables formed by assigning a score of 1.0 to those subjects successfully completing the terminal objectives of the first attempt and a score of 0.0 to those subjects who tried more than once.

The variable "total time to complete the course" was formed by adding the number of days to complete each unit; this sum represents the total number of days to complete all of the units. The variable "total number of errors made while completing the course" was formed by adding the number of attempts made while completing each unit; this sum represents the total number of attempts made while completing all of the units.

Since the efficiency domain is a set of variables created by summing the parts of the instructional domain, there is the problem of part-whole correlations as discussed by Guilford (1965). It is expected that there will be a somewhat inflated canonical correlation coefficient between domains. This is not a serious problem because the most important aspect of this hypothesis is not the size of the canonical correlation. What is important is the differential contribution made by each unit in each canonical variate; hence, it is the regression coefficients, not the correlation coefficients that are of primary importance.

As was mentioned on page 36, the three courses used to test hypothesis number three are freshman trigonometry, freshman English, and freshman analytical geometry. Hypothesis number three will be tested twice (once using the error mode and once using the rate of learning mode) for each course.

The population for testing hypothesis number three consists of all the group one and group two population completing each respective course. There were 63 subjects that completed the trigonometry course, 87 subjects completed the English course, and 37 subjects completed the analytical geometry course.

Hypothesis Number Four

Hypothesis number four when stated in the alternate form reads: There will be a statistically significant relationship between discipline domains. Also, each unit of instruction will make a differential contribution to that relationship.

Each discipline instructional domain consists of a set of variables; each unit of instruction forms a variable in the variable set. As was the situation in hypothesis number three, the variables are formed in two modalities: an error mode and a rate of learning mode. The procedure for forming the variables for hypothesis number four is the same as was used in hypothesis number three; in fact, the instructional domains formed in hypothesis number three are the same domains to be used to test hypothesis number four.

The two courses used to test hypothesis number four are freshman trigonometry and freshman English. The English instructional domain will be correlated with the trigonometry domain using canonical analysis. This will be accomplished twice--once in the error mode and once in the rate of learning mode. The above stated procedure will allow hypothesis number four to be tested one time in the error mode and one time in the rate of learning mode.

The instructional domain for English consists of nine variables in the rate of learning mode and eight variables in error mode. (Everyone passed unit one on the first attempt.) The Trigonometry Instructional domain consists of seven variables in both modes.

The population for testing hypothesis number four consists of all group one and group two subjects that were enrolled in both courses. There were 30 subjects that completed both the trigonometry course and the English course.

Calculations

Hypothesis Number One and Number Two

Both hypothesis number one and number two are statistically tested by step-wise multiple regression. Also, the predictor variables ADS and CDS were generated by a step-wise multiple regression procedure.

The computer program BMDO2R (Biomedical Computer Programs, 1968) was used for the step-wise multiple regression computational routines. The accuracy of BMDO2R was checked by comparing the output with hand-calculated data. This program first computes the product moment correlation coefficients between all of the predictors (independent variables) and between each predictor and the dependent variable. These coefficients are then printed out in a correlation matrix. The program also prints the mean and standard deviation for each variable.

The next step was to compute partial correlation coefficients (Beta Weights) from which regression coefficients are derived. The purpose of the regression coefficient is to "temper" the predictor with which it is associated so that predictor will make the proper contribution to the regression equation when all predictors are taken into consideration (Guildford, 1965). Since the dependent variable may have a different mean than the predictors, the "A" coefficient must be computed. This coefficient (sometimes called the dependent variable intercept) makes the adjustment for this difference.

For the final analysis, the computer considers each predictor one at a time, then selects and retains only those predictors making a significant contribution (at the .05 level of significance) to the regression equation. Before a predictor is added to the regression equation, the computer performs an analysis of variance to determine if the predictor is contributing to the total efficiency of the regression equation. If no significant statistical contribution is being made, the computer rejects the predictor considered and utilizes only those predictors in the regression equation that are making a significant contribution. To determine the least squares efficiency of the regression equation, a multiple correlation coefficient is computed and printed out by the computer. After all coefficients needed for prediction have been computed and printed out, the regression equation is:

$$Y_1 = A + b_1X_1 + b_2X_2 + b_3X_3 + \ldots b_nX_n$$

where: Y_1 = predicted score on dependent variable

A = intercept or "a" coefficient

b_1 = regression coefficient for predictor number one

X_1 = score on predictor number one

b_2 = regression coefficient for predictor number two

X_2 = score on predictor number two

The equation for the multiple correlation coefficient is:

$$R = \sqrt{B_1r_1 + B_2r_2 + B_3r_3 + \ldots B_nr_n}$$

where: R = multiple correlation coefficient

B_1 = beta weight for predictor number one

r_1 = product moment between predictor number one and dependent variable

In hypothesis number two, the dependent variable is a dichotomy (binary variable). Any correlations of a continuous variable with a dichotomy will produce a point-biserial correlation coefficient. Any correlation of another dichotomy with a dichotomy will produce a phi correlation coefficient (if both dichotomies are binary). Since both the phi and the point-biserial are product moments, they have the statistical properties necessary to be used in step-wise multiple regression (Guilford, 1965).

To test hypothesis number two, the computer performs the same operation as outlined when it computes and prints out means, standard deviations, regression coefficients and "A" coefficients; however, this time the dependent variable is a dichotomy. The regression equation is:

$$Y_D = A + b_1X_1 + b_2X_2$$

where: A = "A" coefficient

b_1 = regression coefficient for predictor number one

X_1 = score on predictor number one

Y_D = predicted classification in dichotomy

In this equation since the value of one has been assigned to the satisfactory progress classification (SP), when Y_D equals .50 or more, the student is predicted to be a SP. The multiple R to the dichotomy is computed to determine the efficiency of the regression equation. As is expected of the step-wise program, each predictor is examined one at a time to determine if it should be rejected or accepted into the total regression equation. By the use of the regression equation, the classification NSP or SP can be predicted from known indices.

Another important print-out is the multiple standard error of the estimate (SEE). The SEE allows the analyst to place probability parameters on the errors made in prediction.

<u>Hypothesis Number Three and Number Four</u>

Both hypotheses number three and number four involve analyzing the relationship between two domains (sets of variables). In this study, the relationships between the domains will be investigated by means of canonical analysis.

In canonical analysis, several independent variables are grouped into an independent variable set, and several dependent variables are grouped into a dependent variable set. The independent and dependent variables are transformed into new sets of variables which are called canonical variates. The linear relationship between the new pair of canonical variates is quantified by the canonical correlation coefficient (Hotelling, 1936). Canonical analysis allows for more than one pair of canonical variates; in fact, it is possible to have as many canonical variates as there are variables in the smallest domain (variable set). For example, in hypothesis number three, the smallest set is the efficiency domain which has two variables. This means that the maximum number of canonical variates (and corresponding canonical correlation coefficients) that can be derived with the efficiency domain is two.

Each new pair of canonical variates are orthogonal (zero relationship) to previously derived variates (Cooley and Lohnes, 1962). This means that each new canonical correlation represents a unique linear relationship between the original sets of variables, and this linear relationship is the simplest possible per pair of canonical variates (Kendall, 1957). Each time a new pair of variates are derived, a regression coefficient for each variable in the two sets is generated. The purpose of this regression coefficient is to weight each variable; the variables with the "heaviest" weights are the variables that are contributing the most to the linear relationship between the canonical variates. The regression coefficients allow the analyst to determine the nature of the relationship between domains.

Pictorially, canonical analysis may be depicted as

where: R_1 = the canonical coefficient for the first pair of canonical variates

R_2 = the canonical coefficient for the second pair of canonical variates

X_1 = independent variable number one

X_2 = independent variable number two

X_3 = independent variable number three

Y_1 = dependent variable number one

Y_2 = dependent variable number two

$1b_{1x}$ = regression coefficient for independent variable number one, first pair of canonical variates

$1b_{2x}$ = regression coefficient for independent variable number two, first pair of canonical variates

$1b_{3x}$ = regression coefficient for independent variable number three, first pair of canonical variates

$1b_{1y}$ = regression coefficient for dependent variable number one, first pair of canonical variates

$1b_{2y}$ = regression coefficient for dependent variable number two, first pair of canonical variates

$2b_{1x}$ = regression coefficient for independent variable number one, second pair of canonical variates

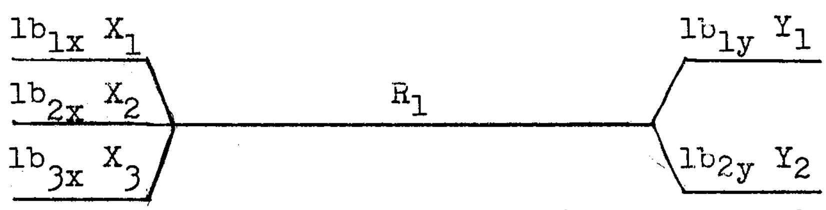
$2b_{2x}$ = regression coefficient for independent variable number two, second pair of canonical variates

$2b_{3x}$ = regression coefficient for independent variable number three, second pair of canonical variates

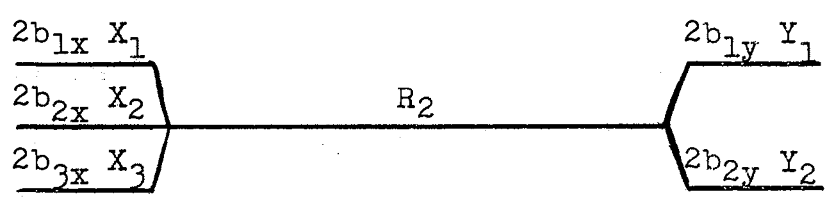
$2b_{1y}$ = regression coefficient for dependent variable number one, second pair of canonical variates

$2b_{2y}$ = regression coefficient for dependent variable number two, second pair of canonical variates.

There are two canonical transformations possible. The first canonical variate pair may be pictured as follows:



The second canonical variate pair may be pictured like this:



As was mentioned, there was as many pairs of canonical variates as there are variables in the smallest set. Each succeeding pair of canonical variates accounts for less shared variance between sets than did the preceding pair.

