To the Graduate Council:

I am submitting herewith a dissertation written by Joyce Bailey Weiler entitled "An Administrative Model for Predicting Student Success in Fundamentals of Mathematics at Lincoln Memorial University." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Educational Administration and Supervision.

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We have read this dissertation and recommend its acceptance:

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Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

AN ADMINISTRATIVE MODEL FOR PREDICTING STUDENT SUCCESS IN FUNDAMENTALS OF MATHEMATICS AT LINCOLN MEMORIAL UNIVERSITY

A Dissertation

Presented for the

Doctor of Education

Degree

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Joyce Bailey Weiler

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ABSTRACT

The purpose of this study was to identify those members of a set of nine variables which best predicted success in Fundamentals of Mathematics at Lincoln Memorial University. The set of variables under consideration included: two scores from the California Achievement Test, Computation Skills, X(1), and Mathematical Concepts, X(2), two scores from the Self Scoring Placement Tests in Mathematics, Applied Arithmetic, X(3), and Algebra I, X(4), age, X(5), income, X(9), years of mathematics completed in high school, X(6), grade in high school mathematics, X(7) and X(8), and years of science in high school, X(10). Data were collected from student test scores and college admissions and financial aid records.

The three variables which were the most significant predictors of success in order of decreasing significance, were Self Scoring Placement Test in Mathematics (Algebra I), X(4), income, X(9), and age, X(5). The total model had an R^2 value of .51. The model containing only those variables which were most significant had an R^2 of .54. The regression equation containing the three most significant variables was:

$$Y = 67.22 + .90\ X(4) + .05\ X(5) + (-1.7 \times 10^{-4})\ X(9).$$

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CHAPTER I

INTRODUCTION

One significant feature of effective instructional design is the identification of potential academic problems. By identifying these problems, academic advisors can save students valuable time and money. Administrators can reduce the problems of class scheduling, overcrowded classrooms, student attrition due to unfair placement, student frustration, and faculty burnout.

Two current crises in education make this study relevant. Carpenter (1983) reported a significant decline in 17 year old American students' scores in mathematics over the past ten years. Paul (1983) reported an increasing shortage of certified mathematics teachers. In Tennessee, interest in education is currently at a high level, and one of the current changes is to increase the number of years of mathematics needed to graduate from high school.

Hecht (1982) discussed changes in college mathematics. According to Hecht (1982) students admitted under "open" policies are often seriously underprepared. Some traditionally prepared high school graduates have either abandoned the field of mathematics, or, whatever they may have learned, they learned without pleasure or understanding. Yet these same students who are deficient in the area of

mathematics desire a degree in fields which require at least a minimum competency in college level mathematics.

In order that this problem be addressed and resolved, Lincoln Memorial University has developed a remedial arithmetic course (three quarter hours credit) and a remedial sequence in introductory algebra (nine quarter hours credit). These courses may be taken for elective credit if a student is deficient in either arithmetic or algebra. Ideally, a student entering Lincoln Memorial University should be able to enroll in Fundamentals of Mathematics, a nine hour sequence of college mathematics, which is currently required for graduation. Questions now exist in the minds of the faculty and administration as to what measures might be appropriate for determining success in this Fundamentals of Mathematics sequence.

I. STATEMENT OF THE PROBLEM

This study examined the problem of placement of students in freshman mathematics at Lincoln Memorial University. Proper placement of students can be accomplished by knowing what measure or measures best predict success in college mathematics.

Wick (1965) demonstrated that the use of multiple regression techniques for predicting success in college mathematics represents a considerable improvement over the use of single predictors. Thus, based on a review of

related literature, the following measures were investigated: 1) California Achievement Test--Test 6--Mathematical Computation; 2) California Achievement Test--Test 7--Mathematical Concepts; 3) Self Scoring Placement Tests in Mathematics--Applied Arithmetic Test; 4) Self Scoring Placement Tests in Mathematics--Elementary Algebra Test; 5) Number of high school mathematics courses taken; 6) Average grade in high school mathematics courses; 7) Age; 8) Income; and 9) Number of high school science courses taken.

The central question was apparent. Did one of the above variables or any combination of those variables accurately predict student success in Fundamentals of Mathematics?

II. DEFINITIONS

1. Average grade in Fundamentals of Mathematics. This grade represents the numerical average on the three tests given during the fall quarter to all students in Fundamentals of Mathematics. This is the dependent variable Y.
2. California Achievement Test (CAT-6). A computation skills level test which measures achievement of mathematical skills such as addition, subtraction, multiplication, and division of rational and real numbers. This is an independent variable, X(1).

3. California Achievement Test (CAT-7). A test which measures achievement of concepts of mathematics including problem solving and algebraic and geometric concepts. This is an independent variable, X(2).
4. Grade in High School Mathematics. A pair of indicator variables X(7) and X(8) in which an assigned score of "good" or "not good" was based on average grades in all high school mathematics course in the following manner:

	X(7)	X(8)
Good-- no grades Below B or 85	1	0
Not Good--at least one grade below B or 85	0	1
Indicates no mathematics taken in high school	0	0

Figure 1. Assignment of Indicator Variable to Represent Grade in High School Mathematics

5. High School Mathematics Courses. The courses included in this group were Algebra I, Algebra II, Geometry, and Advanced Math/Trigonometry. Variable X(6) represents the number of these courses taken.
6. High School Science Courses. The courses included in this group were Biology, Advanced Biology, Zoology, Botany, Chemistry, and Physics. Variable X(10) represents the number of these courses taken.

7. Self Scoring Placement Tests in Mathematics (Applied Arithmetic) (SSPT-AA). A placement test to measure skill in solving word problems. This is an independent variable, X(3).
8. Self Scoring Placement Tests in Mathematics (Elementary Algebra) (SSPT-Alg). A placement test to measure basic algebraic concepts and skills. This is an independent variable, X(4).

III. LIMITATION AND DELIMITATIONS

1. The extent to which Lincoln Memorial University Fundamentals of Mathematics courses compare to those at other colleges limits the external validity of the investigation.
2. The small number of subjects may limit the accuracy of the study.
3. The study is delimited to Lincoln Memorial University Students enrolled in Fundamentals of Mathematics during Fall Quarter 1983.

IV. ASSUMPTIONS

1. It is assumed that the prediction of the dependent variable from the independent variables will be a linear model.
2. It is assumed that the future population of students enrolled in Fundamentals of Mathematics at Lincoln Memorial University will possess the same basic characteristics as the 1983 students enrolled.

V. PROCEDURES

Data for the nine variables in this study were gathered from student test forms, admissions office files and financial aid office files. Subjects in this study were students enrolled at Lincoln Memorial University who possessed certain characteristics:

1. They completed the course entitled Fundamentals of Mathematics (Mathematics 121) during the fall quarter,1983 at Lincoln Memorial University.
2. They were required to take four tests: The California Achievement Test (Test 6 and Test 7), the Self Scoring Placement Tests in Mathematics (Algebra I and Applied Arithemetic).

