The Relationship of Selected Variables in Mathematics Achievement of Teacher Education Applicants

Linda H. Miller
East Tennessee State University

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THE RELATIONSHIP OF SELECTED VARIABLES IN MATHEMATICS ACHIEVEMENT OF TEACHER EDUCATION APPLICANTS

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THE RELATIONSHIP OF SELECTED VARIABLES IN MATHEMATICS
ACHIEVEMENT OF TEACHER EDUCATION APPLICANTS

A Dissertation
Presented to
the Faculty of the Department of Supervision and Administration
East Tennessee State University

In Partial Fulfillment
of the Requirements for the Degree
Doctor of Education

by
Linda H. Miller
August, 1980
APPROVAL

This is to certify that the Graduate Committee of

LINDA H. MILLER

met on the

____________________ day of __________, 1980.

The committee read and examined her dissertation, supervised her
defense of it in an oral examination, and decided to recommend that
her study be submitted to the Graduate Council and the Dean of the
School of Graduate Studies in partial fulfillment of the requirements
for the degree Doctor of Education.

____________________
Chairman, Graduate Committee

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Signed on behalf of
the Graduate Council

____________________
Dean, School of Graduate Studies
Abstract

THE RELATIONSHIP OF SELECTED VARIABLES IN MATHEMATICS

ACHIEVEMENT OF TEACHER EDUCATION APPLICANTS

by

Linda Herman Miller

The purpose of this study was to examine relationships between the variables of (1) sex, (2) attitudes toward mathematics, (3) college grade point average (GPA), (4) American College Test (ACT) mathematics scores, (5) number of mathematics courses taken, and the variable of (6) mathematics computation scores on the California Achievement Test (CAT) Form 6 - Level 19.

A population of 220 applicants for admission to teacher education at East Tennessee State University were available for the study. Academic records of the students were searched for the following information: (1) sex of the subjects, (2) college grade point average, (3) ACT mathematics scores, (4) number of previous high school mathematics courses, (5) number of previous college mathematics courses, and (6) CAT mathematics computation scores.

Attitudes toward mathematics was measured utilizing the Revised Aiken-Dreger Mathematics Scale. The following relationships were examined: (1) difference between the CAT mathematics computation scores of males and females, (2) correlation between the variables of attitudes toward mathematics and CAT mathematics computation scores, (3) difference between scores of males and females on the test of attitudes toward mathematics, (4) correlation between the variables of college grade point average and CAT mathematics computation scores, (5) difference between the college grade point average of males and females, (6) correlation between the variables of ACT mathematics scores and CAT mathematics computation scores, (7) difference between the ACT mathematics scores of males and females, (8) correlation between the variables of weighted number of mathematics courses taken and CAT mathematics computation scores, and (9) difference between the weighted number of mathematics courses taken by males and females.

The findings of the study revealed that:
1. There was no statistically significant difference between the CAT mathematics computation scores of males and females.
2. There was a statistically significant correlation between the variables of attitudes toward mathematics and CAT mathematics computation scores.

3. There was no statistically significant difference between scores of males and females on the test of attitudes toward mathematics.

4. There was a statistically significant correlation between the variables of college grade point average and CAT mathematics computation scores.

5. There was no statistically significant difference between the college grade point average of males and females.

6. There was a statistically significant correlation between the variables of ACT mathematics scores and CAT mathematics computation scores.

7. There was no statistically significant difference between the ACT mathematics scores of males and females.

8. There was a statistically significant correlation between the variables of weighted number of mathematics courses taken and CAT mathematics computation scores.

9. There was no statistically significant difference between the weighted number of mathematics courses taken by males and females.

Based upon the findings of the study, the following conclusions were warranted:

1. The study failed to support the hypotheses that differences existed between male and female teacher education applicants in regard to their (a) CAT mathematics computation scores, (b) attitudes toward mathematics, (c) college grade point average, (d) ACT mathematics scores, and (e) weighted number of mathematics courses.

2. The study revealed that in regard to teacher education applicants there existed a definite correlation between the variables of (a) attitudes toward mathematics and CAT mathematics computation scores, (b) ACT mathematics scores and CAT mathematics computation scores, (c) college grade point average and CAT mathematics computation scores, and (d) weighted number of mathematics courses taken and CAT mathematics computation scores.
Institutional Review Board

This is to certify that the following study has been filed and approved by the Institutional Review Board of East Tennessee State University.

Title of Grant or Project  THE RELATIONSHIP OF SELECTED VARIABLES IN MATHEMATICS ACHIEVEMENT OF TEACHER EDUCATION APPLICANTS

Principal Investigator  Linda H. Miller

Department  Supervision and Administration

Date Submitted  December 4, 1979

Institutional Review Board Approval, Chairman  [Signature]
DEDICATION

Dedicated to my Heavenly Father who has sustained me throughout life
ACKNOWLEDGMENTS

Special appreciation is expressed to the chairman of my doctoral committee, Dr. Gem Kate Greninger, who provided encouragement, inspiration and assistance—not only at the dissertation level, but throughout my graduate program.

The author is deeply grateful to Dr. Albert Hauff, who provided invaluable assistance in the preparation of the dissertation. Also, the author extends appreciation to Dr. Cecil Blankenship, Dr. Floyd Edwards, and Dr. Gerald K. Ginnings for serving as graduate committee members and for assisting in the completion of the study.

Special thanks is extended to Dr. William N. Pafford for providing background information for the study. Also, thanks is extended to Mr. Charles Wilson and Dr. Lester Hartsell for assisting Dr. Gerald K. Ginnings in developing the weighted number of mathematics courses scale for the study.

Special appreciation is extended to Mrs. Madaline Jenkins for her expertise in typing the dissertation and to Mrs. Barbara Charlton for encouragement throughout my doctoral program.

Finally, the author wishes to thank her parents, Mr. and Mrs. John R. Herman for encouragement throughout her educational endeavor. Most importantly special thanks is extended to my husband, Dr. J. Franklin Miller, who encouraged me to try and removed many obstacles that stood in the way.
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Chapter 1

THE INTRODUCTION

One of the tasks facing teacher education institutions today is that of mathematics education for prospective teachers. One could assume that students who become teachers and have not been taught basic mathematics skills would not be prepared to teach the basic mathematics skills. In relation to mathematics, Russell A. Kenny stated: "It is quite evident that understanding of arithmetic concepts and processes does not increase with teaching experience."¹

In 1971 the Panel on Teacher Training of the Mathematical Association of America's Committee on the Undergraduate Program for Mathematics (CUPM) met to discuss mathematical preparation of prospective teachers. As a result of this meeting, the panel members suggested that teacher education institutions evaluate mathematical competencies of applicants for teacher education.²

Several state boards of education have been requiring applicants for admission to teacher education to demonstrate competence in quantitative skills.


²Committee on the Undergraduate Program for Mathematics of the Mathematical Association of America, "Recommendations on Course Content for the Training of Teachers of Mathematics," Berkeley (1971), p. 1. (Mimeoographed.)
The Tennessee State Board of Education adopted a resolution which required all applicants for admission to a teacher education program leading to initial certification satisfactorily pass a prescribed standardized test effective November 10, 1978. The applicants were required to demonstrate competence in quantitative as well as verbal skills at an approved performance level.\(^3\)

The Tennessee State Board of Education authorized the following requirements as a condition of admission to teacher education program.

1. The test to be used will be the California Achievement Test (CAT), Level 19 (Form C or D) 1977 Edition.

2. Only the following tests of the complete battery will be used:
   - Mathematics: Use Test 6 on Mathematics Computation
   - Reading: Use Test 2 on Reading Comprehension
   - Language: Use Test 4 on Language Mechanics and Test 5 on Language Expression

3. The cut-off scores for all subjects areas to be used for all elementary and secondary teachers are listed below:
   - Mathematics: Raw score of 21 on Mathematics Computation
   - Reading: Raw score of 22 on Reading Comprehension
   - Language: Raw scores of 38, Language Mechanics and Expression (combined)

   In addition to the above scores, secondary English teachers must attain a raw score (combined) of 45 in Language. Secondary math teachers must attain a raw score of 26 on math computation.

   The cost of the test administration should be the responsibility of the teacher education program.\(^4\)

RETESTING: For applicants taking the California Achievement Test.

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\(^3\) Letter from L. Scott Honaker, Dean, College of Education, East Tennessee State University, October 10, 1978.

(1) If an applicant for candidacy fails to pass any required area of the California Achievement Test Battery, the test for that area may be re-taken after remediation for at least one quarter or semester following the initial testing.

(2) If an applicant fails any part of the required test battery on the second testing then at least one academic year must be spent in remediation before retesting is permitted. Candidates retaking any portion of the test must attain cut-off scores in effect at the time retesting occurs.

(3) Candidates failing to meet the standards after three attempts shall not be admitted to candidacy. However, after a period of at least three years, a student may again start the series.5

In compliance with the Tennessee State Board of Education policy of June 23, 1978, East Tennessee State University (ETSU) began administering the California Achievement Test (Form C - Level 19) to all applicants for admission to teacher education during winter quarter, 1979.

During the year 1979, William N. Pafford, Assistant Dean of the College of Education compiled the test results of the California Achievement Test taken by 320 applicants. Of the 320 applicants, 7.2 percent failed the mathematics computation test.6

On January 27, 1980, the Tennessee State Board of Education approved changes regarding the testing of candidates seeking admission to approved teacher education programs in Tennessee Colleges and Universities effective Fall quarter, 1980. The changes affected the cut-off scores of Test 6, mathematics computation as follows:

5 Memorandum from Edward A. Cox, Chairman, Tennessee State Board of Education, January 17, 1980.

Beginning in the fall quarter or semester, at Tennessee Colleges and Universities, the following will be the cut-off scores.\(^7\)

<table>
<thead>
<tr>
<th>Year</th>
<th>1979</th>
<th>1980</th>
<th>1981</th>
<th>1982</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>21</td>
<td>24</td>
<td>27</td>
<td>30</td>
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</table>

According to Pafford's analysis of the test results of the California Achievement Test (Form C - Level 19) for the year 1979, future failure on the CAT mathematics computation test would rise as the new standards take effect. Based on the scores of 320 applicants of 1979, Pafford estimated the following increase in percentage of failure:\(^8\)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Year</th>
<th>Failed</th>
<th>Passed</th>
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</thead>
<tbody>
<tr>
<td>Math</td>
<td>1980</td>
<td>52 - 16.2%</td>
<td>268 - 83.8%</td>
</tr>
<tr>
<td></td>
<td>1981</td>
<td>74 - 23.1%</td>
<td>246 - 76.9%</td>
</tr>
<tr>
<td></td>
<td>1982</td>
<td>108 - 33.7%</td>
<td>212 - 66.3%</td>
</tr>
</tbody>
</table>

Therefore, research should be conducted to find variables which influence the mathematics computation scores on the CAT.