There is always the possibility that some of the derived pairs of variates do not represent a statistically significant relationship between sets of variables. This possibility of a chance relationship poses a problem for the analyst. How many of the possible pairs of canonical variates should be interpreted?

Since the canonical correlation coefficient is a statistical index of relationship between each pair of variates, any statistically significant canonical correlation coefficient should represent a statistically significant relationahip between the sets. For the purposes of this study every pair of canonical variates that is associated with a canonical correlation that is statistically significant at the 0.05 level will be interpreted. Rao (1966) suggests that this procedure is a sound one for determining how many pairs of variates are representing a real rather than chance linear relationship.

The procedure that was used for determining the significance of a canonical correlation coefficient is one suggested by Bartlett (1941). This procedure uses a chi-square distribution to test the significance of the coefficients. The formula is as follows:

$X^2 = -N .5 (p + q + 1) \ln \Lambda$ with $(p - r)(q - r)$ degrees of freedom

$\Lambda = (1 - R^2)$

X^2 = chi square value

R = canonical correlation

p = number of variables in one set

q = number of variables in second set

r = number of transformations (canonical roots removed)

N = number of subjects

The computational routine for all canonical analysis was accomplished by a packaged computer program--BMDO2R. This program is one of the biomedical computer programs (1968). The accuracy of the programs was checked by in putting data with known regression coefficients and a known multiple correlation coefficient for a single dependent variable and several independent variables. Multiple correlation is a special case of canonical correlation (Kelly, Boggs, and McNeil, 1969); therefore, if the canonical correlation coefficients with the single dependent variable from BMDO2R match known values, the program is assumed to be accurate. The data from the BMDO2R matched data with known values to five places beyond the decimal point. All computer routines for all four hypotheses in this study were accomplished on an IBM system 360 Model 65 computer.

CHAPTER IV

STATISTICAL RESULTS AND ANALYSES

Introduction

The purpose of this chapter is to present both the results of the statistical analysis and to state the conclusions regarding acceptance or rejection of the null hypotheses. Throughout this study, each hypothesis has been stated in the alternate form. This practice is followed in Chapter IV, and the alternate hypothesis will be either accepted or rejected. Of course, acceptance of the alternate calls for rejection of the null, and rejection of the alternate implies failure to reject the null hypothesis. A table (s) that presents the results of the statistical analysis follows each statement of rejection or acceptance of the null hypothesis. Chapter IV is divided into four parts, one part for each of the four hypothesis.

Hypothesis Number One

Hypothesis number one stated in the alternate form reads: There will be a statistically significant relationship between the independent (predictor) variables-aptitude, prior performance, and personality and the dependent variable-rate of learning. Also, this statistically significant relationship will generate a linear combination of predictors to rate of learning for each unit of instruction.

There were three courses used to test hypothesis number one: English, analytical geometry, and trigonometry. The alternate hypothesis is accepted at the 0.05 level for all units in all three courses.

Tables I through IX present the results of the computational routine performed on rate of learning in the English course. Tables X through XIII present the results of the computational routine performed on rate of learning in the analytical geometry course, and Tables XIV through XX present results related to the trigonometry course. Tables I through XX follow the following format: there is one table for each unit of instruction (dependent variable). The "Predictor" column identifies the variables. Some of the variables listed in the "Predictor" column are predictors for every dependent variable. The first 17 variables in each table are potential predictors. Since a priori prediction is the goal of hypothesis number one, only those units that were completed prior to any particular unit that is the dependent variable are allowed access into the computational routine as potential predictors. Any unit that was completed after the unit that is the particular dependent variable of any given table was withheld from the computational routine. The "Status In Equation" (abbreviated as Stat. Equa.) column classifies each variable's in the regression equation. A variable is classified as "included" (abbreviated as incl.) if it is found to be making a statistically significant contribution to the regression equation. If a variable does not make a significant contribution, it is classified as rejected (abbreviated as rej.). The variable that is the dependent variable is classified as "dependent variable" (abbreviated as de.v.). Variables that were not potential predictors and were not allowed access into the computational routine are classified as "withheld" (abbreviated as w.h.). The "Mean" column presents the means of the variables, and the "S.D." column presents the standard deviations of the variables. The "Dep. Vari. Cor." column presents the product moment correlation coefficient of each variable with the particular dependent variable of that table.

TABLE I

RESULTS OF STEPWISE MULTIPLE REGRESSION
ENGLISH UNIT 1

Predictor	Stat. in Equa.	Re. Coeff.	Mean	S.D.	Dep. Vari. Cor.
English ACT	incl.	- 0.96	22.2	3.4	- .07
Math ACT	incl.	- 0.14	28.0	4.1	- .03
Soc. Sci. ACT	incl.	1.13	22.4	5.4	- .08
Nat. Sci. ACT	incl.	0.80	25.6	4.9	- .08
Composite ACT	rej.		24.7	3.2	- .10
SH-SSHA	incl.	0.39	53.5	16.0	.00
SA-SSHA	rej.		58.3	13.1	.10
SO-SSHA	rej.		111.8	26.7	.05
Verbal-ND	incl.	- 0.37	40.1	11.3	- .03
Comprehension-ND	rej.		48.0	9.8	.04
Total ND	incl.	0.13	84.6	14.0	.00
Rate ND	incl.	0.02	309.2	84.9	.04
Coop. Algebra	incl.	- 0.70	33.0	4.5	- .16
Coop. Trig.	incl.	- 0.71	14.9	6.0	- .27
Percentile Rank	incl.	0.80	20.8	18.1	.02
ADS	incl.	- 6.24	.72	.45	.05
CDS	incl.	-11.80	.55	.50	.04
Rate Unit 1	de.v.		5.4	5.1	1.00
Rate Unit 2	w.h.		18.1	13.7	- .00
Rate Unit 3	w.h.		26.1	22.2	.26
Rate Unit 4	w.h.		27.0	21.1	.31
Rate Unit 5	w.h.		25.6	22.4	.17
Rate Unit 6	w.h.		14.2	13.4	.07
Rate Unit 7	w.h.		18.0	20.1	.20
Rate Unit 8	w.h.		4.5	4.2	- .17
Rate Unit 9	w.h.		6.3	10.1	.03

"A" Coefficient = 6.8
Multiple Correlation Coefficient = .50
Multiple Standard Error of Estimate = 5.13

TABLE II

RESULTS OF STEPWISE MULTIPLE REGRESSION
ENGLISH UNIT 2

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	1.69	22.2	3.4	.07
Math ACT	incl.	-1.15	28.0	4.1	- .23
Soc. Sci. ACT	incl.	-1.64	22.4	5.4	- .16
Nat. Sci. ACT	incl.	-1.75	25.6	4.9	- .10
Composite ACT	incl.	-6.13	24.7	3.2	- .22
SH-SSHA	incl.	.05	53.5	16.0	.06
SA-SSHA	incl.	.29	58.3	13.1	.16
SO-SSHA	rej.		111.8	26.7	.11
Verbal-ND	incl.	- .22	40.1	11.3	- .17
Comprehension-ND	incl.	- .64	48.0	9.8	- .28
Total ND	incl.	- .26	84.6	14.0	- .23
Rate ND	incl.	.04	309.2	84.9	.09
Coop. Algebra	incl.	- .27	33.0	4.5	- .26
Coop. Trig.	incl.	- .49	14.9	6.0	- .21
Percentile Rank	incl.	.23	20.8	18.1	.21
ADS	rej.		.72	.45	.03
CDS	incl.	-4.29	.55	.50	- .09
Rate Unit 1	incl.	- .34	5.4	5.1	- .00
Rate Unit 2	de.v.		18.1	13.7	1.00
Rate Unit 3	w.h.		26.1	22.2	.22
Rate Unit 4	w.h.		27.0	21.1	.11
Rate Unit 5	w.h.		25.6	22.4	- .16
Rate Unit 6	w.h.		14.2	13.4	- .28
Rate Unit 7	w.h.		18.0	20.1	.04
Rate Unit 8	w.h.		4.5	4.2	- .30
Rate Unit 9	w.h.		6.3	10.1	- .22

"A" Coefficient = 19.96
Multiple Correlation Coefficient = .57
Multiple Standard Error of Estimate = 13.26

TABLE III

RESULTS OF STEPWISE MULTIPLE REGRESSION
ENGLISH UNIT 3

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	rej.		22.2	3.4	- .10
Math ACT	incl.	1.33	28.0	4.1	.11
Soc. Sci. ACT	incl.	-2.02	22.4	5.4	- .33
Nat. Sci. ACT	rej.		25.6	4.9	- .13
Composite ACT	incl.	-2.07	24.7	3.2	- .18
SH-SSHA	rej.		53.5	16.0	.00
SA-SSHA	incl.	.90	58.3	13.1	.08
SO-SSHA	incl.	- .40	111.8	26.7	- .04
Verbal-ND	incl.	- .41	40.1	11.3	- .22
Comprehension-ND	rej.		48.0	9.8	- .28
Total ND	incl.	- .19	84.6	14.0	- .28
Rate ND	incl.	.03	309.2	84.9	.11
Coop. Algebra	incl.	- .59	33.0	4.5	- .08
Coop. Trig.	incl.	- .26	14.9	6.0	- .19
Percentile Rank	incl.	- .35	20.8	18.1	.02
ADS	incl.	3.84	.72	.45	.05
CDS	incl.	3.49	.55	.50	.01
Rate Unit 1	incl.	.72	5.4	5.1	.26
Rate Unit 2	incl.	.27	18.1	13.7	.22
Rate Unit 3	de.v.		26.1	22.2	1.00
Rate Unit 4	w.h.		27.0	21.1	.16
Rate Unit 5	w.h.		25.6	22.4	.13
Rate Unit 6	w.h.		14.2	13.4	- .27
Rate Unit 7	w.h.		18.0	20.1	- .08
Rate Unit 8	w.h.		4.5	4.2	- .17
Rate Unit 9	w.h.		6.3	10.1	- .14

"A" Coefficient = 14.78
Multiple Correlation Coefficient = .60
Multiple Standard Error of Estimate = 20.65