3. Information relative to family income was on file in the Financial Aid office at Lincoln Memorial University, or available from another source.
4. High School Transcripts or proof of G.E.D. were on file in the Admissions office at Lincoln Memorial University.

There were sixty students included in the study. These students were enrolled in one of four sections of Fundamentals of Mathematics. Instructors in these sections made every effort to make all sections of the course identical. All students covered the same material and used the same textbook. These students took the same exams at approximately the same times during the quarter, and final grades were averaged using the same standardized scale.

Two standardized instruments were used in this study to establish the measures of arithmetic computation skills, mathematical concepts, applied arithmetic skills and algebraic manipulations and concepts. These instruments were: (1) California Achievement Test (CAT), Test 6 and Test 7, Form C, and (2) Self Scoring Placement Tests in Mathematics (SSPT), Applied Arithemetic and Algebra I.

The CAT was designed for measuring, evaluating and analyzing (no longer diagnosing as in earlier editions) school achievement in terms of student performance in the basic curricular content areas of reading, mathematics, and language (Bryan, 1972). In particular, Test 6, Level 5, Arithmetic Computation is a 40 item test concerned with the

arithmetic of whole and rational numbers. Test 7, Level 5, Mathematics Concepts, is a 45 item test which measures understanding of the basic concepts of arithmetic processes, vocabulary, mathematical generalizations and principles. The CAT provides for a separate score on Test 6 and Test 7 as well as a total mathematics score.

The standardization sample for the entire battery of tests was selected by a two stage method of stratified random sampling from public school districts enrolling more than 300 students and from Catholic schools. The public school population was stratified according to geographic region, average enrollment per grade, and community type; and the Catholic schools, according to enrollment, geographic region and type of school. A proportionate representation of minority group students was in the total school population. The final sample contained 203,684 students from schools in 36 states.

Statistical data related to validity included the intercorrelation coefficients for typical grades of each level of Form A and item difficulties for individual items in all forms. The median of within grade correlation is .75. Median reliabilities for the subtests are: computation, .81; concepts, .82.

Bryan (1972) in her review of the 1970 edition of CAT reported that it was one of the better batteries of its kind. She had generally kind words for the mathematics subtest in

general with one exception. The use of "none of these" is used as a fifth option for almost all items. Only for about 10 percent of these items is "none of these" the correct answer, and it should be the correct response for 20 percent of the items in order to function properly on a five option scale.

The Self Scoring Placement Tests in Mathematics (SSPT) are designed for helping school administrators make reliable placement decisions about incoming and continuing students. The assessment information helps to identify those students who are ready for entry-level college courses, and others who need remediation in basic skills (Abernathy, 1980).

The Applied Arithmetic Test, one subtest of the Self Scoring Placement Test in Mathematics (SSPT), has 25 items which test the students' ability to solve problems relating to percentages, proportions, rates, and averages. It also contains items that test students' ability to interpret data involving charts and graphs.

The Elementary Algebra Test, a second subtest of the Self Scoring Placement Test in Mathematics (SSPT), emphasizes operations with real numbers and algebraic expressions and the solutions of linear equations. This test measures the student's overall readiness to begin work in a fundamental concepts course whose prerequisite is a thorough knowledge of elementary algebra.

The norming sample consisted of a random sample of 30,912 students tested during 1976-78. Of those indicating sex on the answer sheet 12,345 were men and 18,160 were women. Sixty-one percent of the sample was under 21 years old. Minority students made up one-fourth of the sample. Almost half the sample was entering college directly from high school. Of the ninety colleges represented in the sample, 33 were represented by fewer than 100 students; 41 by between 100 and 500 students; 11 by 500 to 1000 students; and 5 by more than 1000 students. Seventeen of the colleges were located in the Midwest; 33 in the Northeast; 31 in the South; 2 in the Southwest; and 7 in the West. The percentile ranks were based on students tested in colleges administering College Guidance Placement on a regular basis as part of their placement procedures. These norms should be considered "program norms" rather than "national norms". Percentile ranks for the two self-scoring mathematics tests were computed individually for each test. Thus, those norms are comparable only within tests and not across tests. Norms for each of the individual mathematics tests indicate a student's performance relative to the group of students who elected to take a certain test. The Kuder-Richardson Formula 20 estimate of reliability of the Applied Arithmetic test (n = 1565) was .83 and for the Elementary Algebra test (n = 1470) was .87. The standard error of measurement for the two tests was 3.53 and 3.41 respectively. The

predictive validities of the mathematics tests (.55) show that performance on the tests is positively related to performance in mathematics courses. Because these validity studies were conducted only at regular College Guidance Placement user institutions these results cannot be generalized to a nation wide population. The validities have been consistent over several studies (Abernathy, 1980.)

The data were analyzed with a Model I Radio Shack micro-computer, using a multiple regression analysis software package.

The following steps were used in treating the data for the study:

1. The means and standard deviations were computed for the dependent variable and each of the independent variables.
2. Pearson-product-moment correlation coefficients among the independent variables were calculated.
3. Pearson-product-moment correlation coefficients between the dependent variable and each of the independent variables were calculated.
4. A backward elimination multiple linear regression analysis as described in Neter and Wasserman (1974, p 386) was made between the dependent variable and the nine independent variables.

To determine the predictive value of each of the particular measures, the following dependent variables were used:

X(1) = CAT, Test 6, Level 5, raw score (40 possible)

X(2) = CAT, Test 7, Level 5, raw score (45 possible)

X(3) = SSPT-AA, Self Scoring Placement test in Applied Arithmetic, raw score (25 possible)

X(4) = SSPT-Alg., Self Scoring Placement test in Elementary Algebra, raw score (35 possible)

X(5) = Age, in months beyond the seventeenth birthday

X(6) = Assigned score (0-4) based on the number of years of high school mathematics completed

X(7) = One of two dummy variables showing grade in high school mathematics courses based on a "good-not good" scale [see X(8)]

X(8) = One of two dummy variables showing grade in high school mathematics courses based on a "good-not good" scale

X(9) = Income

X(10) = Assigned score (0-4) based on number of years of high school science completed

The criterion variable was:

Y = Final Grade in Mathematics 121

Prediction equations were of the following format:

$$Y = B(1) + B(2)X(1) + B(3)X(2) + B(4)X(3) + B(5)X(4) + B(6)X(5) + B(7)X(6) + B(8)X(7) + B(9)X(8) + B(10)X(9) + B(11)X(10)$$

where B(1) represents a constant and B(2), . . . B(11) represent the coefficients of regression.