The research of the five most prevalent variables (sex, attitude toward mathematics, college grade point average, American College Test mathematics scores, and number of mathematics courses taken) which influenced mathematics achievement showed a discrepancy among the results of three of the variables (sex, attitudes toward mathematics and number of mathematics courses taken).

(1) Sex - Eleanor E. Maccoby surveyed the field of sex differences in regard to achievement in college and discovered

\(^7\)Cox, p. 1.

\(^8\)Pafford, p. 1.
that men excel women in mathematics achievement.⁹ The results of a study by D. A. Roach indicated that women excel men in mathematics achievement.¹⁰

(2) Attitudes toward mathematics - Ralph Dreger and Lewis Aiken conducted a study which showed a substantial relationship between mathematics attitudes and mathematics achievement.¹¹ Very little relationship between mathematics attitudes of college students and mathematics achievement was revealed from the results of L. G. Harrington's study.¹²

(3) College grade point average - Francis F. Smith's study revealed that the best single indicator of those who can succeed in any given subject area was to study the correlation of previous quarter's grade point average and the scores on a validated standardized test for that given subject.¹³

(4) American College Test Mathematics Scores - F. W. Price and Suk Hi Kim conducted a study and the results indicated that ACT scores predict achievement in college courses.¹⁴

(5) Number of mathematics courses taken - Joseph V. West and Benjamin Fruchter reported that the number of high school mathematics courses increased scholastic mathematics achieve-


H. R. Douglas concluded that the number of units in any one subject matter field in high school does not furnish a satisfactory basis for predicting college success.

In this study these five variables were investigated in order to determine if a relationship existed between these variables and the variable of mathematics computation scores (6) on the California Achievement Test (Form C - Level 19) of teacher education applicants at East Tennessee State University. The teacher education applicants chosen for this study applied for admission to teacher education at East Tennessee State University during winter and spring quarters, 1980.

**The Problem**

**Statement of the Problem**

The problem of the study was to examine relationships between the variables of (1) sex, (2) attitudes toward mathematics, (3) college grade point average (GPA), (4) American College Test (ACT) mathematics scores, (5) number of mathematics courses taken, and the variable of (6) mathematics computation scores on the California Achievement Test (CAT) Form C - Level 19.

**Hypotheses**

H1. There will be a statistically significant difference between the CAT mathematics computation scores of males and females.

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H2. There will be a statistically significant correlation between the variables of attitudes toward mathematics and CAT mathematics computation scores.

H3. There will be a statistically significant difference between scores of males and females on the test of attitudes toward mathematics.

H4. There will be a statistically significant correlation between the variables of college grade point average and CAT mathematics computation scores.

H5. There will be a statistically significant difference between the college grade point average of males and females.

H6. There will be a statistically significant correlation between the variables of ACT mathematics scores and CAT mathematics computation scores.

H7. There will be a statistically significant difference between the ACT mathematics scores of males and females.

H8. There will be a statistically significant correlation between the variables of weighted number of mathematics courses taken and CAT mathematics computation scores.

H9. There will be a statistically significant difference between the weighted number of mathematics courses taken by males and females.

Significance of The Study

Throughout the review of literature, research studies revealed differences in results as related to the variables in this study,
A study needed to be conducted at East Tennessee State University to
determine if the selected variables were statistically related to
the results on the California Achievement Test. If it were determined
by data analysis, that certain variables were statistically related
to the results on the mathematics computation test of the CAT, then
revisions of the current mathematics requirements at ETSU for teacher
education applicants would be considered. A comprehensive study of
possible ways to aid the applicants before they were required to
participate in the CAT C testing program would be conducted.

**Definitions of Terms**

**Achievement Test**

A test designed to measure a person's knowledge, skills,
understandings, etc., in a given field taught in school, for
example, a mathematics test. (In practice, an achievement
test may include measures of several types of subject matter
and may yield separate scores for each subject; such a test
is usually called an achievement battery.)

**ACT Mathematics Scores**

Numerical scores received based on a subject's performance
on a forty item, fifty minute examination designed to measure the
student's mathematical reasoning ability.

**American College Test (ACT)**

The ACT was a battery of four tests—English usage, mathematics

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17 Carter V. Good, ed., *Dictionary of Education* (3d ed.;
usage, social studies reading, and natural science reading—administered by the American College Testing Program and these measured as directly as possible the abilities of students in basic academic areas.

**Applicant**

Students applying for admission to teacher education at East Tennessee State University as defined in *Bulletin of East Tennessee State University, 1979-80,* and in the memorandum distributed to applicants. (Appendix A)

**Attitude Scale**

"An attitude measuring instrument - the units of which have been experimentally determined and equated; designed to obtain a quantitative evaluation of an attitude ..."\(^{20}\)

**Attitude Toward Mathematics**

"The predisposition or tendency to react specifically toward mathematics as measured by the Revised Aiken-Dreger Mathematics Attitude Scale.


\(^{19}\) William N. Pafford, "Procedure for Admission to Teacher Education - Quarter System." Johnson City, Tennessee: East Tennessee State University, College of Education, 1980. (Mimeographed.)

\(^{20}\) Good, p. 509.

\(^{21}\) Good, p. 49.
California Achievement Test (CAT)

The California Achievement Test (Form C - Level 19) Edition 1977 was used in this study.

The CAT mathematics computation scores were the raw scores for Level 19 - CAT C. The maximum raw score was 40.

College Grade Point Average (GPA)

"A measure of average scholastic success in all school subjects. . . . accumulated for several terms or semesters, obtained by dividing grade points by hours of course work taken . . . ." In this study GPA was based on the following system: A = 4.00, B = 3.00, C = 2.00, D = 1.00, and F = 0.00.

Number of Mathematics Courses Taken

Weighted number of mathematics courses taken in high school and college prior to application for admission to the teacher education program.

Sex

Male and female teacher education applicants at East Tennessee State University.

Organization of the Study

The study is organized into five chapters. Chapter 1 includes the introduction, defines the problem, develops the hypotheses,

\(^{22}\) Good, p. 53.
explains the significance of the study, defines the terms, and summarizes the organization of the study.

Chapter 2 contains the literature related to the study.

In Chapter 3 the procedures used in the study are explained.

Chapter 4 is the compilation of the results and reports of statistical analysis of data.

Chapter 5 includes the findings, conclusions, and recommendations of the study.
Chapter 2

REVIEW OF LITERATURE

Introduction

A thorough search of the literature yielded information which was relevant to this study in the following areas: (1) sex, (2) attitudes toward mathematics, (3) attitude scales for mathematics, (4) Revised Aiken-Dreger Attitude Scale, (5) college grade point average, (6) American College Test (ACT), (7) ACT mathematics test, (8) number of mathematics courses taken, and (9) Mathematics Computation-California Achievement Test (CAT) Form C. The research deemed more significant for this study were categorized accordingly and reported in this chapter.

Sex

Evidence has indicated that many variables affected performance in mathematics achievement between the sexes.

Nancy Frazier and Myra Sadker developed a theory that a child learned the sex role at home. In the home, the young girl was encouraged to exhibit passivity and a strong sense of dependency, while the young boy was discouraged from passivity and docility.¹

David E. Austin and others stated that society dictated standards of conduct which clearly separate the sexes in terms of behavior. Frazier and Sadker explained that to a certain degree society encouraged the female traits of neatness, obedience, studiousness, and orderliness. On the other hand, society dictated that males exhibit traits of individuality, courage, robustness, curiosity, and vigorous activity.

When boys began school, they had already learned their roles according to Austin and others. Boys found it difficult to adjust from the father model at home to the female teacher model at school. This situation became frustrating because boys were at an age level when the ties between father and son were usually the strongest. However, most girls usually entered school easily as they shifted from mother model to the female teacher model at school.

Parents perceived mathematics to be for boys rather than girls. By their action parents often discouraged girls to learn mathematics. Thomas L. Hilton and Gosta W. Berglund have discovered that parents buy mathematical games for boys rather than girls. Lynn Fox concluded that parents provided scientific materials such as toys, books, and games for sons, and aided sons in studying mathematics textbooks.

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3Frazier and Sadker, p. 88.

4Austin and others, p. 37.