TABLE IV

RESULTS OF STEPWISE MULTIPLE REGRESSION
ENGLISH UNIT 4

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	-1.23	22.2	3.4	- .28
Math ACT	rej.		28.0	4.1	- .31
Soc. Sci. ACT	incl.	- .49	22.4	5.4	- .16
Nat. Sci. ACT	incl.	1.02	25.6	4.9	.08
Composite ACT	rej.		24.7	3.2	- .27
SH-SSHA	rej.		53.5	16.0	- .05
SA-SSHA	incl.	.09	58.3	13.1	.09
SO-SSHA	rej.		111.8	26.7	.01
Verbal-ND	incl.	- .59	40.1	11.3	- .03
Comprehension-ND	rej.		48.0	9.8	.03
Total ND	incl.	.89	84.6	14.0	.03
Rate ND	incl.	- .02	309.2	84.9	- .04
Coop. Algebra	incl.	-1.98	33.0	4.5	- .42
Coop. Trig.	rej.		14.9	6.0	- .25
Percentile Rank	incl.	.26	20.8	18.1	.13
ADS	incl.	-13.70	.72	.45	- .21
CDS	rej.		.55	.50	.15
Rate Unit 1	incl.	.79	5.4	4.1	.31
Rate Unit 2	rej.		18.1	13.7	.11
Rate Unit 3	incl.	.15	26.1	22.2	.16
Rate Unit 4	de.v.		27.0	21.1	1.00
Rate Unit 5	w.h.		25.6	22.4	- .01
Rate Unit 6	w.h.		14.2	13.4	- .09
Rate Unit 7	w.h.		18.0	20.1	.05
Rate Unit 8	w.h.		4.5	4.2	-.20
Rate Unit 9	w.h.		6.3	10.1	.15

"A" Coefficient = 49.72
Multiple Correlation Coefficient = .67
Multiple Standard Error of Estimate = 17.50

TABLE V

RESULTS OF STEPWISE MULTIPLE REGRESSION
ENGLISH UNIT 5

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	.97	22.2	3.4	.09
Math ACT	incl.	1.37	28.0	4.1	.12
Soc. Sci. ACT	incl.	- .59	22.4	5.4	- .17
Nat. Sci. ACT	incl.	2.18	25.6	4.9	.07
Composite ACT	incl.	-2.71	24.7	3.2	- .03
SH-SSHA	rej.		53.5	16.0	.08
SA-SSHA	incl.	1.13	58.3	13.1	.16
SO-SSHA	incl.	- .46	111.8	26.7	.13
Verbal-ND	incl.	- .44	40.1	11.3	.00
Comprehension-ND	incl.	-1.56	48.0	9.8	- .14
Total ND	incl.	.79	84.5	14.0	- .07
Rate ND	incl.	.04	309.2	84.9	.24
Coop. Algebra	incl.	.58	33.0	4.5	.17
Coop. Trig.	rej.		14.9	6.0	.08
Percentile Rank	incl.	- .10	20.8	18.1	- .06
ADS	incl.	-14.38	.72	.45	- .21
CDS	incl.	10.36	.55	.50	.23
Rate Unit 1	incl.	.87	5.4	5.1	.17
Rate Unit 2	incl.	- .43	18.1	13.7	- .16
Rate Unit 3	incl.	- .04	26.1	22.2	- .13
Rate Unit 4	incl.	- .10	27.0	21.1	- .01
Rate Unit 5	de.v.		25.6	22.4	1.00
Rate Unit 6	w.h.		14.2	13.4	.09
Rate Unit 7	w.h.		18.0	20.1	.03
Rate Unit 8	w.h.		4.5	4.2	- .08
Rate Unit 9	w.h.		6.3	10.1	- .13

"A" Coefficient = 17.74
Multiple Correlation Coefficient = .66
Multiple Standard Error of Estimate = 20.68

TABLE VI

RESULTS OF STEPWISE MULTIPLE REGRESSION
ENGLISH UNIT 6

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	- .23	22.2	3.4	- .08
Math ACT	incl.	1.63	28.0	4.1	.32
Soc. Sci. ACT	rej.		22.4	5.4	.20
Nat. Sci. ACT	incl.	2.05	25.6	4.9	.29
Composite ACT	incl.	-1.85	24.7	3.2	- .30
SH-SSHA	rej.		53.5	16.0	.22
SA-SSHA	incl.	.39	58.3	13.1	.17
SO-SSHA	rej.		111.8	26.7	.22
Verbal-ND	incl.	- .56	40.1	11.3	- .10
Comprehension-ND	incl.	- .29	48.0	9.5	- .20
Total ND	incl.	.45	84.6	14.0	.21
Rate ND	incl.	- .06	309.2	84.9	- .24
Coop. Algebra	inc.	- .50	33.0	4.5	- .25
Coop. Trig.	incl.	.43	14.9	6.0	.27
Percentile Rank	incl.	.06	20.8	18.1	- .15
ADS	incl.	-2.62	.72	.45	- .07
CDS	incl.	-5.02	.55	.50	- .19
Rate Unit 1	incl.	.47	5.4	5.1	.07
Rate Unit 2	incl.	- .16	18.1	13.7	- .28
Rate Unit 3	incl.	- .18	26.1	22.2	- .27
Rate Unit 4	incl.	- .06	27.0	21.1	- .09
Rate Unit 5	dev.		25.6	22.4	.09
Rate Unit 6	w.h.		14.2	13.4	1.00
Rate Unit 7	w.h.		18.0	20.1	.22
Rate Unit 8	w.h.		4.5	4.2	- .14
Rate Unit 9	W.H.		6.3	10.1	- .12

"A" Coefficient = 19.59
Multiple Correlation Coefficient = .76
Multiple Standard Error of Estimate = 10.54

TABLE VII

RESULTS OF STEPWISE MULTIPLE REGRESSION
ENGLISH UNIT 7

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	- .96	22.2	3.4	- .07
Math ACT	incl.	- .14	28.0	4.1	- .03
Soc. Sci. ACT	incl.	1.13	22.4	5.4	.10
Nat. Sci. ACT	incl.	.80	25.6	4.9	.06
Composite ACT	rej.		24.7	3.2	.06
SH-SSHA	incl.	.39	53.5	16.0	.04
SA-SSHA	rej.		58.3	13.1	.04
SO-SSHA	rej.		111.8	26.7	.04
Verbal-ND	incl.	- .37	40.1	11.3	- .11
Comprehension-ND	rej.		48.0	9.8	- .03
Total ND	incl.	- .13	84.6	14.0	- .06
Rate ND	incl.	- .02	309.2	84.9	- .01
Coop. Algebra	incl.	- .70	33.0	4.5	- .06
Coop. Trig.	rej.		14.9	6.0	- .01
Percentile Rank	incl.	.71	20.8	18.1	.31
ADS	incl.	- 6.24	.72	.45	- .04
CDS	incl.	-11.79	.55	.50	- .01
Rate Unit 1	incl.	.80	5.4	5.1	.20
Rate Unit 2	incl.	- .05	18.1	13.7	- .04
Rate Unit 3	rej.		26.1	22.2	- .08
Rate Unit 4	incl.	- .09	27.0	21.1	- .06
Rate Unit 5	incl.	.06	25.6	22.4	.03
Rate Unit 6	incl.	.18	14.2	13.4	.22
Rate Unit 7	de.v.		18.0	20.1	1.00
Rate Unit 8	w.h.		4.5	4.2	- .16
Rate Unit 9	w.h.		6.3	10.1	- .25

"A" Coefficient = -12.18
Multiple Correlation Coefficient = .58
Multiple Standard Error of Estimate = 19.46

TABLE VIII

RESULTS OF STEPWISE MULTIPLE REGRESSION
ENGLISH UNIT 8

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	.38	22.2	3.4	.19
Math ACT	incl.	.40	28.0	4.1	.02
Soc. Sci. ACT	incl.	.23	22.4	5.4	.05
Nat. Sci. ACT	incl.	.30	25.6	4.9	.03
Composite ACT	incl.	-1.34	24.7	3.2	- .07
SH-SSHA	rej.		53.5	16.0	- .06
SA-SSHA	incl.	- .06	58.3	13.1	- .19
SO-SSHA	incl.	- .02	111.8	26.7	- .13
Verbal-ND	incl.	.08	40.1	11.3	.18
Comprehension-ND	incl.	.07	48.0	9.8	.12
Total ND	incl.	- .07	84.6	14.0	- .11
Rate ND	incl.	.01	309.2	84.9	.11
Coop. Algebra	incl.	- .25	33.0	4.5	- .06
Coop. Trig.	incl.	.08	14.9	6.0	.16
Percentile Rank	rej.		20.8	18.1	- .11
ADS	rej.		.72	.45	.04
CDS	rej.		.55	.50	- .02
Rate Unit 1	incl.	- .08	5.4	5.1	- .17
Rate Unit 2	incl.	- .11	18.1	13.7	- .30
Rate Unit 3	incl.	- .02	26.1	22.2	- .17
Rate Unit 4	incl.	- .03	27.0	21.1	- .20
Rate Unit 5	incl.	- .01	25.6	22.4	- .08
Rate Unit 6	incl.	- .06	14.2	13.4	- .14
Rate Unit 7	incl.	- .01	18.0	20.1	- .16
Rate Unit 8	de.v.		4.5	4.2	1.00
Rate Unit 9	w.h.		6.3	10.1	.08

"A" Coefficient = 17.91
Multiple Correlation Coefficient = .58
Multiple Standard Error of Estimate = 4.27