VI. ORGANIZATION OF THE STUDY

The study was divided into four chapters as follows:

Chapter 1--contains a general introduction, statement of the problem, assumptions, limitation and delimitations, definitions, procedures and organization of the study.

Chapter 2--contains a review of the related literature. This review is limited to post-secondary studies in the area of mathematics.

Chapter 3--contains a presentation of the data as well as an analysis and discussion of the data.

Chapter 4--contains the summary, findings, conclusions, and recommendations of the study.

CHAPTER II

REVIEW OF RELATED LITERATURE

A look at prediction studies in the area of education, and, in particular, in the area of academic performance, shows a range from elementary grades through graduate school, and a wide variety as to subject matter. Studies discussed in detail here are limited to the area of post-secondary mathematics. Other studies which have a bearing on research in the area of mathematics or which are relevant because of the nature or their design or analysis are included at the end of the chapter.

Morgan (1970), in a study at the University of Toledo, found four factors to be significant in predicting success in an introductory mathematics course similar to the Fundamentals of Mathematics course at Lincoln Memorial University. The population consisted of fifty day students who were enrolled in a freshman mathematics course at the University Community and Technical College of the University of Toledo during the 1966-67 academic year. The four significant factors and their respective relative contributions in forecasting success were: 1) Score on the Cooperative Mathematics Test (34 percent); 2) Years High School Math (25 percent); 3) Grade in High School Math (27 percent); and 4) Age

(14 percent). The analysis resulted in the following prediction equation:

$$Y = .01602799\ X(1) + .09726042\ X(2) + .19494335\ X(3) - .00494199\ X(4)$$

where X(1) equaled the student's score on the Cooperative Mathematics Test, X(2) equaled the number of years of high school math completed, X(3) was the mean grade point in high school mathematics and X(4) represented age in months beyond the seventeenth birthday. This prediction equation was reported to deliver accurate predictions 90 percent of the time.

One of Morgan's main purposes for completing the study was to identify those students that required remedial attention prior to entering the basic mathematics course. This information was helpful to the faculty and administration in that it allowed them to deal with the survival rate/attrition rate problem at the University of Toledo more readily. Dahlke (1974) supported Morgan's findings but in a different setting. He conducted an exploratory study of an individualized, self-paced, mastery-oriented course in arithmetic at Washtenaw Community College in Ann Arbor, Michigan. The study was divided into several parts, but one part, predicting student success, was particularly relevant to this study. The sample consisted of 113 students who were enrolled in a three-credit course in arithmetic for the fall semester of 1969. The prediction results were

determined by the use of a stepwise discriminant analysis program. The results of the analysis showed that scores on the Stanford Achievement Test in Computation, Concepts, and Applications were the best predictors and ages and reasons for enrolling in the basic arithmetic course were other significant factors.

In a study conducted at the Federal School of Science in Lagos, Nigeria, Akeju (1970) selected a sample of 109 college students who had completed a battery of six essay-type achievement tests--English Language, Elementary Mathematics, Additional Mathematics, Physics, Chemistry, and Biology. He used the scores from these six tests as predictor variables and an internally administered examination consisting of achievement scores in Physics, Chemistry, Zoology, Botany, Pure Mathematics and Applied Mathematics as criterion variables. In addition, a rating derived from an interview held prior to the student taking the essay-type achievement tests, was used as a predictor variable. Finally, to supplement these data, a series of three tests selected from a battery of 21 aptitude tests and entitled the Internationally Developed Tests--Arithmetic, Reading Comprehension, and Verbal Analogies-- were administered to these students. An unweighted composite score on these three tests was yet another of the predictor variables used in this study. The analysis for this study included finding the Pearson product-moment intercor-

relations among predictor and criterion variables as well as multiple regression equations and multiple R's. The major findings of this study show that a combination of predictors consisting of six achievement tests, an interview, and a scholastic aptitude test was only slightly more valid than was the use of an optimally weighted combination of six achievement tests in predicting success on examinations given at the end of one year of college work. The best predictor of success at the end of the year was an achievement examination based on high school subjects which was given prior to admission. Correlation coefficients for elementary mathematics and additional mathematics were 0.48 and 0.40 respectively.

In a study addressing the problem of placement of students in an undergraduate mathematics curriculum, Fujita and O'Reilly (1970) noted that the initial discrepant background of incoming students, and the changes being made in the college curriculum have created problems in course development and in using traditional placement tests as predictors of course performance. They considered several measures of mathematical ability and achievement, and based on past experiences chose the best measures available to them from existing scores for the students enrolled in mathematics during the semester under investigation. Thus the following were their four "predictor" variables 1) Sequential Test of Educational Progress (STEP-M); 2) The

Scholastic Aptitude Test of Mathematical Ability (SAT-M); 3) The Scholastic Aptitude Test of Verbal Ability (SAT-V) and 4) The Mathematics Test of the Cooperative Test Service (COOP-M). In addition to these predictor variables, sex, college class, and laboratory section in the mathematics course were also considered. From a total enrollment of 1,139 students, data on all of these measures were available for only 325 of these students. Five of these predictor variables were shown to be significant predictors of mathematics grades. The predictors in order of magnitude on their correlation with the criterion variable were the Mathematics Test of the Cooperative Test Service ($r = 0.42$), and Scholastic Aptitude Test of Mathematical Ability ($r = 0.40$), and of lesser significance the Sequential Test of Educational Progress ($r = 0.30$), the Scholastic Aptitude Test of Verbal Ability ($r = 0.22$). The results show that measures of verbal ability and sex differences were not adequate measures to predict success in a college pre-calculus course.

Scannicchio (1969), in a study at Louisiana State University, found that 314 students enrolled in an introductory calculus course in general achieved at least one letter grade lower in college mathematics than in overall high school academic and mathematics achievement. As predictor variables he looked at overall high school academic achievement, overall high school mathematics

achievement, number of high school mathematics units, pattern of college preparatory mathematics and standardized test scores. The two factors he found to be the most useful as predictors of college calculus grades were overall high school academic achievement and overall high school mathematics achievement.

A relationship study conducted in 1972 at Mississippi State University and reported by Kohler (1973) tested the usefulness of the Cooperative Mathematics Tests, Algebra III, the ACT Mathematics Usage Test, and the ACT Composite to predict college algebra grade point average. One hundred sixty-one students who were enrolled in six sections of college algebra participated in the study. The results of this relationship study showed that the correlations between the Cooperative Mathematics Test, Algebra III and the GPA in their college Algebra course were slightly higher than the correlations between the ACT Mathetics and the grade point average, but the lack of a significant difference here would not warrant administration of the Cooperative Mathematics Test, Algebra III to provide information over and above that afforded by the ACT Service. He did not do a regression analysis but based his findings on Pearson-Product-Moment correlations.