Parents showed no interest in daughters who were gifted in mathematics.6

H. S. Astin found that parents reinforced the idea to their children that it is more important for sons to learn mathematics.7 Maccoby realized that parents pushed their sons to achieve in mathematics because in all probability their sons would become engineers or scientists. Parents believed that in all likelihood their daughters would not need mathematics in their occupations.8

Maccoby discovered that some studies in grade school showed boys beginning to move ahead to arithmetical reasoning. However, other studies revealed no differences between the two sexes in grade school.9 Anne Anastasi reported that girls usually do better in verbal and linguistic studies. Boys usually do better in numerical and spatial aptitudes and tests of arithmetical reasoning.10

D. A. Roach administered a mathematics test to 206 boys and 212 girls in five Jamaican elementary schools. Girls had higher mathematical achievement than boys. Analytic conceptual style had no

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relation to sex.\textsuperscript{11}

Elizabeth Fennema and Julia A. Sherman contended that the long accepted belief that boys were better in mathematics than girls cannot be supported. In their recent research, male superiority of mathematics achievement was not supported. According to Fennema and Sherman, it appeared that girls were beginning to pursue careers in the mathematical field.\textsuperscript{12}

College students have been studied in regard to mathematics achievement. Maccoby surveyed the field of sex differences in regard to achievement in high school and college and discovered that "boys excel in arithmetical reasoning in high school, and the differences are substantially in favor of men among college students and adults."\textsuperscript{13}

H. A. Witkin and others suggested that men as a group tended toward an analytical approach in their intellectual and perceptual functioning. Women tended toward a global field approach to their perceptual and intellectual functioning; therefore, men should do better in mathematics.\textsuperscript{14}

Fox reported that girls were as bright as boys and performed as well or better than boys in school classes, yet there was a definite

\textsuperscript{11}D. A. Roach, "The Effects of Conceptual Style Preference, Related Cognitive Variables and Sex on Achievement in Mathematics," \textit{British Journal of Educational Psychology}, XLIX (February, 1979), 79-82.


\textsuperscript{13}Maccoby, p. 25.

difference between the sexes in performance on difficult college-level
tests of mathematics achievement. 15

G. A. Milton's study explored the following hypothesis:

(a) There is a positive relationship between masculine
identification and problem-solving achievement. (b) When an
adjustment is made for the between subjects variance contributed
by sex-role identification, sex differences in problem-solving
achievement will be reduced. 16

Milton implied that the differences between men and women in problem
solving relied on the masculine-role identification. Therefore, the
more "masculine" women will be better equipped to solve problems than
the "feminine" women. Similarly, the "feminine" men will be less likely
to solve problems than the "masculine" men. The results indicated
that a positive relationship existed between masculine identification
and better-solving achievement for both sexes and within sex. 17

Maccoby pointed out that

... sex differences in verbal ability decline during
the age period when the rise of identification and differen­
tial modeling ought to increase them, and consistent sex
differences in quantitative ability do not appear until adoles­
cence, long after the time when boys and girls have begun to
prefer same-sex models. 18

Maccoby did "not believe that the identification hypothesis provided
an adequate explanation of the sex differences in ability profiles." 19

Jerome Kagan and Howard A. Moss reported significant differences
in intellectual skills between females who reject a traditional

15Fox, p. 4.

16G. A. Milton, "The Effects of Sex-Role Identification Upon
LVII (September, 1957), 208-212.

feminine role and females high on feminity. High performance scores on problems requiring analysis and complex reasoning were characteristic of "masculine" females as well as "masculine" males.20

The William J. Meyer and A. W. Bendig,21 and Gerald Arthur Cleveland and Dorothy L. Bosworth22 studies illustrated that a greater interest in mathematics achievement was shown by males than females at the high school and college level. However, in elementary and junior high school, it was not always true that boys as a group were superior in mathematics achievement to girls as a group.

Glorey Carey reported sex differences in problem solving as a function of sex differences in attitude. In the study, Carey discovered that women's attitudes and aptitude scores were highly significant. Men's relationship between attitude and aptitude, however, was not significant which indicated that men would not admit that they disliked problem solving even if their mathematical aptitude was weak.23


Althea Huston Stein and Margaret M. Bailey stated that females believe that mathematics was for males.\textsuperscript{24} Hilton and Berglund found that females do not recognize the usefulness of mathematics in their future. Since they lack this motivation for achievement in mathematics and see no reason for studying mathematics, these two forces could discourage females from putting much effort toward learning mathematics.\textsuperscript{25}

Stephen Dowald Johnson's study with college students revealed that college students tended to be attracted to peers whose attitudes coincided with their own. Therefore, the importance of attitudes toward mathematics influenced social behavior.\textsuperscript{26}

**Attitude Toward Mathematics**

Educators and researchers were concerned with the assessment of attitudes toward mathematics. In recent social-psychological literature, attitudes toward mathematics at all ages have received a great deal of attention. Only those studies that deal specifically with college students' attitudes toward mathematics were presented in this review.

\textsuperscript{24} Althea Huston Stein and Margaret M. Bailey, "The Socialization of Achievement Orientation in Females." \textit{Psychological Bulletin}, LXXX (November, 1973), 345-366.

\textsuperscript{25} Hilton and Berglund, \textit{Sex Differences in Mathematics Achievement--A Longitudinal Study}, p. 50.

E. G. Begle remarked: "Students' attitudes towards mathematics are considered by many to be of great importance, either as educational outcomes of intrinsic importance or as determinants of mathematics achievement." 27

Students' positive attitudes toward mathematics began to decrease at the fourth grade and continued to decrease until junior high. At the beginning of junior high school attitudes begin a slow and steady drop which continues to the end of high school and into college. 28

Robert E. Reys and Floyd G. Delon surveyed prospective teachers. The greatest percentage (40 percent) of the prospective teachers surveyed stated that the junior-high school years were the peak of development. 29 Wilbur H. Dutton's study conducted the same year gave reinforcement to the idea that junior high school years were the critical period in determination of attitudes toward mathematics. 30

Thomas Poffenberger and Donald A. Norton studied two groups of college students. One group consisted of students with negative attitudes toward mathematics, and the other group consisted of students with positive attitudes toward mathematics. They found that attitudes

28Begle, p. 212.
were developed in the home in some cases before the child entered school and that one experience was just built upon another.  

Leon A. McDermott attributed the influence of others, such as parents, siblings, and peers in shaping attitudes of students who fear mathematics and students who do not fear mathematics.

Joanne S. Burris discovered that in addition to deficiencies in mathematical concepts and skills, students commonly exhibit a poor attitude toward learning mathematics.

Traditionally, one expected males to score higher on tests of achievement in mathematics and on mathematics attitudes scale. Carey investigated sex differences in problem solving by developing a scale to measure attitudes toward problem solving. To the experimental group which consisted of an equal number of males and females, the attitude scale and a series of ten problems were administered. The experimental group members then participated in a discussion with the disguised intent to improve attitudes toward problem solving. After the discussion, the experimental group was administered an alternate form of the attitude scale and a second set of ten problems. Men showed no change in performance, but the women showed a significant improvement. The men showed a significantly higher score on the

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Fannie Roberts conducted a study of college freshmen. The subjects consisted of 264 students of whom 183 were enrolled in a terminal mathematics course and eighty-one were beginning engineering students. The attitudes of the students were measured by means of the Rabinowitz Mathematics Attitude Scale. The findings indicated no significant difference in attitudes toward mathematics with respect to sex. However, the beginning engineering students showed a significantly more positive attitude toward mathematics than did the terminal mathematics students.  

Merlyn James Behr selected 150 males and 173 females enrolled in a higher level college mathematics class. The criteria for being included in the sample was that each subject had successfully completed intermediate algebra and had an overall high school average between 75 percent and 85 percent. The subjects were given the Aiken Attitude Toward Mathematics Opinionnaire. Results of the study revealed that there was a difference in attitude at the beginning of the class based on sex and that the correlation of attitude toward mathematics with aptitude and achievement in mathematics was significantly higher for females than for males.  

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34Carey, p. 256.


R. E. Jackson concluded that there was a significant positive correlation between the attitude toward mathematics of a group of disadvantaged students and their achievement in elementary mathematics courses at the college level. 37

Lewis R. Aiken and Ralph Mason Dreger studied the effects of attitude on performance in mathematics. The subjects were sixty males and sixty-seven females enrolled in freshman mathematics at a southeastern college. Aiken and Dreger concluded that mathematics attitudes were apparently related to intellective factors and the achievement in mathematics. 38

J. M. Wilson found that a relationship of pre-course and post-course attitude on final grade was significant at $r = .861$ and that attitude did not change significantly during the course. 39

In a study by Dreger and Aiken a substantial relationship was predicted between attitudes and achievement. The scores of 704 students in a freshman mathematics course and their scores on an anxiety inventory had a correlation of $-.44$. 40


Phillip D. Cristantiello reported that 264 college sophomore men were categorized into high, middle, and low groups on the basis of their attitude toward mathematics. There was a significant correlation between mathematical ability and mathematical achievement in the middle groups. However, the low or high groups of extreme attitudes toward mathematics showed that mathematical ability may be a less important determiner. Jackson's study concluded that the extreme of highly negative and highly positive scores of attitude toward mathematics were only significant in relationships to mathematics achievement rather than the middle range scores.

Lester Garth Harrington's study found the selection of a mathematics course as opposed to no mathematics course was significantly related to attitude. The statistics showed very little relationship between attitude and performance in college mathematics courses.

Ronald R. Edwards conducted a study concerning remedial courses offered to community college students. Since an "open door admissions" policy was maintained at community colleges these remedial courses must be offered. The results of administering the Dutton Attitude Scale to 621 students revealed that males scored higher in attitudes.

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42 Jackson, p. 130.

toward mathematics than females.\textsuperscript{44}

Ralph George Anttonen's investigation during a longitudinal study indicated that inventoried attitudes toward the subject were not valid in primary grades, but at the college level attitude scores contributed something over and above ability test scores, to the prediction of achievement in mathematics.\textsuperscript{45}

\textbf{Attitude Scales for Mathematics}

Several attitude scales have been designed for mathematics. Three of the most widely used are the Thurston, Likert, and Guttman Attitude Scales.

The Thurston scaling technique was developed in 1928 and first used by Louis L. Thurston and Ernest J. Chave in 1929 to develop a scale for the measurement of attitudes toward the church. The Thurston method is a series of statements which reflected different degrees of negative and positive statements about mathematics. The respondent's score consisted of a series of such statements which was the sum of the scale values of the statements with which he/she agrees or disagrees.\textsuperscript{46}


An example of a Thurston scale is the Dutton Scale which is used for measuring attitudes of elementary teachers and junior high students. Dutton's scale was used by Fedon for third graders. In the J. Peter Fedon study the students were asked to use colors for the intensity of their attitudes. The colors ranged from black for an extreme negative attitude to yellow for neutral to red for positive attitude. Dutton's scale is a multidimensional scale consisting of fifteen different statements which assess attitudes toward different aspects of arithmetic.