TABLE IX

RESULTS OF STEPWISE MULTIPLE REGRESSION
ENGLISH UNIT 9

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	.76	22.2	3.4	.04
Math ACT	incl.	- .66	28.0	4.1	-.11
Soc. Sci. ACT	incl.	.55	22.4	5.4	.07
Nat. Sci. ACT	rej.		25.6	4.9	-.13
Composite ACT	incl.	-1.02	24.7	3.2	-.04
SH-SSHA	incl.	- .07	53.5	16.0	-.15
SA-SSHA	rej.		58.3	13.1	-.08
SO-SSHA	rej.		111.8	26.7	-.13
Verbal-ND	incl.	.26	40.1	11.3	.11
Comprehension-ND	rej.		48.0	9.8	.07
Total ND	incl.	- .26	84.6	14.0	-.03
Rate ND	rej.		309.2	84.9	-.10
Coop. Algebra	incl.	- .77	33.0	4.5	-.26
Coop. Trig.	incl.	- .18	14.9	6.0	-.13
Percentile Rank	rej.		20.8	18.1	-.05
ADS	incl.	-4.08	.72	.45	-.11
CDS	incl.	-1.26	.55	.50	.00
Rate Unit 1	rej.		5.4	5.1	.03
Rate Unit 2	incl.	- .25	18.1	13.7	-.22
Rate Unit 3	incl.	- .08	26.1	22.2	-.14
Rate Unit 4	incl.	.06	27.0	21.1	.15
Rate Unit 5	incl.	- .04	25.6	22.4	-.13
Rate Unit 6	incl.	- .07	14.2	13.4	-.12
Rate Unit 7	incl.	- .13	18.0	20.1	-.25
Rate Unit 8	incl.	- .37	4.5	4.2	-.08
Rate Unit 9	de.v.		6.3	10.1	1.00

"A" Coefficient = 41.81
Multiple Correlation Coefficient = .61
Multiple Standard Error of Estimate = 9.62

TABLE X

RESULTS OF STEPWISE MULTIPLE REGRESSION
ANALYTICAL GEOMETRY UNIT 1

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	1.61	22.9	3.5	.01
Math ACT	incl.	-4.49	30.2	2.1	-.35
Soc. Sci. ACT	incl.	-3.24	22.9	5.3	-.14
Nat. Sci. ACT	incl.	3.18	26.2	5.3	.24
Composite ACT	incl.	2.67	25.7	3.0	.04
SH-SSHA	incl.	- .19	55.7	16.0	-.18
SA-SSHA	incl.	- .17	60.9	14.1	-.20
SO-SSHA	rej.		116.5	27.5	-.21
Verbal-ND	incl.	- .49	40.4	12.3	-.13
Comprehension-ND	incl.	- .60	49.1	10.5	-.10
Total-ND	incl.	.59	84.9	14.6	-.14
Rate-ND	rej.		333.8	93.8	.03
Coop. Algebra	rej.		36.2	2.2	-.39
Coop. Trig.	incl.	- .44	16.8	6.0	-.33
Percentile Rank	rej.		18.0	18.6	.22
Enroll. in Trig.	incl.	16.27	0.40	0.50	.28
ADS	incl.	7.48	.71	.46	.14
CDS	incl.	13.88	.54	.50	.36
Rate Unit 1	de.v.		41.4	24.9	1.00
Rate Unit 2	w.h.		20.7	12.6	-.22
Rate Unit 3	w.h.		20.0	9.6	-.36
Rate Unit 4	w.h.		17.6	10.9	-.10

"A" Coefficient = 49.61
Multiple Correlation Coefficient = .80
Multiple Standard Error of Estimate = 19.66

TABLE XI

RESULTS OF STEPWISE MULTIPLE REGRESSION
ANALYTICAL GEOMETRY UNIT 2

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	-1.26	22.9	3.5	-.06
Math ACT	incl.	-2.24	30.2	2.1	.06
Soc. Sci. ACT	incl.	- .78	22.9	5.3	-.12
Nat. Sci. ACT	incl.	-2.55	26.2	5.3	-.26
Composite ACT	incl.	5.05	25.7	3.0	.13
SH-SSHA	incl.	.30	55.7	16.0	.12
SA-SSHA	incl.	- .13	60.9	14.1	.07
SO-SSHA	rej.		116.5	27.5	.10
Verbal-ND	rej.		40.4	12.3	.01
Comprehension-ND	incl.	- .41	49.1	10.5	-.10
Total-ND	incl.	.22	84.9	14.6	.01
Rate-ND	incl.	.05	333.8	93.8	.17
Coop. Algebra	incl.	1.30	36.2	2.2	.17
Coop. Trig.	incl.	- .72	16.8	6.0	-.09
Percentile Rank	incl.	- .11	18.0	18.6	-.11
Enroll. in Trig.	w.h.		.40	.50	-.13
ADS	incl.	3.10	.71	.46	-.05
CDS	incl.	3.65	.54	.50	.04
Rate Unit 1	rej.		41.4	24.9	-.22
Rate Unit 2	de.v.		20.7	12.6	1.00
Rate Unit 3	w.h.		20.0	9.6	.11
Rate Unit 4	w.h.		17.6	10.9	.02

"A" Coefficient = 12.18
Multiple Correlation Coefficient = .63
Multiple Standard Error of Estimate = 13.50

TABLE XII

RESULTS OF STEPWISE MULTIPLE REGRESSION
ANALYTICAL GEOMETRY UNIT 3

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	.81	22.9	3.5	.21
Math ACT	incl.	2.12	30.2	2.1	.37
Soc. Sci. ACT	incl.	.49	22.9	5.3	.22
Nat. Sci. ACT	incl.	1.35	26.2	5.3	.10
Composite ACT	incl.	-1.97	25.7	3.0	-.23
SH-SSHA	incl.	.08	55.7	16.0	.06
SA-SSHA	incl.	- .18	60.9	14.1	-.02
SO-SSHA	rej.		116.5	27.5	.05
Verbal-ND	incl.	- .20	40.4	12.3	-.06
Comprehension-ND	incl.	- .25	49.1	10.5	-.12
Total-ND	incl.	.20	84.9	14.6	.17
Rate-ND	incl.	- .02	333.8	93.8	-.02
Coop. Algebra	rej.		36.2	2.2	.18
Coop. Trig.	incl.	- .85	16.8	6.0	-.21
Percentile Rank	rej.		18.0	18.6	.02
Enroll. in Trig.	w.h.		0.40	0.50	.11
ADS	rej.		.71	.46	-.03
CDS	incl.	4.69	.54	.50	.02
Rate Unit 1	incl.	- .25	41.4	24.9	-.36
Rate Unit 2	incl.	.06	20.7	12.6	.11
Rate Unit 3	de.v.		20.0	9.6	1.00
Rate Unit 4	w.h.		17.6	10.9	.07

"A" Coefficient = 19.39
Multiple Correlation Coefficient = .75
Multiple Standard Error of Estimate = 8.57

TABLE XIII

RESULTS OF STEPWISE MULTIPLE REGRESSION
ANALYTICAL GEOMETRY UNIT 4

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	1.27	22.9	3.5	.21
Math ACT	rej.		30.2	2.1	.20
Soc. Sci. ACT	incl.	2.75	22.9	5.3	.12
Nat. Sci. ACT	rej.		26.2	5.3	-.06
Composite ACT	incl.	-4.21	25.7	3.0	-.08
SH-SSHA	incl.	.75	55.7	3.0	.26
SA-SSHA	rej.		60.9	14.1	.14
SO-SSHA	incl.	- .25	116.5	27.5	-.22
Verbal-ND	incl.	.15	40.4	12.3	.07
Comprehension-ND	incl.	- .85	49.1	10.5	-.03
Total-ND	incl.	.38	84.9	14.6	.10
Rate-ND	incl.	.03	333.8	93.8	.09
Coop. Algebra	incl.	2.66	36.2	2.2	.18
Coop. Trig.	incl.	- .46	16.8	6.0	-.04
Percentile Rank	incl.	.51	18.0	18.6	.08
Enroll. in Trig.	w.h.		0.40	0.50	-.11
ADS	incl.	-11.19	.71	.46	-.03
CDS	incl.	-2.97	.54	.50	-.02
Rate Unit 1	incl.	- .03	41.4	24.9	.10
Rate Unit 2	incl.	.13	20.7	12.6	-.02
Rate Unit 3	incl.	- .16	20.0	9.6	-.07
Rate Unit 4	de.v.		17.6	10.9	1.00

"A" Coefficient = 70.29
Multiple Correlation Coefficient = .72
Multiple Standard Error of Estimate = 10.74

TABLE XIV

RESULTS OF STEPWISE MULTIPLE REGRESSION
TRIGONOMETRY UNIT 1

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	.78	21.1	3.5	.06
Math ACT	rej.		27.0	3.4	-.08
Soc. Sci. ACT	incl.	- .40	20.4	4.8	-.12
Nat. Sci. ACT	rej.		24.4	4.3	-.004
Composite ACT	incl.	.40	23.4	2.8	.06
SH-SSHA	rej.		50.6	17.0	.02
SA-SSHA	incl.	.02	57.4	15.5	.03
SO-SSHA	rej.		108.1	30.4	.02
Verbal-ND	incl.	- .06	35.1	8.2	-.18
Comprehensive-ND	incl.	.32	44.5	9.6	.12
Total-ND	incl.	- .27	77.6	15.8	-.15
Coop. Algebra	incl.	.06	284.4	62.0	.28
Coop. Trig.	incl.	-1.16	32.4	3.6	-.32
Percentile Rank	incl.	.05	24.1	19.7	.24
ADS	rej.		.61	.49	.11
CDS	incl.	-1.02	.61	.49	-.20
Rate Unit 1	de.v.		16.2	7.9	1.00
Rate Unit 2	w.h.		9.5	6.0	.09
Rate Unit 3	w.h.		14.1	8.4	.22
Rate Unit 4	w.h.		15.7	12.0	.36
Rate Unit 5	w.h.		15.3	11.4	.28
Rate Unit 6	w.h.		18.5	16.1	-.09
Rate Unit 7	w.h.		14.9	11.1	.03

"A" Coefficient = 30.0
Multiple Correlation Coefficient = .65
Multiple Standard Error of Estimate = 7.0