Troutman (1977) conducted a predictive study at York College of Eastern Pennsylvania during the fall of 1976. The population consisted of 627 students enrolled in finite

mathematics. Since York College has a liberal admission policy similar to Lincoln Memorial University's policy the design of Troutman's study addressed similar problems to those present at Lincoln Memorial University. For example, of the 627 students enrolled in finite mathematics at York College, seven withdrew and ninety received a failing grade. He designed the study to identify those students who are likely to fail and to recommend to advisors that these students be placed in a basic mathematics course. The positive psychological experience and self-confidence developed in the basic mathematics course could then be transferred to the finite mathematics course. A similar argument might be true for the Fundamentals of Mathematics student at Lincoln Memorial University.

His method of investigation included a step-wise linear regression in which he tested the effects of using intelligence quotients, high school rank, aptitude test scores, and high school mathematics grades as predictors of success in finite mathematics. He found the Scholastic Aptitude Test-Math to be the best predictor followed by the high school rank and the high school mathematics grade average. The variable he found to be the least helpful in predicting success in finite mathematics was the intelligence quotient. The full model had a correlation coefficient of .611.

Another study, (Wick, 1965) conducted approximately 10 years prior to Troutman's study, investigated eleven first year college mathematics courses to determine the factors most closely associated with success in each of them. For the college algebra course the significant variables and their respective correlations with final averages in college algebra are listed: 1) Mathematics grade average, grades 10-12; .59; 2) Mathematics grade average, grades 11-12, .57; 3) Mathematics grade average, grade 12, .51; 4) Ratio of A's, grades 10-12, to the number of semesters of mathematics taken in grades 10-12, .55; 5) High school rank, .51; 6) Scholastic Aptitude Tests, .34; 7) Mathematics Aptitude Tests, .36; and 8) Mathematics placement tests, .37. In the conclusions relative to the study Wick noted that the high school record was consistently the source of the best predictors of success in first year college mathematics. The mathematics average over grades 10-12 gave the highest correlations with success in college algebra courses, although all of these correlations were best described as being low. In conflict with Wick's study, Pugh (1969) and others concluded that SAT-M and high school rank (HSR) were the most efficacious predictors of success in beginning college mathematics courses.

Costello (1977), in his Study on the Validity of Admissions Policy as Applied to the School of Engineeringat an Ubran University, concludes that SAT math scores, verbal

scores, and total SAT scores are not related to the students' performance in college mathematics.

Suddick and Collins (1982) reported that the Descriptive Tests of Mathematics proved to be an effective placement instrument at Governor's State University for older, upper division students in a curriculum demanding advanced level (calculus) mathematics courses, and that these tests may be used as a preliminary guideline for placement at other institutions. Two studies (Bridgeman),1980) and (Bridgeman, 1982) showed that the Descriptive Tests of Mathematics Skills (DTMS) was a valid predictor of remedial level college courses grades, and that the DTMS (higher level tests) were as accurate a predictor as the College Board Scholastic Aptitude Test--Mathematics (SAT-M) for more advanced college level courses. These studies were relative to this study because the Descriptive Tests of Mathematics Skills (DTMS) preceded the Self Scoring Placement Tests in Mathematics (SSPT) of which scores from two subtests of the SSPT are predictor variables in this study.

Shevel and Whitney (1969) in cooperation with the American College Testing Program, conducted a study to determine the predictive validity of the Mathematics Placement Examination. They then compared these prediction medians with prediction medians for the standard ACT. They found that for higher level courses that a combination of

both the Mathematics Placement Examination and the ACT provided a substantial increase in predictive R values, .206 increase in R value for Calculus and a .396 increase in R value for honors courses. The increases in R values were significantly lower for college algebra classes, (increase in R value of .086). Their final conclusions for the study show that the Mathematics Placement Examination were no more effective for predicting first semester college mathematics grades for lower ability classes than are ACT Scores or high school grades.

In other studies, both multiple regression and stepwise regression methods were used to predict performance levels in statistics (Suddick and Collins, 1982), computer science (Konvalina, 1983), and (Alspaugh, 1972), and physics (Hudson and Rottman, 1981). In general, all of these studies showed mathematical test scores or prior mathematical ability to be a primary influence on performance in the subject areas.

These studies indicated that the problem of predicting student success is of interest to education administrators, and the answers that research will produce still need to be found. The literature consistently pointed to two areas of concern when dealing with both predictors of success and persistence. The first area was achievement/aptitude tests. The second was the high school record. Although at times the literature seemed contradictory in stating the best single predictor, many concluded that the use of multiple

predictors seemed to be most effective. Where one variable was singled out as the best predictor then that predictor appeared to be the high school grade average or class rank. Merante (1983), in a general overview of the topic of predicting student success in college, addressed this two-sided argument. He believed in the theory that standardized test results were the best indicators of future academic success was a theory that received its support at home but not in the classroom. His experience had shown that rank in graduating class was the single best predictor of academic performance in college. When taken in combination with the SAT/ACT, it was an excellent indicator at the time these tests were taken. Should a student have delayed entrance to college for any reason, then age became a better predictor. He pointed out other factors which played a crucial role in predicting success. Such factors as external environmental conditions, inspirational mentorism, self-discipline, determination, luck, or demographic factors such as sex, birth order, income, parent education, religious/ethnic status, geographic factors, life style, personality, residential living as opposed to community living were some factors that had been determined to affect success in higher academic development. Some of these factors were important, but they were nearly impossible to measure by instruments which were highly

reliable and valid. Merante (1983, p.46) gave this advice to educational researchers.

> We must keep in mind, however, that the performance of students is determined not only by what they bring with them, but also by what they encounter and interact with at the institution. So, predictions of collegiate achievement must include more than intelligence, antecedent, and personality factors. Behavior is a function of the interaction between a student and his or her environment. An analysis of both the student and the college environment and their likely effects on each other is critical if one is to attain an accurate and useful prediction.
>
> What we cannot do--and should not aspire to do--is to arrive at a standard group of variables that would purport to determine to the future response pattern in all situations for all individuals. A more appropriate goal should be the development of critical variables that will allow us to consider each individual within his or her respective environment and predict his or her behavior within this specific situation.
>
> The closer we get to that kind of understanding, the better we can support the efforts of secondary school educators to prepare and advise their college-bound students and the efforts of college educators to recognize their best-suited applicants and to structure an environment that meets their needs.
>
> That is our goal in predicting academic success, that and one thing more: No matter how good our statistical models become, let's always be ready to welcome the individual student who will come along and delight us all by proving us wrong.

CHAPTER III

PRESENTATION, ANALYSIS AND DISCUSSION OF DATA

Construction of equations to predict student success for Fundamentals of Mathematics students at Lincoln Memorial University, using the criterion of final average in the course, was central to the purpose of this study. A backward elimination multiple linear regression was used. The variables were described in Chapter I. The data in this chapter are presented under three headings. Part I contains the descriptive data relative to the students enrolled in Fundamentals of Mathematics during Fall Quarter 1983 at Lincoln Memorial University. Part II contains the correlations based on the data collected from the population. Part III contains the results of the regression analysis and the resulting "best fit" prediction equation.