The Guttman scalogram was used least frequently because it was less useful for affective items like attitude statements. Anttonen developed ninety-four attitude items and arranged them into fifteen Guttman type scales. In 1960, Anttonen tested 1,017 fifth and sixth grade students with an arithmetic attitude scale. Six years later the same test was given to the 607 students who had not dropped out of school or were absent. The only change in the test was the changing of the word arithmetic to mathematics for the high school students.

The Likert-type scale had been used extensively in psychology and the social sciences for some time. Researchers preferred Likert scales because they were easier to construct than either Thurstone or


50 Anttonen, p. 467.
Guttman scales. It was not until the late fifties that a Likert scale was used to measure attitudes toward mathematics. The respondents answer questions of either a negative or positive attitude toward something. The respondent must choose a response of strongly agrees, agrees, undecided, disagrees, or strongly disagrees. The scales usually consist of twenty or more statements. The Likert procedure was developed for summated ratings. The subjects' score should be the sum of their statements.

Revised Aiken-Dreger Attitude Scale

The subjects of this study were given the Revised Aiken-Dreger Attitude Scale which was developed by using the Likert scaling procedure. First, 310 college students wrote paragraphs describing attitudes toward mathematics. From these paragraphs of a twenty-item scale was developed which consisted of ten items negative toward mathematics attitudes and ten items positive toward mathematics attitudes. A sample of 160 college sophomores from a southeastern college for women was used for validity estimates. Validity of the scale was determined by Aiken and Dreger after they discovered that scores on the scale also predicted gain in scores from initial to final administration of a mathematics achievement when training intervened. Scores on the attitude scale were positively correlated with numerical ability. Aiken and Dreger reported a test-retest reliability coefficient of .94.

Each item contains five response alternatives: strongly agree, agree, undecided, disagree, and strongly disagree. The negative items must be reversed for scoring. The subjects' scores must be the
The sum of the weighted alternatives endorsed by them. High scores reflect positive attitudes toward mathematics. 51

**College Grade Point Average**

Lyle F. Schoenfeldt and Donald H. Brush suggested "that the current system of grades (GPA) could be considered singular for most predictive purposes." 52

Several studies have been conducted concerning the high school grade point average. William R. Passons chose 376 males and 506 females enrolled in freshman courses at Fresno State College to study the degree of relationship of nine predictor variables and the variables of first semester grade point average and grades in selected freshman courses. The findings revealed that the high school grade point average was the best predictor of first semester college grade point average. 53

Results from fifty colleges which participated in the ACT Testing Research Services showed that women obtained higher high school GPA's than did men. 54

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L. Gross, Jane Faggen and Karen McCarthy did a study to determine if males or females were more predictable in an academic setting. Data for the study were collected from 17,745 students from the City University of New York which consisted of twelve senior colleges, ten two-year or community colleges, a graduate school and a medical school. College grade point average was used to measure academic performance. It was found that academic performance for female college students was more predictable than academic performance of male college students. Wayne L. Schroeder and George W. Seashore conducted studies which revealed that females were more predictable than males in academic settings.

John R. Kinzer and Lydia G. Kinzer followed the achievements of 1,244 students at Ohio State University who had enrolled in college algebra in the fall of 1946. The purpose of the study was to determine the relation between test scores and GPA in advanced mathematics. It was found that test scores of the selected mathematics courses--college algebra, trigonometry, analytic geometry, Calculus I, Calculus II, Calculus III and advanced calculus and the GPA averages were significant at the .01 level.


From the results of fifty colleges which participated in the ACT Testing Research Services to develop generalized regression weights for the ACT composite and the high school average, it was discovered that women obtained higher college grade point averages than did men. 59

John M. Nickens conducted a study which consisted of the population of approximately five hundred Florida junior college transfer students which were randomly selected. The variables were first term Florida State University grades, college grade point average, Florida Twelfth Grade Test Score and sex. The mathematics test scores were found to account for significant proportions of variance in college grade point average. 60

Terry L. James and Wayne Dumas found a statistical relationship between academic success as measured by the cumulative college GPA, and success in student teaching, as measured by the six-teacher effectiveness ratings used in their study. "Results of the study indicated that the use of college GPA as a selective admission criteria for teacher education may be useful and appropriate when used judiciously in combinations with other variables." 61

Charles D. Adair's study revealed the following:

1) Significant correlations are few between undergraduate GPAs and rated success of first year teachers.

59 Hoyt, pp. 130-136.


(2) Total undergraduate GPA was the best indicator of teaching success to other grade categories.

(3) The correlations between grades and teaching success are very low, but are positive.

(4) Some evidence suggested that the most successful teachers have the highest undergraduate GPA.\(^2\)

Smith's research indicated that the best single indicator of those students who can succeed in any given subject area can be found by studying the correlation of previous quarter's grade point average and the scores on a standardized test for that given subject.\(^3\)

The authors, Ray D. Goldman and Robert E. Slaughter, suggested that investigations of GPA should be replicated at other institutions. Each institution's investigators should do research about their own college's grade point average.\(^4\)

**American College Test (ACT)**

The ACT Assessment Program began in 1959 by the American College Testing Program. Over the years the ACT had changed slowly from a repackaged version of the *Iowa Tests of Educational Development*. Five times a year the American College Test was offered. The test consisted of reading, natural sciences, mathematics usage, English usage, social

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\(^2\) Charles D. Adair, "Relationship Between Undergraduate Grades and First Year Teaching Success," *School and Community*, LX (January, 1974), 22.


studies, and a composite scores computed as the mean of the sub-scores.65

American College Test Program began producing its own test apart from the Iowa Tests of Educational Development in 1973. The prediction of correlation between ACT scores and college grades in the appropriate subject would be about .4.66

Individual researchers such as Donald P. Hoyt67 and Leo A. Munday68 as well as American College Program have established the predictive validity of the ACT. These investigations have been validated to predict college grades. Later, Ray Merritt's findings supported the composite score of the ACT to be a valid predictor of college grades for students from a low socioeconomic background.69

Several studies have been conducted with proved that the American College Test battery was as good a predictor of grades for typical college populations as the SAT battery. These studies included.


66Hills, p. 469.


68Leo A. Munday, "Correlation Between ACT and Other Predictors of Academic Success in College," College and University, XLIV (Fall, 1968), 67-76.


76 Passons, "Predictive Validities of the ACT, SAT and High School Grades for First Semester GPA and Freshman Courses," pp. 1143-1145.

The (ACT) Mathematics Usage Test is a 40 item, 50-minute examination that measures the student's mathematical reasoning ability. It emphasizes the solution of practical quantitative problems which are encountered in most postsecondary curriculum and includes a sampling of mathematics techniques covered in high school courses.

The five types of content of the mathematics usage test were the following: (1) arithmetic and algebraic reasoning, (2) arithmetic and algebraic operations, (3) advanced algebra, (4) geometry, and (5) miscellaneous.

The ACT Mathematics Usage Test's reliability was examined by a) test-retest, b) parallel forms, and c) internal consistency. The results were the following:

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79 Lawrence M. Aleamoni and Linda Oboler, "ACT Versus SAT in Predicting First Semester GPA," Educational and Psychological Measurement, XXXVIII (Summer, 1978), 393-399.

80 Risdon J. Weston and Oscar T. Lenning, "Prediction at a Highly Selective Institution After Corrections Have Been Made for Selection: ACT Versus SAT," College and University, XLIX (Fall, 1973), 68-76.

81 Hills, p. 469.


a) Test-retest - Munday and Hoyt retested sixty-three students after two years of college.

Table 1

ACT Reliability - (Test-Retest)

<table>
<thead>
<tr>
<th>Mean</th>
<th>S. D.</th>
<th>Mean</th>
<th>S. D.</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td>10.3</td>
<td>5.0</td>
<td>10.9</td>
<td>5.6</td>
</tr>
</tbody>
</table>

b) Parallel forms - (N = 433)

Table 2

ACT Reliability - (Parallel Forms)

<table>
<thead>
<tr>
<th>Form 6AC</th>
<th>Form 7AC</th>
<th>Corrected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>S. D.</td>
<td>Mean</td>
</tr>
<tr>
<td>Math</td>
<td>22.61</td>
<td>6.03</td>
</tr>
</tbody>
</table>

c) Internal consistency - Summary of reliability figures for the ACT tests.

Table 3

ACT Reliability - (Internal Consistency)

<table>
<thead>
<tr>
<th>No. of Forms</th>
<th>Median Reliability</th>
<th>Range of Reliabilities</th>
<th>Median Standard Error</th>
<th>Range of Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Math</td>
<td>.88</td>
<td>.85 - .89</td>
<td>2.20</td>
<td>2.00-2.57</td>
</tr>
</tbody>
</table>
"The predictive validity of the ACT Program's test is (was) best examined by reviewing their multiple correlations with academic criteria."\(^{84}\)

The following results were compiled for the ACT Mathematics Usage Test: \(^ {85}\)

Table 4

Predictive Validity of the Five ACT Test Scores

<table>
<thead>
<tr>
<th>Variables</th>
<th>Number of Colleges</th>
<th>Number of Students</th>
<th>Median r</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT Mathematics Test vs College Mathematics GPA</td>
<td>91</td>
<td>27.582</td>
<td>.374</td>
</tr>
</tbody>
</table>

Table 5

Predictive Validity of the Four ACT Tests Combined

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Number of Colleges</th>
<th>Number of Students</th>
<th>Median R*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics GPA</td>
<td>393</td>
<td>119,116</td>
<td>.421</td>
</tr>
</tbody>
</table>

* Multiple R of the four ACT tests with each criterion

\(^{84}\)American College Testing Program, pp. 16-19.

\(^{85}\)American College Testing Program, p. 19.
Number of Mathematics Courses

The majority of studies surveyed for the review of literature indicated that the number of mathematics courses taken affected mathematics achievement.