TABLE XV

RESULTS OF STEPWISE MULTIPLE REGRESSION
TRIGONOMETRY UNIT 2

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	- .72	21.1	3.5	-.11
Math ACT	incl.	- .33	27.0	3.4	-.28
Soc. Sci. ACT	incl.	1.04	20.4	4.8	.11
Nat. Sci. ACT	incl.	.50	24.4	4.3	.04
Composite ACT	incl.	-2.89	23.4	2.8	-.07
SH-SSHA	incl.	- .12	50.6	17.0	-.03
SA-SSHA	rej.		57.4	15.5	.02
SO-SSHA	incl.	.05	108.1	30.4	.01
Verbal-ND	incl.	.08	35.1	8.2	.09
Comprehensive-ND	incl.	.16	44.5	9.6	.05
Total-ND	incl.	- .15	77.6	15.8	.03
Rate-ND	incl.	.04	284.4	62.0	.23
Coop. Algebra	incl.	- .67	32.4	3.6	-.40
Coop. Trig.	incl.	- .27	11.8	3.8	-.22
Percentile Rank	rej.		24.1	19.7	.06
ADS	incl.	1.78	.61	.49	.13
CDS	rej.		.61	.49	.18
Rate Unit 1	incl.	- .17	16.2	7.9	-.09
Rate Unit 2	de.v.		9.5	6.0	1.00
Rate Unit 3	w.h.		14.1	8.4	.19
Rate Unit 4	w.h.		15.7	12.0	-.05
Rate Unit 5	w.h.		15.3	11.4	.27
Rate Unit 6	w.h.		18.5	16.1	-.05
Rate Unit 7	w.h.		14.9	11.1	-.02

"A" Coefficient = 35.71
Multiple Correlation Coefficient = .64
Multiple Standard Error of Estimate = 5.66

TABLE XVI

RESULTS OF STEPWISE MULTIPLE REGRESSION
TRIGONOMETRY UNIT 3

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	1.37	21.1	3.5	.22
Math ACT	incl.	1.10	27.0	3.4	.02
Soc. Sci. ACT	incl.	- .13	20.4	4.8	-.03
Nat. Sci. ACT	incl.	.55	24.4	4.3	.01
Composite ACT	incl.	-1.73	23.4	2.8	-.04
SH-SSHA	rej.		50.6	17.0	.16
SA-SSHA	incl.	.05	57.4	15.5	.27
SO-SSHA	incl.	.10	108.1	30.4	.22
Verbal-ND	incl.	- .14	35.1	8.2	-.11
Comprehensive-ND	incl.	.33	44.5	9.6	.10
Total-ND	incl.	- .15	77.6	15.8	.03
Rate-ND	incl.	- .03	284.4	62.0	-.15
Coop. Algebra	incl.	-1.27	32.4	3.6	-.31
Coop. Trig.	incl.	- .55	11.8	3.8	-.32
Percentile Rank	rej.		24.1	19.7	.19
ADS	incl.	-2.65	.61	.49	-.12
CDS	incl.	3.08	.61	.49	.20
Rate Unit 1	incl.	- .04	16.2	7.9	.22
Rate Unit 2	incl.	.21	9.5	6.0	.19
Rate Unit 3	de.v.		14.1	8.4	1.00
Rate Unit 4	w.h.		15.7	12.0	-.01
Rate Unit 5	w.h.		15.3	11.4	.06
Rate Unit 6	w.h.		18.5	16.1	.20
Rate Unit 7	w.h.		14.9	11.1	.48

"A" Coefficient = 33.74
Multiple Correlation Coefficient = .74
Multiple Standard Error of Estimate = 7.10

TABLE XVII

RESULTS OF STEPWISE MULTIPLE REGRESSION
TRIGONOMETRY UNIT 4

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	1.28	21.1	3.5	+.06
Math ACT	incl.	- .12	27.0	3.4	-.07
Soc. Sci. ACT	incl.	1.86	20.4	4.8	-.15
Nat. Sci. ACT	incl.	.68	24.4	4.3	-.13
Composite ACT	incl.	-5.16	23.4	2.8	-.17
SH-SSHA	incl.	.13	50.6	17.0	-.10
SA-SSHA	incl.	- .33	57.4	15.5	-.28
SO-SSHA	rej.		108.1	30.4	-.20
Verbal-ND	incl.	- .21	35.1	8.2	-.24
Comprehensive-ND	rej.		44.5	9.6	-.13
Total-ND	rej.		77.6	15.8	-.19
Rate-ND	incl.	.05	284.4	62.0	.12
Coop. Algebra	incl.	.80	32.4	3.6	.07
Coop. Trig.	incl.	- .34	11.8	3.8	-.09
Percentile Rank	incl.	.10	24.1	19.7	.14
ADS	incl.	4.97	0.61	0.49	.09
CDS	incl.	-8.30	0.61	0.49	-.14
Rate Unit 1	incl.	.49	16.2	7.9	.36
Rate Unit 2	incl.	- .35	9.5	6.0	-.05
Rate Unit 3	incl.	.12	14.1	8.4	.01
Rate Unit 4	de.v.		15.7	12.0	1.00
Rate Unit 5	w.h.		15.3	11.4	.08
Rate Unit 6	w.h.		18.5	16.1	-.16
Rate Unit 7	w.h.		14.9	11.1	-.26

"A" Coefficient = 35.67
Multiple Correlation Coefficient = .64
Multiple Standard Error of Estimate = 11.62

TABLE XVIII

RESULTS OF STEPWISE MULTIPLE REGRESSION
TRIGONOMETRY UNIT 5

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	- .45	21.1	3.5	-.05
Math ACT	incl.	.86	27.0	3.4	-.04
Soc. Sci. ACT	incl.	.34	20.4	4.8	.19
Nat. Sci. ACT	rej.		24.4	4.3	.07
Composite ACT	rej.		23.4	2.8	.12
SH-SSHA	incl.	- .18	50.6	17.0	-.25
SA-SSHA	incl.	.10	57.4	15.5	-.08
SO-SSHA	rej.		108.1	30.4	-.18
Verbal-ND	incl.	- .29	35.1	8.2	-.08
Comprehensive-ND	incl.	.37	44.5	9.6	.06
Total-ND	rej.		77.6	15.8	.02
Rate-ND	incl.	- .07	284.4	62.0	-.12
Coop. Algebra	incl.	- .31	32.4	3.6	-.21
Coop. Trig.	incl.	- .20	11.8	3.8	-.14
Percentile Rank	incl.	.07	24.1	19.7	.18
ADS	rej.		0.61	0.49	.10
CDS	incl.	5.79	0.61	0.49	.23
Rate Unit 1	incl.	.62	16.2	7.9	.29
Rate Unit 2	incl.	.61	9.5	6.0	.27
Rate Unit 3	incl.	- .35	14.1	8.4	-.06
Rate Unit 4	incl.	- .10	15.7	12.0	-.08
Rate Unit 5	de.v.		15.3	11.4	1.00
Rate Unit 6	w.h.		18.5	16.1	-.18
Rate Unit 7	w.h.		14.9	11.1	.21

"A" Coefficient = 13.07
Multiple Correlation Coefficient = .66
Multiple Standard Error of Estimate = 10.58

TABLE XIX

RESULTS OF STEPWISE MULTIPLE REGRESSION
TRIGONOMETRY UNIT 6

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	.13	21.1	3.5	-.10
Math ACT	incl.	.67	27.0	3.4	-.19
Soc. Sci. ACT	incl.	1.37	20.4	4.8	.07
Nat. Sci. ACT	incl.	2.42	24.4	4.3	.20
Composite ACT	incl.	-4.97	23.4	2.8	-.02
SH-SSHA	incl.	.29	50.6	17.0	.27
SA-SSHA	rej.		57.4	15.5	.20
SO-SSHA	rej.		108.1	30.4	.25
Verbal-ND	incl.	.77	35.1	8.2	.13
Comprehensive-ND	incl.	.23	44.5	9.6	-.06
Total-ND	incl.	- .44	77.6	15.8	-.08
Rate-ND	incl.	- .06	284.4	62.0	-.26
Coop. Algebra	incl.	- .76	32.4	3.6	-.22
Coop. Trig.	rej.		11.8	3.8	-.03
Percentile Rank	incl.	.44	24.1	19.7	.20
ADS	incl.	-4.38	0.61	0.49	-.18
CDS	incl.	-12.16	0.61	0.49	.00
Rate Unit 1	rej.		16.2	7.9	-.09
Rate Unit 2	rej.		9.5	6.0	.04
Rate Unit 3	incl.	.23	14.1	8.4	.20
Rate Unit 4	incl.	- .26	15.7	12.0	-.16
Rate Unit 5	incl.	- .26	15.3	11.4	-.18
Rate Unit 6	de.v.		18.5	16.1	1.00
Rate Unit 7	w.h.		14.9	11.1	.03

"A" Coefficient = 54.17
Multiple Correlation Coefficient = .74
Multiple Standard Error of Estimate = 13.64

TABLE XX

RESULTS OF STEPWISE MULTIPLE REGRESSION
TRIGONOMETRY UNIT 7

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	.60	21.1	3.5	.12
Math ACT	incl.	1.10	27.0	3.4	.10
Soc. Sci. ACT	incl.	- .49	20.4	4.8	-.14
Nat. Sci. ACT	rej.		24.4	4.3	-.18
Composite ACT	incl.	-1.59	23.4	2.8	-.07
SH-SSHA	incl.	.35	50.6	17.0	.23
SA-SSHA	incl.	- .21	57.4	15.5	-.24
SO-SSHA	rej.		108.1	30.4	.25
Verbal-ND	rej.		35.1	8.2	-.07
Comprehensive-ND	incl.	.20	44.5	9.6	.19
Total-ND	incl.	.06	77.6	15.8	-.08
Rate-ND	incl.	- .06	284.4	62.0	-.27
Coop. Algebra	incl.	- .46	32.4	3.6	-.22
Coop. Trig.	incl.	- .20	11.8	3.8	-.03
Percentile Rank	rej.		24.1	19.7	.20
ADS	incl.	-2.40	0.61	0.49	-.02
CDS	incl.	1.42	0.61	0.49	.04
Rate Unit 1	rej.		16.2	7.9	-.09
Rate Unit 2	rej.		9.5	6.0	.04
Rate Unit 3	incl.	.38	14.1	8.4	.48
Rate Unit 4	incl.	- .23	15.7	12.0	-.26
Rate Unit 5	incl.	.23	15.3	11.4	.21
Rate Unit 6	incl.	- .06	18.5	16.1	-.03
Rate Unit 7	de.v.		14.9	11.1	1.00

"A" Coefficient = 31.06
Multiple Correlation Coefficient = .77
Multiple Standard Error of Estimate = 8.94

Hypothesis Number Two

Hypothesis number two stated in the alternate form reads: There will be a statistically significant (0.05 level) relationship between the independent (predictor) variables-aptitude, prior performance, and personality and the binary dependent variable-"procrastination." Also, this statistically significant relationship will generate a linear combination of predictors to the dependent variable.