I. DESCRIPTIVE DATA RELATIVE TO THE 1983 STUDENT POPULATION

Table I shows the calculated means and standard deviations of the ten independent variables, as well as the dependent variable. The first column in Table I shows a list of variable names and their respective descriptions.

TABLE I

Means and Standard Deviations of the Variables for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter 1983 (n = 60)

Variable	Mean	Standard Deviation
X(1) CAT-6	30.87	6.00
X(2) CAT-7	27.50	7.44
X(3) SSPT-AA	18.05	3.93
X(4) SSPT-Alg	17.58	6.13
X(5) Age (Months beyond 17th birthday)	38.00	30.18
X(6) Years H.S. Math	1.91	1.19
X(7) Grade H.S. Math	.23	.43
X(8) Grade H.S. Math	.65	.48
X(9) Income	17819.50	13729.10
X(10) Years H.S. Science	1.32	.98
Y Grade in Math 121	81.87	8.08

The second column shows the means of each variable for the sixty students included in this study. The last column shows the standard deviations for the sample (n = 60).

II. CORRELATION MATRIX BASED ON DATA FROM THE 1983 STUDENT POPULATION

Table II shows the inter-correlations between the variables. A correlation of $\pm$.21 was necessary to indicate significance for the sample size of 60 subjects at the .05 level (Christensen, 1977). The only variables with

Table II

Correlations Between the Variables for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	X(1)	X(2)	X(3)	X(4)	X(5)	X(6)	X(7)	X(8)	X(9)	X(10)	Y
X(1) CAT6	1.0000	0.6863	0.3222	0.6165	-.0983	0.2048	0.3197	0.2968	-.1185	0.0701	0.4315
X(2) CAT7		1.0000	0.5997	0.8610	0.1135	0.3196	0.3418	0.2786	-.1308	0.1589	0.6031
X(3) SSPT-AA			1.0000	0.6206	-.1181	0.0275	0.1464	0.2366	-.1249	-.1312	0.4884
X(4) SSPT-Alg				1.0000	0.0117	0.3402	0.2984	0.2104	-.1233	-.1017	0.6668
X(5) Age					1.0000	0.0451	-.1108	-.1312	-.1308	0.1221	-.1023
X(6) # Yrs. H.S. Math						1.0000	0.2069	0.1249	-.1181	0.5689	0.1919
X(7) Grade H.S. Math							1.0000	0.7468	0.0923	0.1807	0.2442
X(8) Grade H.S. Math								1.0000	-.1172	-.1133	0.2350
X(9) Income									1.0000	0.1086	0.2877
X(10)# Yrs. H.S. Sci.										1.0000	-.1311
Y Final average in Math 121											1.0000

correlation coefficients greater than .80 were X(2) and X(4) which were the California Achievement Test (CAT-7) and the Self Scoring Placement Test in Mathematics (Elementary Algebra). This indicated that both of these variables should not be included in the model.

CAT-6 correlated positively with all other variables except income and age, but the correlations were only significant (alpha=.05) with variables X(2), X(3), X(4), X(7), X(8), and Y. CAT-7 correlated positively with all other variables except income, but the correlations were only significant with variables X(1), X(3), X(4), X(6), X(7), X(8), and Y.

SPSS-AA correlated positively with all other variables except age, income and science courses taken. This correlation was significant with variables X(4) and Y. SPSS-Alg correlated positively with all other variables except science courses taken and income. The correlations were significant with variables X(6), X(7), X(8), and Y. Age correlated negatively with all other variables except X(2), X(4), X(6), and X(10). None of these correlations were significant. Only three variables, X(2), X(4), and X(10), correlated significantly with X(6). High school mathematics grades X(7) and X(8) correlated positively and significantly with X(1), X(2), X(4), and Y. No significant correlations existed between income and any other variable. Variable X(10), high school science courses, correlated

significantly with high school mathematics courses taken. The dependent variable correlated significantly with X(1), X(2), X(3), X(4), X(7), X(8), and X(9).

Correlations measure a type of co-relation or the degree to which the variables vary together. This could also be described as a measure of the intensity of association of any pair of variables. This means that for any obtained zero order correlation between two variables, it cannot be concluded that the relationship would be the same if a different value for a third variable which influences the first two was also considered in the model. In order to find more information one type of regression analysis, backward elimination of variables, was used. The results of this analysis are reported in Part III.

III. PREDICTION EQUATIONS DERIVED USING DATA FROM THE 1983 STUDENT POPULATION

Results of the regression analysis are summarized in Tables III-XII, pages 31 to 40. The first column for each of the table contains the variables included in the model. The second column lists the beta weights or coefficients of regression. The third column contains the standard errors for each variable and the fourth column contains the F-ratio, which is calculated by dividing the second column by the third column. Also included for each regression

TABLE III

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing all Variables for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	65.7141	5.9951	10.9613
X(1)	-.0174	.1787	-.0976
X(2)	.1341	.2289	.5857
X(3)	.2155	.2593	.8310
X(4)	.6056	.2652	2.2834**
X(5)	.0452	.0255	1.7713
X(6)	.4046	.9590	.4219
X(7)	1.0990	3.3736	.3257
X(8)	-1.3086	2.9866	-.4382
X(9)	-1.8462×10^{-4}	5.5961×10^{-5}	-3.2991 *
X(10)	-.1033	.9989	-.1034

R^2 = .511267 $SS_{Residuals}$ = 1564.82

Standard Error of Estimate = 5.65113

Degrees of Freedom = 49

* Significant alpha = .025

** Significant alpha = 0.10

X(1) CAT6
X(2) CAT7
X(3) SSPT-AA
X(4) SSPT-Alg
X(5) Age
X(6) # Years H. S. Math
X(7) Grade in H. S. Math
X(8) Grade in H. S. Math
X(9) Income
X(10)# Years H. S. Science

TABLE IV

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(2), X(3), X(4), X(5), X(6), X(7), X(8), X(9), and X(10) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	65.3798	4.8702	13.4245
X(2)	.1260	.2111	.5967
X(3)	.2189	.2544	.8607
X(4)	.6029	.2612	2.3085**
X(5)	.0453	.0252	1.7940
X(6)	.4097	.9480	.4321
X(7)	1.0459	3.2964	.3173
X(8)	-1.3146	2.9562	-.4447
X(9)	-1.8410×10^{-4}	5.5156×10^{-5}	-3.3379*
X(10)	-.1039	.9890	-.1051