Herbert Sorenson determined from his research that there was an apparent relationship between the number of various subjects taken in high school and college achievement. Mathematics was second to Latin in predicting that relationship.86

George Ferguson's investigations involved the study of records of 1,709 students - 1,439 from secondary school and 270 from other colleges. Students who had had four units of mathematics plus four units of science were the superior students in relation to the percentage of students on the dean's list.87

West and Fruchter conducted a study at the University of Texas involving fifty-six males and sixty females from the freshmen classes of 1950, 1951, and 1952. The study revealed that increased study of mathematics in high school showed a consistent trend of increased scholastic achievement in all first semester college grades, and mainly in mathematics grades. However, none of the mean differences


87 George O. Ferguson, Jr., "Some Factors in Predicting College Success," School and Society, XXXVII (April 29, 1933), 566-568.
<table>
<thead>
<tr>
<th>Subject</th>
<th>Number of Units</th>
<th>Percentage on Dean's List</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>3½</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>2½</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Latin</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>History</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Latin and Math</td>
<td>4 each</td>
<td>61</td>
</tr>
<tr>
<td>Latin and History</td>
<td>4 each</td>
<td>50</td>
</tr>
<tr>
<td>Math and Science</td>
<td>4 each</td>
<td>62</td>
</tr>
<tr>
<td>Math and History</td>
<td>4 each</td>
<td>42</td>
</tr>
<tr>
<td>History and Science</td>
<td>4 each</td>
<td>27</td>
</tr>
</tbody>
</table>
from these comparisons were significant. 88

In 1931 H. R. Douglas studied high school records of 1,196 students at the University of Oregon. Conclusions from the study indicated that the number of units in any one subject matter field in high school did not furnish a satisfactory basis for predicting success. 89

Culbreth Y. Melton conducted a study at the University of Georgia in 1961. The results of the study indicated that number of units in various areas that a student had taken was of little value in predicting successful achievement in college. 90

John R. Hills reported that the pattern of high school units as well as the number of high school units was of little value as a predictor of academic success in college. 91

Sigmund Tobias' investigations confirmed that mathematics achievement was based on prior preparation along with proper instruction. 92 Ernest T. Pascarella verified Tobias' investigations in the


study of prior mathematics preparation in regard to college calculus. 93

Ina Ann Cauthen's study consisted of data on 1420 students - 1048 male subjects and 372 female subjects. The 1420 students were volunteers who ranged from freshmen to seniors with a few graduate students. The Cauthen study revealed that "subjects who had taken more mathematics courses in high school scored higher on both" the trigonometry test and the algebra test. 94

Winston M. Scott and John P. Gill discovered that the lack of high school algebra contributed to failure in college mathematics. 95 A. Pemberton Johnson studied male non-veterans in 101 colleges. The results of the study showed that 56 percent of the engineering students withdrew during the four years because of lack of mathematical background. 96 William P. Morgan's study indicated that the number of years of high school mathematics was a significant predictor of mathematics success in college at the .01 level. 97

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Marshall E. Wick found that first year college students who had four semesters of high school experimental mathematics tended to do consistently better over the entire range of mathematics aptitudes than the student who had had only one to three semesters of high school mathematics. He concluded that the high school record was consistently the best indicator of success in first year college mathematics.98

Thomas C. Gibney, John L. Ginther, and Fred L. Pigge conducted a study to "compare the number of mathematics courses taken by approximately 1050 elementary teachers and their mathematical understanding." Their conclusions were:

(1) Elementary teachers, in general, with some years of high school mathematics did progressively better (significant beyond .05 level) on a test of mathematical understanding.

(2) Elementary teachers with more college mathematics courses did progressively better (significant beyond .05 level) on a test of mathematical understandings.

(3) Elementary teachers with more exposure to 'modern mathematics' did progressively better (significant beyond .05 level) on a test of mathematical understandings.99

Mathematics Computation, California Achievement Test (CAT) Form C

The California Achievement Test - Form C - Level 19 combined reporting of both criterion referenced and norm referenced information.


This combination provided extensive data on the relative ranking of an individual student against local or national norm group of the student's contemporaries.  

The complete battery of the CAT C contained five basic content areas: Reading, Spelling, Language, Mathematics, and Reference Skills.  


The Kuder-Richardson Formula 20 was used to estimate reliability of CAT C scores.  

California Achievement Test (Form C) was based on objectives stated in recent textbooks, curriculum guides, and other instructional materials used by school systems. A large staff of qualified writers, mostly teachers, developed the test materials. The Tryout Edition of Cat C was administered by teachers who returned comments and suggestions. The Dale-Chall Formula and Fry Formula were used to test readability of the Cat C.  

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101 California Achievement Test Program, p. 21.

102 California Achievement Test Program, p. 13.

103 California Achievement Test Program, p. 39.

104 California Achievement Test Program, pp. 10-11.
CAT Mathematics Computation (Test 6 - Form C - Level 19) contained 40-items that measured the following CAT objectives:

<table>
<thead>
<tr>
<th>Objective Number</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>69</td>
<td>The student will solve computation problems in addition.*</td>
</tr>
<tr>
<td>70</td>
<td>The student will solve computation problems in subtraction.*</td>
</tr>
<tr>
<td>71</td>
<td>The student will solve computation problems in multiplication.*</td>
</tr>
<tr>
<td>72</td>
<td>The student will solve computation problems in division.*</td>
</tr>
</tbody>
</table>

* All four operations used whole numbers, fractions, decimals, integers, and algebraic expression.

Summary

Various texts and current periodical literature pertaining to the problem of the study were reviewed. Studies related specifically to mathematics achievement of college students were isolated by consulting Current Index to Journals in Education (CIJE), Education Index, and Psychological Abstracts. Computer retrieval system, Datrix and ERIC were utilized for dissertations, journals, and periodicals.

The review of related literature was divided into eight sections. The sections consisted of five variables which influenced mathematics achievement, attitude scales for mathematics, and CAT mathematics computation test.

105California Achievement Test Program, p. 92.
In the review of related literature the five variables—sex, attitudes toward mathematics, college grade point average, American College Test Mathematics scores, and number of mathematics courses taken were the most prevalent variables which influenced mathematics achievement. Discrepancy was found among the researchers' findings concerning these variables and mathematics achievement. Research was needed to determine if a relationship existed between these variables and the variable of mathematics computation scores on the California Achievement Test (Form C - Level 19) of teacher education applicants at East Tennessee State University.
Chapter 3

METHOD

The problem of the study was to examine relationships between the variables of (1) sex, (2) attitudes toward mathematics, (3) college grade point average (GPA), (4) American College Test (ACT) mathematics scores, (5) number of mathematics courses taken, and the variable of (6) mathematics computation scores on the California Achievement Test (CAT) Form C - Level 19.

Subjects

A population of 220 applicants for admission to teacher education at East Tennessee State University were available for the study. The population consisted of 117 applicants for winter quarter, 1980, and 103 applicants for spring quarter, 1980.

The academic records of the entire population were studied. The records revealed that 132 of the 220 applicants had taken the ACT test. Only the 132 subjects were available for the study of null hypotheses 6 and 7.

The entire population was available for the study of null hypotheses 1 through 5 and null hypotheses 8 and 9.

Facilities

The California Achievement Test (Form C - Level 19) and the Revised Aiken-Dregor Mathematics Attitude Test were given to the
teacher education applicants in a large classroom at East Tennessee State University.

Two testing sessions were held. One testing session occurred during winter quarter, 1980, for 117 participants and the other session during spring quarter, 1980, for 103 participants.

**Instruments**

Instruments used in the study were the Revised Aiken-Dreger Mathematics Attitude Scale and the California Achievement Test (Form C - Level 19).

The Assistant Dean of the College of Education, Dr. W. N. Pafford, administered the California Achievement Test (Form C - Level 19) to the subjects. The CAT was machine scored.

The Revised Aiken-Dreger Mathematics Attitude Scale was administered by the investigator to the subjects prior to their taking the California Achievement Test. The Revised Aiken-Dreger Mathematics Attitude Scale was scored by the investigator. The table used for scoring the Revised Aiken-Dreger Mathematics Attitude Scale can be found in Appendix B.

**Procedures**

Collection of data for the study was obtained from the subject's academic records and scores on the Revised Aiken-Dreger Mathematics Attitude Scale.

Permission was granted by the East Tennessee State University Institutional Review Board to administer the Revised Aiken-Dreger
Mathematics Attitude Scale and for the subjects to list mathematics courses taken in high school (Appendix C).

Dr. L. S. Honaker, Dean of the College of Education, gave the investigator permission for administration of the Revised Aiken-Dreger Mathematics Attitude Scale to the teacher education applicants prior to the taking of the California Achievement Test.

The subjects entered the room for testing after showing proper identification to Assistant Dean of the College of Education, Dr. W. N. Pafford. Each subject was asked to select a seat. After all subjects were seated, the investigator proceeded to read orally the informed consent document. The subjects were asked to sign their names on the informed consent document (Appendix D).

Instructions for the Revised Aiken-Dreger Mathematics Attitude Scale were read orally by the investigator. The subjects were instructed to give appropriate answers which expressed their true feelings. Each item contained five response alternatives: strongly agree, agree, undecided, disagree, and strongly disagree. Instructions are found in Appendix D.

The subjects were instructed to list the names of their previous high school mathematics courses on the third page beside the appropriate grade level. The time for the entire process was fifteen minutes.

Dr. W. N. Pafford administered the California Achievement Test. The instructions are found in Appendix E.

The East Tennessee State University's Admission and Records Office gave the investigator permission to obtain pertinent
data from the academic records of the subjects. The following information was obtained:

(1) Sex of the subjects
(2) College grade point average
(3) ACT mathematics scores
(4) Number of previous high school mathematics courses
(5) Number of previous college mathematics courses
(6) CAT mathematics computation scores

A committee of three professors in the Department of Mathematics at East Tennessee State University developed a mathematics scale for the weighted number of mathematics courses taken by the subjects. The process for the development of the mathematics scale can be found in Appendix F.