The statistical method of testing hypothesis number two is step-wise multiple regression. The significance level that was specified to the computer for inclusion of any predictor was the 0.05 level of significance; therefore, if any one or more predictors are accepted into the regression equation, there is a statistically significant relationship between the combined independent variables and the dependent variable.

The step-wise multiple regression program accepted 16 of the 17 potential predictors into the regression equation; therefore, the alternate hypothesis is accepted. Table XXI presents the results of the computational routine. Table XXI follows basically the same format as Table I through Table XX with the exception that the dependent variable is not listed in the table. The mean of the dependent variable is 0.67 and the standard deviation is 0.49.

TABLE XXI

RESULTS OF STEPWISE MULTIPLE REGRESSION
PREDICTION OF NSP

Predictor	Stat. in Equa.	Reg. Coeff.	Mean	S.D.	Dep. Vari. Corr.
English ACT	incl.	0.68	21.5	3.2	0.13
Math ACT	incl.	-0.04	27.7	3.7	-0.02
Soc. Sci. ACT	incl.	0.01	21.9	5.2	0.11
Nat. Sci. ACT	incl.	-0.01	25.7	4.7	-0.02
Composite ACT	incl.	-0.05	24.4	3.1	-0.09
SH-SSHA	incl.	-0.01	52.6	17.7	-0.09
SA-SSHA	incl.	-0.01	58.8	16.7	-0.13
SO-SSHA	incl.	0.01	110.7	31.7	-0.13
Verbal-ND	incl.	-0.01	39.9	11.4	-0.02
Comprehension-ND	incl.	0.01	47.8	9.9	0.12
Total-ND	rej.		87.7	19.0	0.05
Rate-ND	incl.	-0.01	315.1	85.6	-0.17
Coop. Algebra	incl.	0.07	33.2	4.0	0.23
Coop. Trig.	incl.	-0.01	13.6	5.6	-0.01
Percentile Rank	incl.	-0.01	21.4	19.7	-0.22
ADS	incl.	0.40	0.6	0.5	0.18
CDS	incl.	0.11	0.7	0.5	0.30

"A" Coefficient = 0.68
Multiple Correlation Coefficient = 0.58
Multiple Standard Error of Estimate = 0.45

Hypothesis Number Three

Hypothesis number three stated in the alternate form reads: There will be a statistically significant relationship between the instructional domain and the efficiency domain. Also, each instructional unit will make a differential contribution to the relationship between domains.

Hypothesis number three was tested three times in a rate of learning mode and three times in an error mode. In each mode, hypothesis number two was tested once for English, once for trigonometry, and once for analytical geometry. In all of the testings, the first and only the first pair of canonical variates derived were found to be significant at the 0.05 level of significance; therefore, the alternate hypothesis is accepted. Table XXII presents the canonical correlation coefficients associated with all of the first derived canonical variate pairs, and Table XXIII presents the canonical correlation coefficients associated with all of the second derived canonical variate pairs. Tables XXII and XXIII have the following format: the "Course" column identifies the course in which the hypothesis is being tested. The "Mode" column identifies the mode (rate or error) in which the hypothesis is being tested, and the "Canonical Correlation Coefficient" column presents the canonical correlation coefficient associated with that particular test of the hypothesis.

Table XXIV through Table XXXV present the statistics associated with each significant pair of canonical variates. Only statistically significant variate pairs are presented. Tables XXIV, XXVI, XXXVIII, XXX, XXXII, and XXXIV have the following format: the "Instructional Domain" column identifies the variable (instructional units) in the instructional domain. To the immediate right of the "Instructional Domain" column is the "Reg. Coeff." column which

which presents the regression coefficients associated with each instructional unit. The "Efficiency Domain" column identifies the variables, Total Errors and Total Number of Days (Rate), contained in the efficiency domain. The statistically significant canonical correlation coefficient is presented at the bottom of each table.

TABLE XXII

INSTRUCTIONAL AND EFFICIENCY DOMAINS
CANONICAL CORRELATION COEFFICIENTS
FIRST VARIATE PAIR

Course	Mode	Canonical Correlation Coefficients	P
English	Error	0.97	<.05
English	Rate	0.57	<.05
Trigonometry	Error	0.99	<.05
Trigonometry	Rate	0.99	<.05
Analytical Geometry	Error	0.98	<.05
Analytical Geometry	Rate	0.95	<.05

TABLE XXIII

INSTRUCTIONAL AND EFFICIENCY DOMAINS
CANONICAL CORRELATION COEFFICIENTS
SECOND VARIATE PAIR

Course	Mode	Canonical Correlation Coefficients	P
English	Error	0.28	NS
English	Rate	0.33	NS
Trigonometry	Error	0.29	NS
Trigonometry	Rate	0.23	NS
Analytical Geometry	Error	0.08	NS
Analytical Geometry	Rate	0.21	NS

TABLE XXIV

INSTRUCTIONAL AND EFFICIENCY DOMAINS
FIRST PAIR OF CANONICAL VARIATES
ENGLISH ERROR MODE

Instructional Domain	Reg. Coeff.	Efficiency Domain	Reg. Coeff.
Unit 1	0.07	Error	0.99
Unit 2	0.23	Rate	-0.02
Unit 3	0.23		
Unit 4	0.33		
Unit 5	0.26		
Unit 6	0.10		
Unit 7	0.26		
Unit 8	0.25		
Unit 9	0.29		

Canonical Correlation Coefficient = 0.97

TABLE XXV

INSTRUCTIONAL AND EFFICIENCY DOMAINS
INTERCORRELATION MATRIX
ENGLISH ERROR MODE

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Error 10	Rate 11
1	1.00	.01	-.02	.41	.48	.56	.32	.33	.51	.62	.62
2		1.00	-.13	-.09	-.00	.15	-.11	-.06	.02	-.04	-.01
3			1.00	-.03	-.04	-.08	-.04	-.03	-.05	-.05	-.05
4				1.00	.23	.13	-.10	.23	.07	.11	.21
5					1.00	.23	-.04	.12	.06	.18	.25
6						1.00	.09	-.02	.07	.29	.19
7							1.00	.36	.09	.04	.03
8								1.00	.09	.12	.11
9									1.00	.38	.27
10										1.00	.34
11											1.00

TABLE XXVI

INSTRUCTIONAL AND EFFICIENCY DOMAINS
FIRST PAIR OF CANONICAL VARIATES
ENGLISH RATE MODE

Instructional Domain	Reg. Coeff.	Efficiency Domain	Reg. Coeff.
Unit 1	-0.03	Error	0.15
Unit 2	0.09	Rate	0.99
Unit 3	0.24		
Unit 4	0.60		
Unit 5	0.45		
Unit 6	-0.26		
Unit 7	0.35		
Unit 8	-0.23		
Unit 9	0.03		

Canonical Correlation Coefficient = 0.57

TABLE XXVII

INSTRUCTIONAL AND EFFICIENCY DOMAINS
INTERCORRELATIONAL MATRIX
ENGLISH RATE MODE

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9	Error 10	Rate 11
1	1.00	-.01	-.04	-.17	.02	.15	-.10	.00	.11	-.06	-.10
2		1.00	.10	.07	.25	.39	.24	-.16	.17	-.24	-.00
3			1.00	.18	.14	.11	.17	.08	.02	-.09	-.06
4				1.00	.12	.02	-.15	-.14	-.06	-.09	-.22
5					1.00	.14	.11	-.19	-.07	-.14	-.08
6						1.00	-.01	-.10	.03	-.15	.20
7							1.00	.22	-.04	-.06	-.17
8								1.00	.08	.07	-.16
9									1.00	-.09	-.21
10										1.00	.18
11											1.00

TABLE XXVIII

INSTRUCTIONAL AND EFFICIENCY DOMAINS
FIRST PAIR OF CANONICAL VARIATES
TRIGONOMETRY ERROR MODE

Instructional Domain	Reg. Coeff.	Efficiency Domain	Reg. Coeff.
Unit 1	0.20	Error	1.00
Unit 2	0.19	Rate	-0.00
Unit 3	0.31		
Unit 4	0.21		
Unit 5	0.23		
Unit 6	0.33		
Unit 7	0.24		

Canonical Correlation Coefficient = 0.99

TABLE XXIX

INSTRUCTIONAL AND EFFICIENCY DOMAINS
INTERCORRELATION MATRIX
TRIGONOMETRY ERROR MODE

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Error 8	Rate 9
1	1.00	.51	.48	.60	.68	.55	.53	.67	.50
2		1.00	.23	.37	.38	.45	.24	.27	.17
3			1.00	.10	.29	.33	.15	.16	.03
4				1.00	.38	.12	.20	.35	.33
5					1.00	.44	.15	.23	.15
6						1.00	.17	.24	-.02
7							1.00	.23	.28
8								1.00	.25
9									1.00

TABLE XXX

INSTRUCTIONAL AND EFFICIENCY DOMAINS
FIRST PAIR OF CANONICAL VARIATES
TRIGONOMETRY RATE MODE

Instructional Domain	Reg. Coeff.	Efficiency Domain	Reg. Coeff.
Unit 1	0.24	Error	-0.00
Unit 2	0.23	Rate	1.00
Unit 3	0.25		
Unit 4	0.39		
Unit 5	0.35		
Unit 6	0.48		
Unit 7	0.33		