R^2 = .520955 $SS_{Residuals}$ = 1565.11

Standard Error of Estimate = 5.59483

Degrees of Freedom = 50

* Significant alpha = .025

** Significant alpha = 0.10

X(2) CAT7
X(3) SSPT-AA
X(4) SSPT-Alg
X(5) Age
X(6) # Years H. S. Math
X(7) Grade in H. S. Math
X(8) Grade in H. S. Math
X(9) Income
X(10)# Years H. S. Science

TABLE V

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(2), X(3), X(4), X(5), X(6), X(7), X(8), and X(9) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	65.3511	4.8152	13.5718
X(2)	.1203	.2021	.5953
X(3)	.2197	.2518	.8725
X(4)	.6111	.2470	2.4742**
X(5)	.0456	.0249	1.8336
X(6)	.3620	.8247	.4390
X(7)	1.0162	3.2522	.3125
X(8)	-1.3282	2.9246	-.4541
X(9)	-1.8489×10^{-4}	5.4115×10^{-5}	-3.4166 *

R^2 = .530239 $SS_{Residuals}$ = 1565.47

Standard Error of Estimate = 5.54035

Degrees of Freedom = 51

* Significant alpha = .05

** Significant alpha = 0.10

X(2) CAT7
X(3) SSPT-AA
X(4) SSPT-Alg
X(5) Age
X(6) # Years H. S. Math
X(7) Grade in H. S. Math
X(8) Grade in H. S. Math
X(9) Income

TABLE VI

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(2), X(3), X(4), X(5), X(6), X(8), and X(9) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	65.9211	4.4174	14.9230
X(2)	.1204	.2003	.6009
X(3)	.2062	.2459	.8387
X(4)	.6154	.2444	2.5174**
X(5)	.0456	.0246	1.8501
X(6)	.5005	.6893	.7261
X(8)	-2.0778	1.6581	-1.2531
X(9)	-1.8185×10^{-4}	5.2768×10^{-5}	-3.4461 *

R^2 = .538399 $SS_{Residuals}$ = 1568.44

Standard Error of Estimate = 5.49202

Degrees of Freedom = 52

* Significant alpha = .05

** Significant alpha = 0.10

X(2) CAT7
X(3) SSPT-AA
X(4) SSPT-Alg
X(5) Age
X(6) # Years H. S. Math
X(8) Grade in H. S. Math
X(9) Income

TABLE VII

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(3), X(4), X(5), X(6), X(8), and X(9) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	66.9816	4.0252	16.6406
X(3)	.2326	.2405	.9670
X(4)	.7220	.1672	4.3191 *
X(5)	.0434	.0242	1.7921
X(6)	.5551	.6792	.8172
X(8)	-2.2777	1.6146	-1.4107
X(9)	-1.8140×10^{-4}	5.2445×10^{-5}	-3.4589 *

R^2 = .543957 $SS_{Residuals}$ = 1579.35

Standard Error of Estimate = 5.45886

Degrees of Freedom = 53

* Significant alpha = .05

X(3) SSPT-AA
X(4) SSPT-Alg
X(5) Age
X(6) # Years H. S. Math
X(8) Grade in H. S. Math
X(9) Income

TABLE VIII

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(3), X(4), X(5), X(8), and X(9) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	67.1387	4.0082	16.7504
X(3)	.2160	.2389	.9041
X(4)	.7746	.1538	5.0370 *
X(5)	.0419	.0241	1.7388
X(8)	-1.8938	1.5399	-1.2298
X(9)	-1.7659×10^{-4}	5.1953×10^{-5}	-3.3991**

R^2 = .546767 $SS_{Residuals}$ = 1599.24

Standard Error of Estimate = 5.44202

Degrees of Freedom = 54

* Significant alpha = .05

** Significant alpha = 0.10

X(3) SSPT-AA
X(4) SSPT-Alg
X(5) Age
X(8) Grade in H. S. Math
X(9) Income

TABLE IX

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(4), X(5), X(8), and X(9) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	69.4364	3.0943	22.4400
X(4)	.8608	.1204	7.1496 *
X(5)	.0457	.0236	1.9344
X(8)	-2.0925	1.5217	-1.3752
X(9)	-1.7289×10^{-4}	5.1705×10^{-5}	-3.3438**

R^2 = .548267 $SS_{Residuals}$ = 1623.46

Standard Error of Estimate = 5.433

Degrees of Freedom = 55

* Significant alpha = .025

** Significant alpha = 0.10

X(4) SSPT-Alg
X(5) Age
X(8) Grade in H. S. Math
X(9) Income

TABLE X

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(4), X(5), and X(9) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	67.2207	2.6627	25.2455
X(4)	.9023	.1175	7.6805 *
X(5)	.0467	.0238	1.9585
X(9)	-1.6779×10^{-4}	5.1981×10^{-5}	-3.2279

R^2 = .541079 $SS_{Residuals}$ = 1679.28

Standard Error of Estimate = 5.47606

Degrees of Freedom = 56

* Significant alpha = .05

X(4) SSPT-Alg
X(5) Age
X(9) Income

TABLE XI

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(4) and X(9) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	69.5112	2.4509	28.3618
X(4)	.8723	.1193	7.3095 *
X(9)	-1.6722×10^{-4}	5.3257×10^{-5}	-3.1399

R^2 = .518247 $SS_{Residuals}$ = 1794.31

Standard Error of Estimate = 5.61062

Degrees of Freedom = 57

* Significant alpha = .10

X(4) SSPT-Alg
X(9) Income

TABLE XII

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variable X(4) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	66.2369	2.3813	27.8151
X(4)	.8891	.1280	6.9457 *

R^2 = .444666 $SS_{Residuals}$ = 2104.65

Standard Error of Estimate = 6.02387

Degrees of Freedom = 58

* Significant alpha = .10

X(4) SSPT-Alg

analysis is the R^2, which reflects the amount of variance accounted for by the variables, the sum of the squared residuals, the standard error of estimate for the entire model and the degrees of freedom. The variables which show significance are marked with a single or double asterisk. Alpha levels are included at the bottom of each table.

Table III, page 31, shows the results of the regression analysis for the model containing all variables. This analysis leads to the following prediction equation:

$$Y = 65.7141 - .0174\ X(1) + .1341\ X(2) + .2155\ X(3) + .6056\ X(4) + .0452\ X(5) + .4046\ X(6) + 1.0990\ X(7) - 1.3086\ X(8) - 1.8461 \times 10^{-4}\ X(9) - .1033\ X(10)$$

An R^2 value of .511267 shows that this analysis accounts for approximately 50 percent of the variance with a standard error of 5.6511. Two variables out of ten are significant, X(4), (alpha=.10) and X(9), (alpha = .025).