It was proposed to analyze the data collected from the study by the Pearson Product-Moment Correlation Coefficient and the Mann-Whitney U-Test for Large Samples.

The Pearson Product-Moment Coefficient of Correlation was used to test the following null hypotheses:

\[ H_0: 2H_0, 4H_0, 6H_0, \text{ and } 8H_0 \]

The Mann-Whitney U-Test for Large Samples was used to test the following null hypotheses:

\[ H_0: 1H_0, 3H_0, 5H_0, 7H_0, \text{ and } 9H_0 \]

Data were analyzed by means of the IBM 370/135 Computer at East Tennessee State University utilizing the Statistical Package of the Social Sciences (SPSS) which computed the Pearson Product-Moment Coefficient of Correlation and the Mann-Whitney U-Test for Large Samples.
Samples (Appendix G). Raw data on all subjects are listed in Appendix H.

**Null Hypotheses**

The research hypotheses were presented in the null hypothesis format to facilitate statistical analysis.

1. $H_0$: There will be no statistically significant difference between the CAT mathematics computation scores of males and females.

2. $H_0$: There will be no statistically significant correlation between the variables of attitudes toward mathematics and CAT mathematics computation scores.

3. $H_0$: There will be no statistically significant difference between scores of males and females on the test of attitudes toward mathematics.

4. $H_0$: There will be no statistically significant correlation between the variables of college grade point average and CAT mathematics computation scores.

5. $H_0$: There will be no statistically significant difference between the college grade point average of males and females.

6. $H_0$: There will be no statistically significant correlation between the variables of ACT mathematics scores and CAT mathematics computation scores.

7. $H_0$: There will be no statistically significant difference between the ACT mathematics scores of males and females.

8. $H_0$: There will be no statistically significant correlation between the variables of weighted number of mathematics courses taken
and CAT mathematics computation scores.

9H₀: There will be no statistically significant difference between the weighted number of mathematics courses taken by males and females.

**Summary**

Data were collected from the subjects academic records which consisted of sex of subjects, college grade point average, ACT mathematics scores, number of previous high school mathematics courses, number of previous college mathematics courses, and CAT mathematics computation scores; and scores obtained on the Aiken-Dreger Mathematics Attitude Scale to test the nine null hypotheses.

The Pearson Product-Moment Coefficient of Correlation and the Mann-Whitney U-Test for Large Samples were used to analyze the data collected. The results of the data analysis are explained in Chapter 4.
Chapter 4

ANALYSIS OF THE DATA

An analysis of the data collected for the study is presented in this chapter. The data were analyzed by utilizing correlation and difference techniques. The nine null hypotheses in Chapter 3 were analyzed and discussed individually.

Statistical Analysis

$H_0$: There will be no statistically significant difference between the CAT computation scores of males and females.

The difference (Table 7) between the CAT computation scores of males ($N = 64$) and females ($N = 158$) for the population was 0.465. This value was not significant at the 0.05 level. The null hypothesis could not be rejected, indicating no significant difference between the CAT computation scores of males and females.

Table 7

Difference Between the CAT Computation Scores of Males and Females

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Cases</td>
<td>158</td>
<td>64</td>
</tr>
<tr>
<td>Mean Rank</td>
<td>113.50</td>
<td>106.56</td>
</tr>
<tr>
<td>$U$</td>
<td></td>
<td>4740.0</td>
</tr>
<tr>
<td>$Z$</td>
<td></td>
<td>-0.730</td>
</tr>
<tr>
<td>Two Tailed $F$</td>
<td></td>
<td>0.465</td>
</tr>
</tbody>
</table>
There will be no statistically significant correlation between the variables of attitudes toward mathematics and CAT mathematics computation scores.

The correlation (Table 8) between the variables of attitudes toward mathematics and CAT mathematics computation scores for the population (N = 222) and 0.4185 was significant at the 0.001 level. The null hypothesis was rejected indicating a significant relationship between the variables of attitude toward mathematics and CAT mathematics computation scores,

Table 8

<table>
<thead>
<tr>
<th>Math Attitude</th>
<th>CAT Mathematics Computation Scores (N = 222)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>*r = 0.4185</td>
</tr>
<tr>
<td></td>
<td>**(N = 222)</td>
</tr>
<tr>
<td></td>
<td>***S = 0.001</td>
</tr>
</tbody>
</table>

3H_0: There will be no statistically significant difference between scores of males and females on the test of attitude toward mathematics.

The difference (Table 9) between the mathematics attitude scores of males (N = 64) and females (N = 158) for the population was 0.188. This value was not significant at the 0.05 level. The null hypothesis could not be rejected, indicating no significant difference between the attitudes toward mathematics of males and females.
Table 9

Difference Between the Mathematics Attitude Scores of Males and Females

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Cases</td>
<td>158</td>
<td>64</td>
</tr>
<tr>
<td>Mean Rank</td>
<td>115.11</td>
<td>102.58</td>
</tr>
<tr>
<td>U</td>
<td></td>
<td>4485.0</td>
</tr>
<tr>
<td>Z</td>
<td>-1.318</td>
<td></td>
</tr>
<tr>
<td>Two-Tailed P</td>
<td></td>
<td>0.188</td>
</tr>
</tbody>
</table>

$H_0$: There will be no statistically significant correlation between the variables of college grade point average and CAT mathematics computation scores.

The correlation (Table 10) between the variables of college grade point average and CAT mathematics computation scores for the population ($N = 222$) was 0.4514 which was significant at the 0.001 level. The null hypothesis was rejected indicating a significant relationship between the variables of college grade point average and CAT mathematics computation scores.

Table 10

Correlation Between the Variables of College Grade Point Average and CAT Mathematics Computation Scores

<table>
<thead>
<tr>
<th>College Grade Point Average</th>
<th>CAT Mathematics Computation Scores ($N = 222$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>*$r = 0.4514$</td>
</tr>
<tr>
<td></td>
<td><strong>($N = 222$)</strong></td>
</tr>
<tr>
<td></td>
<td>***$S = 0.001$</td>
</tr>
</tbody>
</table>

*$r = \text{coefficient}$  **$N = \text{Cases}$  ***$S = \text{Significance level}$
5H₀: There will be no statistically significant difference between college grade point average of males and females.

The difference (Table 11) between the college grade point average of males (N = 64) and females (N = 158) for the population was 0.200. This value was not significant at the 0.05 level. The null hypothesis could not be rejected, indicating no significant difference between the college grade point average of males and females.

Table 11
Difference Between the College Grade Point Average of Males and Females

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Cases</td>
<td>158</td>
<td>64</td>
</tr>
<tr>
<td>Mean Rank</td>
<td>115.02</td>
<td>102.81</td>
</tr>
<tr>
<td>U</td>
<td></td>
<td>4500.0</td>
</tr>
<tr>
<td>Z</td>
<td></td>
<td>-1.283</td>
</tr>
<tr>
<td>Two-Tailed P</td>
<td></td>
<td>0.200</td>
</tr>
</tbody>
</table>

6H₀: There will be no statistically significant correlation between the variables of ACT mathematics scores and CAT mathematics computation scores.

The correlation (Table 12) between the variables of ACT mathematics scores and CAT mathematics computation scores for the population (N = 222) was 0.4700, was significant at the 0.001 level. The null hypothesis was rejected, indicating a significant relationship between the variable of ACT mathematics computation scores and CAT mathematics computation scores.
Table 12
Correlation Between the Variables of ACT Mathematics Scores and CAT Mathematics Computation Scores

<table>
<thead>
<tr>
<th>CAT Mathematics Computation Scores</th>
<th>*r = 0.4700</th>
</tr>
</thead>
<tbody>
<tr>
<td>(N = 222)</td>
<td>**(N = 222)</td>
</tr>
<tr>
<td>***S = -.001</td>
<td></td>
</tr>
</tbody>
</table>

* = coefficient  ** = Cases  *** = Significance level

H₀: There will be no significant difference between the ACT mathematics scores of males and females.

The difference (Table 13) between the ACT mathematics scores of males (N = 64) and females (N = 158) for the population was 0.053. This value was not significant at the 0.05 level. The null hypothesis was rejected. As indicated by 0.053, further study of the difference between ACT mathematics scores of males and females should be considered.

Table 13
Difference Between the ACT Mathematics Scores of Males and Females

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Cases</td>
<td>96</td>
<td>34</td>
</tr>
<tr>
<td>Mean Rank</td>
<td>61.71</td>
<td>76.21</td>
</tr>
<tr>
<td>U</td>
<td></td>
<td>1268.0</td>
</tr>
<tr>
<td>Z</td>
<td></td>
<td>-1.931</td>
</tr>
<tr>
<td>Two-Tailed P</td>
<td></td>
<td>0.053</td>
</tr>
</tbody>
</table>
There will be no statistically significant correlation between the variables of weighted number of mathematics courses taken and CAT mathematics computation scores.

The correlation (Table 14) between the variables of weighted number of mathematics courses taken and CAT mathematics computation scores for the population (N = 222) was 0.3731 was significant at the 0.001 level. The null hypothesis was rejected, indicating a significant relationship between the variables of weighted number of mathematics courses taken and CAT mathematics computation scores.

Table 14

Correlation Between the Variables of Weighted Number of Mathematics Courses Taken and CAT Mathematics Computation Scores

<table>
<thead>
<tr>
<th>Weighted Number of Mathematics Courses Taken</th>
<th>CAT Mathematics Computation Scores (N=222)</th>
</tr>
</thead>
<tbody>
<tr>
<td>*r = 0.3731</td>
<td>**N = 222</td>
</tr>
<tr>
<td>**(N = 222)</td>
<td>***S = 0.001</td>
</tr>
</tbody>
</table>

There will be no statistically significant difference between the weighted number of mathematics courses taken by males and females.