Canonical Correlation Coefficient = .99

TABLE XXXI

INSTRUCTIONAL AND EFFICIENCY DOMAINS
INTERCORRELATION MATRIX
TRIGONOMETRY RATE MODE

	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Error 8	Rate 9
1	1.00	.51	.31	.30	.34	.22	.14	.24	.12
2		1.00	.47	.41	.58	.36	.41	.49	.39
3			1.00	.00	.23	.25	.30	-.10	.05
4				1.00	.07	.18	.19	.12	-.08
5					1.00	-.05	.10	.18	.49
6						1.00	-.06	-.01	-.29
7							1.00	-.17	.11
8								1.00	.05
9									1.00

TABLE XXXII

INSTRUCTIONAL AND EFFICIENCY DOMAINS
FIRST PAIR OF CANONICAL VARIATES
ANALYTICAL GEOMETRY ERROR MODE

Instructional Domain	Reg. Coeff.	Efficiency Domain	Reg. Coeff.
Unit 1	0.41	Error	0.99
Unit 2	0.48	Rate	0.04
Unit 3	0.38		
Unit 4	0.44		

Canonical Correlation Coefficient = 0.98

TABLE XXXIII

INSTRUCTIONAL AND EFFICIENCY DOMAINS
ANALYTICAL GEOMETRY ERROR MODE
INTERCORRELATION MATRIX

	Unit 1	Unit 2	Unit 3	Unit 4	Error 5	Rate 6
1	1.00	.14	.43	.74	.48	.60
2		1.00	.02	.12	.10	.16
3			1.00	.16	-.13	-.01
4				1.00	.22	.26
5					1.00	.13
6						1.00

TABLE XXXIV

INSTRUCTIONAL AND EFFICIENCY DOMAINS
FIRST PAIR OF CANONICAL VARIATES
ANALYTICAL GEOMETRY RATE MODE

Instructional Domain	Reg. Coeff.	Efficiency Domain	Reg. Coeff.
Unit 1	0.97	Error	0.09
Unit 2	0.53	Rate	0.98
Unit 3			
Unit 4			

Canonical Correlation Coefficient = 0.95

TABLE XXXV

INSTRUCTIONAL AND EFFICIENCY DOMAINS
ANALYTICAL GEOMETRY RATE MODE
INTERCORRELATION MATRIX

	Unit 1	Unit 2	Unit 3	Unit 4	Error 5	Rate 6
1	1.00	.14	.12	.22	-.10	.05
2		1.00	.64	.33	.06	.32
3			1.00	-.25	-.40	-.06
4				1.00	.19	-.00
5					1.00	-.02
6						1.00

Hypothesis Number Four

Hypothesis number four stated in the alternate form reads: There will be a statistically significant relationship between discipline domains. Also, each instructional unit will make a differential contribution to that relationship.

Canonical analysis was used to test hypothesis number four. There were seven pairs of canonical variates derived in the error mode and seven in the rate mode. None of the canonical correlation coefficient in the error mode were statistically significant. Only the first canonical correlation coefficient in the rate mode was significant at the 0.05 level. The alternate hypothesis is accepted only for the rate mode. Table XXXVI presents the seven canonical correlation coefficients for the error mode, and Table XXXVII presents the seven canonical correlations for the rate mode. Table XXXVIII presents the intercorrelation matrix for the English and trigonometry domains. Table XXXIX presents the statistics associated with the rate mode--first canonical variate pair.

TABLE XXXVI

ENGLISH AND TRIGONOMETRY DOMAINS
CANONICAL CORRELATIONS
ERROR MODE

Canonical Variate Pair	Canonical Correlation Coeff.	P
First	0.83	NS
Second	0.73	NS
Third	0.63	NS
Fourth	0.56	NS
Fifth	0.39	NS
Sixth	0.25	NS
Seventh	0.11	NS

TABLE XXXVII

ENGLISH AND TRIGONOMETRY DOMAINS
CANONICAL CORRELATIONS
RATE MODE

Canonical Variate Pair	Canonical Correlation Coeff.	P
First	0.96	<.05
Second	0.89	NS
Third	0.70	NS
Fourth	0.58	NS
Fifth	0.42	NS
Sixth	0.30	NS
Seventh	0.04	NS

TABLE XXXVIII

ENGLISH AND TRIGONOMETRY DOMAINS
INTERCORRELATION MATRIX
RATE MODE

	Trigonometry Domain						
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
1	1.00	.12	.19	.25	.27	-.07	-.16
2		1.00	.22	-.07	.45	.09	-.03
3			1.00	-.14	.08	.27	.60
4				1.00	-.10	-.18	-.39
5					1.00	-.15	.02
6						1.00	.10
7							1.00

	English Domain								
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7	Unit 8	Unit 9
1	-.04	.43	.25	.25	-.16	-.20	.22	-.15	-.23
2	.31	.30	.09	.26	-.09	-.04	.01	-.21	.03
3	.47	.40	.30	.56	-.02	.09	-.05	-.18	-.14
4	.09	.18	-.10	.04	-.12	-.37	-.03	-.03	.52
5	.24	.17	-.08	.12	-.07	.05	.24	-.18	-.12
6	.14	.13	.14	.31	.05	.23	.49	.16	-.19
7	.23	.17	.34	.41	-.16	.25	-.06	-.25	-.06
8	1.00	-.03	.14	.24	-.02	.14	.19	-.23	.05
9		1.00	.27	.04	.01	-.26	.15	-.29	-.22
10			1.00	.45	-.11	-.23	-.15	-.28	-.16
11				1.00	-.13	-.01	-.09	-.22	.19
12					1.00	-.07	-.15	-.01	-.24
13						1.00	.26	-.13	-.10
14							1.00	-.20	-.27
15								1.00	-.00
16									1.00

TABLE XXXIX

ENGLISH AND TRIGONOMETRY DOMAINS
FIRST CANONICAL VARIATE PAIR
RATE MODE

English Domain	Reg. Coeff.	Trigonometry Domain	Reg. Coeff.
Unit 1	-0.31	Unit 1	-0.31
Unit 2	-0.63	Unit 2	-0.21
Unit 3	0.03	Unit 3	-0.32
Unit 4	-0.68	Unit 4	-0.34
Unit 5	0.05	Unit 5	-0.20
Unit 6	-0.14	Unit 6	-0.51
Unit 7	-0.24	Unit 7	-0.37
Unit 8	-0.25		
Unit 9	0.02		

Canonical Correlation Coefficient = 0.96

CHAPTER V

CONCLUSIONS, RECOMMENDATIONS AND SUMMARY

Introduction

A problem in educational research has been created by a need for research methodology that is involved with increasing the efficiency of instructional systems. The purpose of the present investigation was to develop, describe, and suggest uses for multivariant analysis techniques that will eventually become tools to assist managers of instructional systems. The above mentioned research problem has been attacked by creating four research questions. The purpose of Chapter V is to draw conclusions as to whether each research question has been answered, and simultaneously, to conclude if the educational need associated with each research question has been satisfied. Also, suggestions and recommendations regarding the results of the present study will be offered. Immediately following this introduction will be a brief recapitulation of the study. Then, as has been the format throughout the document, each of the four research questions (and its accompanying hypothesis) will be considered separately. Chapter V will end with a brief summary of the results, conclusions, and recommendations.

Recapitulation

Chapter I brought a research need and problem to the reader's attention. A theoretical approach using the concept of mathemagenic behaviors was advanced as the framework for solving the four research problems which were developed in Chapter I. Also, the instructional system (a mastery learning-Individually Prescribed Instruction) which the present study specifically deals with was articulated. Chapter II used a review of the related literature to both suggest ways of solving the four research questions and to convert each research question into a research hypothesis. Chapter III outlined the methodology used to test the four hypotheses. Hypotheses I and II were tested by a multivariate technique--multiple regression. Hypotheses III and IV were tested by the multivariant technique known as canonical analysis. Chapter IV presented the statements of acceptance or rejection of the alternate research hypotheses, and the statistics that accompanied each hypothesis were presented by means of statistical tables.

Hypothesis Number One

Hypothesis and research question number one deal with the mathemagenic behavior-rate of learning. It is important to be able to predict individual rate of learning in order to truly individualize instruction. The statistical results as presented in Chpter IV lead to the conclusion that the multivariate technique of multiple regression and prediction is successful and sound research methodology to predict rate of learning. Examination of the single and multiple correlation coefficients reveals the tremendous gain in prediction when one uses multiple predictors rather than just one predictor. For example, the single correlations with rate of learning ranged from 0.0 to 0.42, and the multiple correlations ranged from 0.57 to 0.80. Another statistical phenomenon that is manifested in Tables I through XX is that the predictors that represent the optimal combination for prediction change from unit to unit. Even in the same course there is no single variable that is the best predictor for every unit. The step-wise computational routine is advantageous because the investigator can examine a broad spectrum of potential predictors, and at the same time, with little or no hand calculation, he can reduce the regression equation to a simple and useful form.

Probably the single most effective use of this research methodology is the identification of people who are procrastinating. If John Smith is predicted to finish Unit three in 38 days (plus or minus a week 68% of the time) and 45 days have passed, John needs some counseling. The instructor can bring John in and tell him that he is not progressing satisfactorily. The instructor can now take this action and feel fairly confident that he has not violated the mastery learning philosophy. Mastery learning asserts that a student should be given the time he needs to master the subject matter. The multivariate technique associated with hypothesis number one can supply the instructor with means of identifying how much time each individual needs. Using the "time needed" information, the instructor can keep the student working closer to an optimal pace, thereby increasing the efficiency of the instructional system.

Although the express study of relationships is beyond the scope of the research question (which deals only with predictive power), an investigator who is insterested in which skills are most closely related to rate of learning in each unit could examine the correlation coefficients and partial correlations which are computed as part of the computational routine. This information could point the way to important revision of learning activities.