Table IV, page 32, shows the results of the regression analysis for the model containing all of the variables except X(1). The resulting prediction equation is:

$$Y = 65.3798 + .1260\ X(2) + .2189\ X(3) + .6029\ X(4) + .0453\ X(5) - .4097\ X(6) + 1.0459\ X(7) - 1.3146\ X(8) - 1.8410 \times 10^{-4}\ X(9) - .1039\ X(10).$$

The R^2 value only improved .01 to .520955, and the same two variables are significant.

Table V, page 33, shows the results of the regression model after variable X(10) is removed. The R^2 value is

slightly higher,and the same two variables are significant. Tables VI page 34, shows that the same pattern continues as variables X(7) is removed from the model. Table VII, page 35, shows that the F-ratio for variable X(4) increases significantly when variable X(2) is removed from the model as the correlation between the two variables was .86. The following prediction equation:

$$Y = 66.9816 + .2326\ X(3) + .7220\ X(4) + .0434\ X(5) + .5551\ X(6) - 2.2777\ X(8) - 1.8140 \times 10^{-4}\ X(9)$$

results in $R^2 = .5440$.

Table VIII, page 36, shows a continued increase in the R^2 value as X(6) is removed from the model. Tables IX to XII, pages 37 to 40, show the remaining steps in the backward elimination procedure for stepwise multiple linear regression analysis. The R^2 value in Table IX, page 37, is the highest R^2 for the entire analysis. After variable X(8) is removed from the model, the R^2 values begin to decrease.

Another analysis, in which one of the two closely correlated variables X(2) was initially eliminated from the model, did not add further knowledge nor a better prediction equation. Initially it resulted in a higher significance level for variable X(4), but after six variables were eliminated from the model the resulting prediction equations were identical to those in the previous analysis. Tables XIII to XVIII, pages 43 to 48, show the results of this analysis.

TABLE XIII

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(1), X(3), X(4), X(5), X(6), X(7), X(8), X(9), and X(10) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio	
X(0)	65.9001	5.9472	11.0809	
X(1)	.0207	.1653	.1253	
X(3)	.2478	.2517	.9847	
X(4)	.7069	.1997	3.5393	*
X(5)	.0438	.0252	1.7362	
X(6)	.4006	.9526	.4205	
X(7)	.9454	3.3412	.2829	
X(8)	-1.5187	2.9454	-.5156	
X(9)	-1.8415×10^{-4}	5.5586×10^{-5}	-3.3129	*
X(10)	.0348	.9643	.0361	

R^2 = .517695 $SS_{Residuals}$ = 1575.76

Standard Error of Estimate = 5.61384

Degrees of Freedom = 50

* Significant alpha = .025

X(1) CAT6
X(3) SSPT-AA
X(4) SSPT-Alg
X(5) Age
X(6) # Years H. S. Math
X(7) Grade in H. S. Math
X(8) Grade in H. S. Math
X(9) Income
X(10)# Years H. S. Science

TABLE XIV

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(1), X(3), X(4), X(5), X(6), X(7), X(8), and X(9) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	65.9122	5.8793	11.2109
X(1)	.0213	.1628	.1310
X(3)	.2480	.2491	.9956
X(4)	.7055	.1941	3.6356**
X(5)	.0437	.0248	1.7644
X(6)	.4174	.8224	.5076
X(7)	.9535	3.3008	.2889
X(8)	-1.5170	2.9160	-.5202
X(9)	-1.8386×10^{-4}	5.4473×10^{-5}	-3.3753 *

R^2 = .527144 $SS_{Residuals}$ = 1575.78

Standard Error of Estimate = 5.55857

Degrees of Freedom = 51

* Significant alpha = .050

** Significant alpha = .025

X(1) CAT6
X(3) SSPT-AA
X(4) SSPT-Alg
X(5) Age
X(6) # Years H. S. Math
X(7) Grade in H. S. Math
X(8) Grade in H. S. Math
X(9) Income

TABLE XV

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(3), X(4), X(5), X(6), X(7), X(8), and X(9) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	66.4093	4.4472	14.9329
X(3)	.2460	.2463	.9989
X(4)	.7176	.1692	4.2418**
X(5)	.0434	.0244	1.7766
X(6)	.4161	.8145	.5109
X(7)	1.0189	3.2319	.3152
X(8)	-1.5260	2.8876	-.5285
X(9)	-1.8445×10^{-4}	5.3773×10^{-5}	-3.4302 *

R^2 = .536075 $SS_{Residuals}$ = 1576.33

Standard Error of Estimate = 5.50583

Degrees of Freedom = 52

* Significant alpha = .050

** Significant alpha = .025

X(3) SSPT-AA
X(4) SSPT-Alg
X(5) Age
X(6) # Years H. S. Math
X(7) Grade in H. S. Math
X(8) Grade in H. S. Math
X(9) Income

TABLE XVI

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(3), X(4), X(5), X(6), X(8), and X(9) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	66.9816	4.0252	16.6406
X(3)	.2326	.2405	.9670
X(4)	.7220	.1672	4.3191**
X(5)	.0434	.0242	1.7921
X(6)	.5551	.6792	.8172
X(8)	-2.2777	1.6146	-1.4107
X(9)	-1.8140×10^{-4}	5.2445×10^{-5}	-3.4589 *

R^2 = .543957 $SS_{Residuals}$ = 1579.35

Standard Error of Estimate = 5.45886

Degrees of Freedom = 53

* Significant alpha = .050

** Significant alpha = .025

X(3) SSPT-AA
X(4) SSPT-Alg
X(5) Age
X(6) # Years H. S. Math
X(8) Grade in H. S. Math
X(9) Income

TABLE XVII

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(3), X(4), X(5), X(8), and X(9) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	67.1387	4.0082	16.7504
X(3)	.2160	.2389	.9041
X(4)	.7746	.1538	5.0370**
X(5)	.0419	.0241	1.7388
X(8)	-1.8938	1.5399	-1.2298
X(9)	-1.7659×10^{-4}	5.1953×10^{-5}	-3.3991 *

R^2 = .546767 $SS_{Residuals}$ = 1599.24

Standard Error of Estimate = 5.44202

Degrees of Freedom = 54

* Significant alpha = .050

** Significant alpha = .025

X(3) SSPT-AA
X(4) SSPT-Alg
X(5) Age
X(8) Grade in H. S. Math
X(9) Income

TABLE XVIII

Beta Weights, Standard Errors, F-Ratios, R^2, SSR, Standard Error of Estimate for Model Containing Variables X(4), X(5), X(8), and X(9) for Students Enrolled in Fundamentals of Mathematics at Lincoln Memorial University during Fall Quarter, 1983 (n = 60)

Variable	Beta	Std. Error	F-Ratio
X(0)	69.4364	3.0943	22.4400
X(4)	.8608	.1204	7.1496**
X(5)	.0457	.0236	1.9344
X(8)	-2.0925	1.5217	-1.3752
X(9)	-1.7289×10^{-4}	5.1705×10^{-5}	-3.3438 *

R^2 = .548268 $SS_{Residuals}$ = 1623.46

Standard Error of Estimate = 5.433

Degrees of Freedom = 55

* Significant alpha = .050

** Significant alpha = .025

X(4) SSPT-Alg
X(5) Age
X(8) Grade in H. S. Math
X(9) Income

IV. DISCUSSION

The analyses of data show that three of the independent variables were in fact significant predictors of success in Fundamentals of Mathematics. The Self Scoring Placement Test in Mathematics (Algebra I) was the best precictor, but age and income were also factors which cannot be ignored when trying to predict student success in Fundamentals of Mathematics.