The difference (Table 15) between the weighted number of mathematics courses taken by males (N = 64) and females (N = 158) for the population was 0.223. This value was not significant at the 0.05 level. The null hypothesis could not be rejected, indicating no significant difference between the weighted number of mathematics courses taken by males and females.
Table 15

'Difference Between the Weighted Number of Mathematics Courses Taken By Males and Females

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Females</th>
<th>Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. Cases</td>
<td>158</td>
<td>64</td>
</tr>
<tr>
<td>Mean Rank</td>
<td>108.16</td>
<td>119.74</td>
</tr>
<tr>
<td>U</td>
<td></td>
<td>4528.5</td>
</tr>
<tr>
<td>Z</td>
<td>-1.220</td>
<td></td>
</tr>
<tr>
<td>Two-Tailed P</td>
<td></td>
<td>0.223</td>
</tr>
</tbody>
</table>

Summary

Correlations were significant at the 0.001 level in the following instances:

1. A statistically significant correlation was found to exist between the variables of attitudes toward mathematics and CAT mathematics computation scores.

2. A statistically significant correlation was found to exist between the variables of ACT mathematics scores and CAT mathematics computation scores.

3. A statistically significant correlation was found to exist between the variables of weighted number of mathematics courses taken and CAT mathematics computation scores.

4. A statistically significant correlation was found to exist between the variables of college grade point average and CAT mathematics computation scores.
Differences were not significant at the 0.05 level in the following instances:

1. No statistically significant difference was found to exist between the CAT computation scores of males and females.

2. No statistically significant difference was found to exist between scores of males and females on the test of attitudes toward mathematics.

3. No statistically significant difference was found to exist between the ACT mathematics scores of males and females.

4. No statistically significant difference was found to exist between the weighted number of mathematics courses taken by males and females.

5. No statistically significant difference was found to exist between college grade point average of males and females.
The purposes of this chapter were to summarize the findings of the study, draw conclusions, and make recommendations based on the conclusions.

Summary

Problem. The problem of the study was to examine relationships between the variables of (1) sex, (2) attitudes toward mathematics, (3) college grade point average (GPA), (4) American College Test (ACT) mathematics scores, (5) number of mathematics courses taken, and the variable of (6) mathematics computation scores on the California Achievement Test (CAT) Form C - Level 19.

Procedures. Two hundred twenty-two teacher education applicants were selected for the analysis. The applicants' attitudes toward mathematics were measured by the Revised Aiken-Dreger Mathematics Attitude Scale. The following information was obtained from the academic records of the subjects: (1) sex of the subjects, (2) college grade point average, (3) ACT mathematics scores, (4) number of previous high school mathematics courses, (5) number of previous college mathematics courses, and (6) CAT mathematics computation scores.

The following correlations were examined between the variables of (a) attitudes toward mathematics and CAT mathematics computation
scores, (b) college grade point average and CAT mathematics computation scores, (c) ACT mathematics scores and CAT mathematics computation scores, and (d) weighted number of mathematics courses taken and CAT mathematics computation scores. The following differences were examined between (a) the CAT mathematics computation scores of males and females, (b) scores of males and females on the test of attitudes toward mathematics, (c) college grade point average of males and females, (d) the ACT mathematics scores of males and females, (e) the weighted number of mathematics courses taken by males and females.

Results. A statistically significant correlation at the 0.001 level was found to exist between the variables of (a) attitudes toward mathematics and CAT mathematics computation scores, (b) ACT mathematics scores and CAT mathematics computation scores, (c) weighted number of mathematics courses taken and CAT mathematics computation scores, and (d) college grade point average of males and females.

No statistically significant difference at the 0.05 level was found to exist between (a) the CAT computation scores of males and females, (b) scores of males and females on the test of attitudes toward mathematics, (c) the ACT mathematics scores of males and females, (d) the weighted number of mathematics courses taken by males and females, and (e) college grade point average to males and females.

Conclusions

Based upon the findings of the study, the following conclusions were warranted:

1) The study failed to support the hypotheses that differences
existed between male and female teacher education applicants in regard to their (a) CAT mathematics computation scores, (b) attitudes toward mathematics, (c) college grade point average, (d) ACT mathematics scores, and (e) weighted number of mathematics courses.

2) The study revealed that in regard to teacher education applicants there existed a definite correlation between the variables of (a) attitudes toward mathematics and CAT mathematics computation scores, (b) ACT mathematics scores and CAT mathematics computation scores, (c) college grade point average and CAT mathematics computation scores, and (d) weighted number of mathematics courses taken and CAT mathematics computation scores.

**Recommendations**

Based on the findings and conclusions of this study, it was recommended that

1) Since attitudes toward mathematics of teacher education applicants were significantly related in this study, an attempt should be made to change negative attitudes toward mathematics at all educational levels.

2) Research be conducted to further explain the lack of significant findings of differences existing between male and female teacher education applicants to their (a) CAT mathematics computation scores, (b) attitudes toward mathematics, (c) college grade point averages, (d) ACT mathematics scores, (e) weighted number of mathematics courses.

3) The validity of this research be determined by a replication of the study.
4) Additional studies be conducted using the same variables of the study to explain the lack of significant findings in relationship to differences of males and females and their relationships to the variables.

4) Since a significant correlation was found between ACT mathematics scores and CAT mathematics scores, another investigation could be conducted. This investigation might be used to determine the feasibility of choosing a cut-off score on the ACT mathematics test. The ACT scores above the cut-off point would serve in lieu of requiring the teacher education applicant to take the CAT.
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APPENDIXES
APPENDIX A

MEMORANDUM DISTRIBUTED TO APPLICANTS
COLLEGE OF EDUCATION

PROCEDURE FOR ADMISSION TO TEACHER EDUCATION - QUARTER SYSTEM

1. All students pursuing a teacher preparation program must apply for admission to Teacher Education and must take the State Board of Education Test unless they were admitted prior to November 10, 1978.

2. They must apply during the period set up each quarter. The period for applying for the Spring Quarter, 1980, is March 31-April 11. No applications can be accepted after April 11.

3. Only one application is used - the application for Teacher Education is for the Test also. Students must pick up applications in the office of the Dean of the College of Education - E319. The Test for the Spring Quarter will be given at 2:00 p.m. in Room 315, Education Building, on April 14. It is given only once each quarter, and there is no provision for make-ups.

4. Following are the requirements for eligibility to Teacher Education:

   a. Ninety (90) quarter hours of academic credit.

   b. Completion of the general education requirements for teacher education (see the General Education Program for Teacher Education Students beginning on page 257 of the 1979-80 catalog); satisfactory completion of Education 2010, Psychology 2320 and Psychology 2330; achievement of a 2.20 quality point average in all work completed—students with a 2.0 may be admitted on probation but must remove this deficiency to become eligible to enroll in student teaching; acceptance by a department offering an approved teaching major and a department offering an approved teaching minor or by a department offering an approved teaching concentration; recommendation by the major and minor departments for admission to Teacher Education.

   c. Students who have completed all of the above requirements, with the exception of not more than two general education courses, may be admitted on "condition" that such courses are completed in the next quarter. Transfer students may be admitted to Teacher Education lacking as many as six general education courses on "condition" and should complete such deficiencies in the next two quarters.

5. Students eligible for Teacher Education will be required to take the State test during the quarter of application. If they are not eligible, the application will be rejected and returned to the Chairman of the major department. They must re-apply when they become eligible.

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6. The State test is a part of admission to Teacher Education. The applications of students who do not take the test or who fail all or any part of it will be rejected and returned to the Chairman of the major department. The students must then re-apply for Teacher Education during the next period when they wish to be admitted and take the test. The test can be repeated after one quarter has elapsed; (i.e., the following quarter). If a student fails the test a second time, however, he/she cannot repeat it until one year has elapsed.

7. The tests are shipped to Knoxville for grading. After the results of the tests are known, the applications are endorsed by the Dean and forwarded to the Admissions Office for processing. After processing, a list of students who gained admittance to Teacher Education is forwarded to the chairmen of the departments involved.
APPENDIX B

SCORING TABLE FOR REVISED AIKEN-DREGER MATHEMATICS ATTITUDE SCALE
RESPONSE VALUES FOR AIKEN-DREGER MATHEMATICS ATTITUDE SCALE

<table>
<thead>
<tr>
<th>ITEMS</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>The negative items:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1, 2, 6, 7, 8, 10, 12,</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13, 16, 17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The positive items:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3, 4, 5, 9, 11, 14,</td>
<td>4</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>15, 18, 19, 20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A = Strongly agree  B = Agree  C = Undecided  D = Disagree  E = Strongly disagree
Dear Ms. Miller:

At the December 6, 1979 meeting of the Institutional Review Board, your above proposal was reviewed. The recommendation of the Short-Review Subcommittee to approve your project was approved by the Institutional Review Board at the meeting. If any significant alterations take place in the format of the proposed study, or if any untoward reactions are noted in the conduct of the study, please communicate these promptly to the Institutional Review Board.

Sincerely yours,

Frank H. Shepard, M.D.
Professor and Chairman
Department of Pediatrics
Chairman, Institutional Review Board

Enclosure
APPENDIX D

INFORMED CONSENT FORM

REVISED AIKEN–DREGER MATHEMATICS ATTITUDE SCALE

MATH COURSES LISTING
East Tennessee State University
Institutional Review Board
Informed Consent Form

Principal Investigator: Linda H. Miller

Title of Project: The Relationship of Selected Variables in Mathematics Achievement of Teacher Education Applicants

1) Purpose of study:
To determine if there is a correlation between teacher education applicants' attitudes toward mathematics and scores received on the California Achievement Test which is required by Tennessee State Board of Education.

2) Procedures:
Students will fill out an opinionnaire concerning mathematics attitude. Also, they will list math courses taken in high school and the last math course taken prior to the California Achievement Test at ETSU.

3) The approximate duration of opinionnaire:
Ten minute opinionnaire

4) I understand the procedures to be used in this study. I am entering into answering this opinionnaire freely. I, also, understand that my refusal to fill out this questionnaire will not affect my academic performance. I understand my identity will be kept confidential.