Hypothesis Number Two

Hypothesis and research question number two is concerned with the dishabilitating mathemagenic behavior--procrastination. In self-pacing programs, there are some students who cannot seem to manage their time. This may seem to be a strange trait to find in an individual whose scholastic achievements have gotten him as far as college freshman status. However, most college freshmen are used to (for 12 years) an instructional system that places rather severe constraints on factors involving time to learn. In light of this fact, many students have always responded to deadlines set for them, not by them; thus, these students have not had the opportunity to manage their own academic time schedule. For some students, even at college level, the removal of time constraints is not a wise educational move because many cannot seem to get started; thus, they fall behind, use up instructional resources, and then drop out. This phenomenon of procrastination as it now manifests itself creates a tremendous drain on the efficiency of an instructional system. Obviously there is an educational need to make early identification of potential procrastinators so that either an alternative for the procrastinator can be built into the system or he can be screened out of the ML-IPI type of instructional system. It is a disservice to the NSP student to allow him to enter the ML-IPI system (as it now exists) for he may do well or at least survive in a more conventional system (he has for 12 years).

The research methodology used to attempt to satisfy the educational need associated with research question number two is again step-wise multiple linear regression. The results of the analysis as presented in Chapter IV indicate that a large step forward in satisfying the above stated need has been made. Although the predictive efficiency of the regression equation is only moderate (standard error of estimate = 0.45), predictions can be made at better than chance accuracy and probability parameters can be placed to mispredictions. The superiority of multiple regression is manifested by the fact that the largest single correlation with the dependent variable was 0.30 while multiple correlation was 0.58. Again, a side-benefit beyond the scope of this study but available is the study of individual variable relationships via the correlation coefficients.

It is suggested that the research methodology associated with research question number two be used to predict procrastinators for the purpose of assignment to special instructional subsystems within the larger ML-IPI system and/or for the purpose of exclusion of certain students from the self-pacing system. When using the regression equations, the researcher and instructor can manipulate the direction of misprediction. Depending on the reasons for prediction and the value judgements of the particular managers of instruction, the exact probability of misidentifying a student as a NSP can be computed and manipulated. For instance, if only students with a predicted score of 0.95 or above were classified as a SP and allowed into the instructional system, one could expect that approximately 34% of the predicted NSPs would actually be students who would have progressed satisfactorily (assuming a standard error of the estimate of 0.45). In this situation, only approximately 15% of the students predicted to be suitable for the system would actually be NSPs. Of course, the cut-off scores could be manipulated such that the greater probability would be to mistakenly classify a student as one who would do well in a self-pacing system.

The tables concerned with hypothesis number one and hypothesis number two yielded a rather unexpected statistical result. The step-wise multiple regression program seemed to be including an unusually high number of predictors which have small correlation coefficients with the dependent variable. Although the program was carefully checked out with hand-calculated data before it was used, the results indicated the possibility that when a vast array of potential predictors were used there might have been a mistake somewhere in the program that was making it too liberal with regard to inclusion of predictors.

Because of the above mentioned suspicions, the multiple regression routine for hypothesis number two was duplicated on another step-wise multiple regression program, BMDOED. The program BMOED did not use the same variance ratio as BMDO2R used for an inclusion constant. However, BMDOED did compute the same F-ratio as a by product of the program. Based on this F-ratio, a constant that represented statistical significance at the 0.05 level was computed for BMDOED and the two step-wise multiple regression programs duplicated each other's results on the check run.

A possible reason for so many predictors with low dependent variable correlations being included in the regression equation was that there may be a great number of suppressor variables present. A suppressor variable is a predictor that correlates lowly with the dependent variable but very highly with another predictor. The ACT scales, the

Nelson-Denny scales, Cooperative series, and the SSHA scales were all validated with GPA. As a result of this method of validation, these scales intercorrelate relatively high which increases the potential for suppressors to appear when the above mentioned scales are used simultaneously in a prediction equation.

The reader is cautioned that the regression coefficients and other specific statistics should not be used until they have been cross-validated with another sample. The reason for displaying Tables I through XXI was to show the methodology at work; it is the methodology that is recommended in the present study.

Hypothesis Number Three

Hypothesis and research question number three were generated from the need to identify the instructional units in a course that have the highest relationship to the total efficiency of a course. This information concerning efficiency-unit relationships should prove valuable when choosing which units should be revised first in order to have the maximum effect on the total efficiency of the instructional system. Results of the canonical analysis as presented in Chapter IV indicate that it is possible to identify the instructional units that contribute the greatest amount of variance to the linkage between the instructional domain and the efficiency domain. The instructional units within each analysis (Tables XXIV through Tables XXXV) can be rank ordered according to the size of the regression coefficients associated with each unit. This rank order may be considered a tentative priority for revision of the units. While correlation does not prove cause-and-effect, it is reasonable to speculate that changing (revising methods and materials) the instructional unit that has the greatest relationship with the efficiency domain could possibly result in the largest change in the total efficiency of the system. The next step in studying the relationship between efficiency and units should be to look for common characteristics, both inter and intra-discipline, between those instructional units that have the highest regression coefficients. For instance, are those units having the largest regression coefficients the longest units or the shortest units? Do they ask higher cognitive level questions on the assessment questions; are they the most boring units; do they come just before Christmas break; or do they have their error or progress rate correlate highly with some certain aptitude? If common variables across these units could be discovered, insight into which variable to manipulate in the revision of activities and materials within these units would be gained.

The results of the analysis as presented in Chapter IV indicate that simple multiple regression to a single dependent variable would be as effective a statistical strategy as canonical analysis with regard to research question number three. This assertion is made in light of the fact that only the first of the two possible canonical correlations were significant each time hypothesis number three was tested. In essence, this means that the only significant linkages between instructional and efficiency domains were either error-error or rate-rate. There were no significant rate-error linkages.

It is suggested that when a data base becomes available, this part of the present study be replicated while adding a third variable to the efficiency domain. This third variable should be a measure of amount of learning gained by the student while in the instructional system. This gain of learning would be a gain score computed by subtracting a pretest score from a posttest score. If only a single modality instructional-efficiency relationship continues to manifest itself, either canonical or single dependent variable multiple regression analysis could be used to identify the unit that has the greatest relative relationship to the efficiency domain.

Hypothesis Number Four

Hypothesis and research question number four were created because of a need to discover if instructional disciplines are related and to identify which of the instructional units are responsible for the relationship between disciplines. The results of canonical analysis on an English discipline and a trigonometry discipline are presented in Chapter IV. These results indicate that canonical analysis was successful in identifying one major linear relationship between the two disciplines and the units that were contributing the most to the relationship were also identified. Only in the rate mode was there a statistically significant canonical correlation coefficient, and then only the first canonical correlation out of a possible seven coefficients represented statistical significance. The size of the regression coefficients associated with each variable is the key to insight into the nature of the two domain's relationship. In the case of the present study, Unit four and Unit two in the English course have the largest coefficient. The nature of the Trigonometry-English linkage is to be found primarily in these three units, English four and two and trigonometry unit six.

Canonical analysis appears to be a successful strategy for identifying the magnitude of discipline relationships and identifying where to look to explain the nature of the relationship. Once the canonical analysis provides these preliminary identifications, it is then the responsibility of those who are intimately familiar with the content and instructional procedure contained within the identified units to explain why the linkage exists where it does. It is beyond the scope of the present study to make a detailed analysis to explain just why the relationship exists; however, some methodology to do so will be suggested. One reason a linkage might exist is because rate of learning in those particular units identified by the canonical analysis might have the same aptitudes correlates. In other words, reading skills could be a factor in the units with the largest regression coefficients; therefore, in part, the relationship across disciplines is due to reading skills linkage. The analyst could obtain the data to look for these aptitude linkages from the tables presented in Chapter IV--hypothesis number one. These tables present the aptitude-rate of learning correlations for each unit. For example, in the present study English Units two and four and trigonometry Unit six all have relatively high correlations with the Cooperative Algebra Test.

Another possible reason for a linkage could be a content linkage; that is to say, passage of the identified units is dependent on knowledge of the same content. If a content linkage is discovered, the managers of instruction may want to make one unit prerequisite to another, especially if one of the units teaches that particular content. If none of the units involved specifically teaches that content, the managers could manipulate the distributed practice effect in the total instructional system by careful sequencing across disciplines.

Perhaps the reason for the linkage is to be found in the "personality" of the students. For example, the structure and content of the identified units could be such that those with best study habits consistantly pass through the units more quickly. If this type of linkage is found, the instructional system's managers might want to consider strategic placement of a unit that has as its objective promoting better study habits. This careful placement could have a more complete and integrated effect on the entire instructional system. Perhaps the identified units are so difficult and boring that the highly motivated are the ones that move through at a reasonable rate. If this type linkage is found (or if the boring factor cannot be removed), the managers would want to manipulate the sequencing so that the students would not be working on these units simultaneously in more than one course. Such a situation could create an aversion to the instructional system that could alter efficiency of the entire system.

These are just a few of many facets to a detailed analysis of across discipline relationships that are all made possible by the methodology evolved in research question number four.

Summary

The purpose of this short section is to summarize conclusions and suggestions that are common to two or more of the four research questions.

It was concluded that step-wise multiple regression and prediction is a successful research strategy for both research question number one and research question number two. The step-wise computational routine allows the analyst to examine a vast array of predictors, and at the end of the routine, have an optimal and manageable prediction equation.

The superiority in predictive efficiency of having a multiple rather than a single predictor was demonstrated.

The results of the present study allowed for the conclusion that canonical analysis is a successful strategy for answering both research question number three and research question number four. In each canonical analysis, only the first canonical correlation coefficient reached statistical significance at the 0.05 level (this was perhaps due to small sample sizes). Since only the first canonical variate pair were significant, perhaps multiple regression to a single dependent variable to answer research question number three might prove as effective as canonical analysis if the above statistical phenomenon continues to manifest itself with a larger sample size and with gain scores included in the efficiency domain.

The reader is cautioned to remember that it is the methodology and not the specific statistical results that can be generalized to other instructional systems of the mastery learning-individually prescribed instructional type. Those who use these procedures should be cognizant of the fact that the correlation and regression coefficients must be updated periodically. Each time procedures and materials are revised and new generations of students enter the courses, the old statistics are no longer representative of the instructional system. Only careful and faithful replication can properly accomplish the updating.

In closing, it is concluded that the present study was successful in the Development of Multivariant Analysis to Improve the Efficiency of an IPI Learning System.

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