The significance of age as a factor in predicting success in Fundamentals of Mathematics may be a result of the seriousness or maturity of many of the students who have spent a few years between high school and college engaged in one of three endeavors. These students may be described as 1) returning veterans who have, because of their experience in various service related jobs, a "plan of action" in mind and the perseverance to complete that plan; 2) mothers, who have raised their young children to school age and now because of economic reasons feel the need to help support their families; and 3) students, who dropped out of high school to accept blue collar jobs and now are "caught up in" the seriousness of the unemployment situation in the immediate vicinity of Lincoln Memorial University, have now passed the GED examination and are seriously pursuing degrees in education and/or nursing in order to find a more

stable employment picture and a professional status in their lives.

The relationship between age and success in mathematics may not be a linear one, and a better linear "fit" could be obtained by transforming the data gathered on age by use of a logarithmic transformation (Nie, et. al., 1975) prior to entering these data into the regression analysis.

The significance of income as a negative predictor of success might be explained by the fact that in many studies the effects of income tend to decrease as students become older. Lavin (1965) reported that the socio-economic level of students is a better predictor of academic success in elementary grades than in secondary grades. This may be even more pronounced in college students.

CHAPTER IV

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

I. SUMMARY

The purpose of this study was to determine the value of selected factors in predicting the academic success of college freshmen in Fundamentals of Mathematics at Lincoln Memorial University. The factors selected and investigated were; scores on two sections of the California Achievement Test, Computation Skills and Mathematical Concepts; scores on two tests in the Self Scoring Placement Tests in Mathematics, Applied Arithmetic and Algebra I; age; income; number of years of high school mathematics completed; grade in high school mathematics; and number of years of high school science completed. The criterion of academic success in Fundamentals of Mathematics used in this study was the average grade on three major examinations given at three week intervals. Age was defined as number of months beyond the seventeenth birthday. High school mathematics was defined as Algebra I, II, Geometry, and Advanced Mathematics, Trigonometry or Pre-Calculus. Grade in high school mathematics was defined using dummy variables and two classifications 1) good--meaning A or B grades only and 2) not good--meaning at least one C, D, or F grade. High

school science was defined as Biology I, II, Chemistry I, II, Botany, Zoology or Physics.

The population for the study consisted of 60 students enrolled in all sections of Fundamentals of Mathematics during Fall Quarter of 1983. The subjects included were required to take the California Achievement Test, both Computational Skills and Concepts sections, as well as the Self Scoring Placement Tests in Mathematics, Applied Arithemetic and Algebra I. In addition, information taken from financial aid records and high school transcripts was included as data from which to predict the final average in Fundamentals of Mathematics.

Zero-order correlation coefficients were computed among all variables. In only one case did the comparisons indicate a high ($r > .80$) relationship. This was between the California Achievement Test, Mathematical Concepts and the Self Scoring Placement Test, Algebra I ($r = .86$). Two stepwise regression analyses were completed using the backward elimination process. The first included all ten predictor variables, leaving in both the CAT (Test 7) and the SSPT (Algebra I) even though they were closely correlated. In the second analysis only nine predictor variables were used omitting the CAT (Test 7).

II. FINDINGS

1. The model containing all ten of the predictor variables resulted in the following prediction equation:

$$Y = 65.7141 - .0174\ X(1) + .1341\ X(2) + .2155\ X(3) + .6056\ X(4) + .0452\ X(5) + .4046\ X(6) + 1.0990\ X(7) - 1.3086\ X(8) - 1.8462 \times 10^{-4}\ X(9) - .1033\ X(10)$$

Only variables X(4), SSPT (Alg I), and X(9), income were found to be significant in this model. Using this model it was possible to account for only 51 percent of the variation in the predicted value of success in Fundamentals of Mathematics.

2. After eliminating all non-significant variables, one at a time, from the complete model the following prediction equation

$$Y = 66.2369 + .8891\ X(4)$$

accounted for 44.5 percent of the variance.

3. The highest R^2 value was obtained when four variables were contained in the model--X(4), X(5), X(8), X(9). This R^2 value was .548268 which shows that approximately 55 percent of the variance in final grades was attributable to these four variables.

4. By reducing the model initally to nine variables, that is, eliminating the CAT (Test 7) from the model because of its high correlation to SSPT (Alg I), the F-ratio for the SSPT (Alg I) increased to a higher significance level

(from .10 to .025), but after the elimination of six non-significant variables the prediction equations were identical.

III. CONCLUSIONS

Based on the findings, it may be concluded that predictions relative to student success in Fundamentals of Mathematics for students at Lincoln Memorial University can be made. Approximately fifty-five percent of the variation in final averages can be accounted for by using SSPT (Alg I) score, age, and income as predictor variables. The value of R^2 in the prediction equation with the best R^2 value was .55. Since the SSPT (Alg I) score was the most significant predictor of success in Fundamentals of Mathematics, it would seem important to determine each student's mastery of algebraic concepts prior to placement in the Fundamentals of Mathematics course at Lincoln Memorial University. However, rigid placement based on the results of any single predictor variable is not advocated.

IV. RECOMMENDATIONS

1. A cross-validation of this study should be completed in the fall of 1984.

2. New prediction equations should be computed with a larger population.
3. The CAT6 and the number of high school courses taken should not be used as predictor variables in any subsequent studies.
4. A two classification discriminant analysis should be performed using a pair of dummy variables in place of the criterion variable used in this study.
5. Other academic placement tests should be considered as possible predictors.
6. Another scale for measuring number of high school mathematics courses taken should be considered.
7. Another scale for measuring high school math grades should be considered.

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VITA

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From 1975-80 she was employed by Clinch-Powell Educational Cooperative as a teacher in and director of pre-school home-based educational and social services programs. During that time she began work toward a Doctor of Education degree at the University of Tennessee, Knoxville.

For the past four years she has been employed by Lincoln Memorial University as an Instructor and Assistant Professor of Mathematics. In August 1984 she received a Doctor of Education degree from the University of Tennessee, Knoxville, with a major in Educational Administration and Supervision and collateral areas in Statistics and Educational and Counseling Psychology.

In September 1984 she will assume the duties as Chairperson of the Mathematics and Computer Science Division of Lincoln Memorial University.