________________________ (date) Signature of volunteer

________________________ (date) Signature of investigator

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DIRECTIONS: Please write your name in the upper right hand corner. Each of the statements on this opinionnaire expresses a feeling which a particular person has toward mathematics and reading. You are to express, on a five-point scale, the extent of agreement between the feeling expressed in each statement and your own personal feeling. The five points are: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), Strongly Agree (SA). You are to encircle the letter(s) which best indicates how closely you agree or disagree with the feeling expressed in each statement AS IT CONCERNS YOU.

1. I am always under a terrible strain in a math class. SD D U A SA
2. I do not like mathematics, and it scares me to have to take it. SD D U A SA
3. Mathematics is very interesting to me, and I enjoy math courses. SD D U A SA
4. Mathematics is fascinating and fun. SD D U A SA
5. Mathematics makes me feel secure, and at the same time it is stimulating. SD D U A SA
6. My mind goes blank, and I am unable to think clearly when working math. SD D U A SA
7. I feel a sense of insecurity when attempting mathematics. SD D U A SA
8. Mathematics makes me feel uncomfortable, restless, irritable, and impatient. SD D U A SA
9. The feeling that I have toward mathematics is a good feeling. SD D U A SA
10. Mathematics makes me feel as though I'm lost in a jungle of numbers and can't find my way out. SD D U A SA
11. Mathematics is something which I enjoy a great deal. SD D U A SA
12. When I hear the word math, I have a feeling of dislike. SD D U A SA
13. I approach math with a feeling of hesitation, resulting from a fear of not being able to do math. SD D U A SA
14. I really like mathematics. SD D U A SA
15. Mathematics is a course in school which I have always enjoyed studying. SD D U A SA
16. It makes me nervous to even think about having to do a math problem. SD D U A SA
17. I have never liked math, and it is my most dreaded subject. SD D U A SA
18. I am happier in a math class than in any other class. SD D U A SA
19. I feel at ease in mathematics, and I like it very much. SD D U A SA
20. I feel a definite positive reaction to mathematics; it enjoyable. SD D U A SA
HIGH SCHOOL MATHEMATICS COURSES

FRESHMAN

SOPHOMORE

JUNIOR

SENIOR
APPENDIX E

CALIFORNIA ACHIEVEMENT TEST INSTRUCTIONS
CALIFORNIA ACHIEVEMENT TEST INSTRUCTIONS

The Assistant Dean of the College of Education administered the California Achievement Test. The following instructions were presented by Dr. Pafford.

1. The California Achievement Test is required by the Tennessee State Board of Education, not East Tennessee State University. One must obtain a satisfactory score in order to be admitted to teacher education in any college or university in Tennessee.

2. "RETESTING: For applicants taking the California Achievement Test

   (1) If an applicant for candidacy fails to pass any required area of the California Achievement Test battery, the test for that area may be re-taken after remediation for at least one quarter or semester following the initial testing.
   (2) If an applicant fails any part of the required test battery on the second testing then at least one academic year must be spent in remediation before retesting is permitted. Candidates re-taking any portion of the test must attain cut-off scores in effect at the time retesting occurs.
   (3) Candidates failing to meet the standards after three attempts shall not be admitted to candidacy. However, after a period of at least three years, a student may again start the series.

3. This is a timed test. You should work only on the portion of the test which is assigned. Stop when you are told to do so. Do not go back to the test after time is called.

4. Make marks with a number two pencil which is provided. On your answer sheet, make sure the entire space for your answer is covered thoroughly. Erase errors well. Make No marks on the test booklet.

5. Please do not talk while completing the test. Raise your hands if you have a question.

6. You will be taking Tests 2, 4, 5, and 6.

The mathematics computation test on the California Achievement Test was taken after tests 2, 4, and 5. The following directions were read orally by Dr. Pafford for the mathematics computation test:
TEST 6 MATHEMATICS COMPUTATION

Be sure that each student has a copy of the test book, her or his own answer sheet, pencils, and scratch paper. Test 6 takes approximately 28 minutes to administer.

SAY; Find the section of your answer sheet labeled "TEST 6 MATHEMATICS COMPUTATION."

Demonstrate. Make sure that all students have found the correct section of the answer sheet.

SAY; Now open your book to "Test 6 Mathematics Computation" on Page M1. Read the directions to yourself while I read them aloud.

This test will show how well you add, subtract, multiply, and divide. Use scratch paper to work the problems. Reduce fractions to lowest terms. Fill in the space that goes with the answer you choose. If the correct answer is not given, fill in the space that goes with "None of the above."

Do Sample Item L and mark your answer.

Pause to allow students to do the sample item. Do not read the item aloud.

Levels 14, 15, 16, 17, 18, 19

SAMPLE ITEM L

Addition

\[
\begin{array}{ccc}
7 & + & 3 \\
\hline
\end{array}
\begin{array}{c}
a \\
b \\
c \\
d \\
e \\
4 \\
10 \\
37 \\
73 \\
None of the above
\end{array}
\]

SAY: You should have filled in space "b," because seven plus three is ten.

Pause to be sure that each student has filled in the correct answer space for the sample item.

SAY: Now you are going to do some more items. When you come to the word "STOP," you may check your answers in Test 6 only. Then wait for further directions. You will have 25 minutes to do this test. Are there any questions?

When you are sure that all students understand the directions,
SAY: Turn to Page M2.

Pause.

SAY: You may begin.

Start timing and record the starting time on this line: ___________

Add 25 minutes.

and record the stopping time on this line ___________

At the stopping time,

SAY: Stop. This is the end of Test 6. Close your book. Make sure that all your marks are heavy and dark and that you have completely erased any marks that you do not want.

Pause.

If this is the end of this testing session, collect all test books, answer sheets, and scratch paper.
APPENDIX F

SCALE FOR THE WEIGHTED NUMBER OF MATHEMATICS COURSES
SCALE FOR THE WEIGHTED NUMBER OF MATHEMATICS COURSES

Introduction

A committee consisting of Dr. G. K. Ginnings, Mr. Charles Wilson, and Dr. Lester Hartsell, members of the East Tennessee State University Math Department, helped the author devise a weighted number of mathematics courses scale. High school and college mathematics courses taken by the teacher education applicants were given a weight from one to six. The more difficult the mathematics courses the larger the weight assigned.
WEIGHTED NUMBER OF MATHEMATICS COURSES

1
- Business Mathematics - H. S.
- General Mathematics - H. S.
- Applied Mathematics - H. S.
- Consumer Mathematics - H. S.
- College Arithmetic - 1000

2
- Pre-Algebra - H. S.
- Algebra I - H. S.
- Algebra II - H. S.
- Introductory Algebra - 1002
- Elementary Analysis - 1022
- College Algebra - 1020
- Concepts of Math - 2910
- Concepts of Math - 2920
- Concepts of Math - 2930
- College Math - 2950
- College Math - 2960

3
- Geometry - H. S.
- Algebra III - H. S.
- Advanced Mathematics - H. S.
- Pre-Calculus Mathematics - 1050
- College Algebra - 1030
- College Trigonometry - 1040
- Pre-Calculus Math - 1060

4
- Analytic Geometry and Calculus - 1110
- Pre-Calculus Mathematics - 1070
- Elementary Analysis - 1032
- Elementary Analysis - 1042
- Probability and Statistics - 3060
- Probability and Statistics - 3070
- Analytic Geometry - 2010
- Analytic Geometry - 2020
- Analytic Geometry - 2030
APPENDIX G

PEARSON PRODUCT-MOMENT COEFFICIENT OF CORRELATION

MANN-WHITNEY U-TEST
PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENT

\[ r_{xy} = \frac{N \sum XY - \sum X \sum Y}{\sqrt{\left[N \sum X^2 - (\sum X)^2\right] \left[N \sum Y^2 - (\sum Y)^2\right]}} \]

2H₀, 4H₀, 6H₀, 8H₀
MANN-WHITNEY U-TEST FOR LARGE SAMPLES

\[
z = \frac{U - u_U}{\sigma_U}
\]

\[
U - \frac{n_1n_2}{2}
\]

\[
\sqrt{\frac{(n_1)(n_2)(n_1 + n_2 + 1)}{12}}
\]

If a computed z-value exceeds the critical value at a specified level of significance, the null hypothesis is rejected.
APPENDIX H

RAW DATA ON ALL SUBJECTS
### RAW DATA ON ALL SUBJECTS

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VITA
VITA

NAME: Linda Herman Hiller

PERSONAL DATA:

Born: April 19, 1948
Age: 32
Marital Status: Married to Dr. Joseph F. Miller
Children: none
Parents: Mr. and Mrs. John R. Herman
Address: Route 6, Box 137
Boone, North Carolina 28607

EDUCATION:

Watauga High School, Boone, North Carolina, College Preparatory, 1966

B. S. Appalachian State University, Boone, North Carolina, Elementary Education-Math Concentration, 1969

M. A. Appalachian State University, Boone, North Carolina, Elementary Education-Science Concentration, 1972

Post-M.A. Caldwell Community College, Hudson, North Carolina, Summer science and mathematics program funded by National Science Foundation

Appalachian State University, Boone, North Carolina, Early Childhood Education, 1974

Indiana State University, Terre Haute, Indiana, Early Childhood Education, 1975

Ed.S. Appalachian State University, Boone, North Carolina, Early Childhood Education, Science Concentration, 1977

Post Ed.S. Appalachian State University, Boone, North Carolina, Administration, 1978-1979

Ed.D. East Tennessee State University, Johnson City, Tennessee, Supervision, to graduate in 1980.
PROFESSIONAL EXPERIENCE:

September, 1979-June, 1980  Doctoral Fellowship-Assistant Supervisor for the Master of Arts and Teaching Program

August, 1976-June, 1979  Teacher, First, Second and Third Grades, Mabel Elementary, Zionville, North Carolina

August, 1975-June, 1976  Curriculum Coordinator for Watauga County Schools employed by Appalachian State University, Boone, North Carolina

June, 1974-August, 1975  Title I-Reading and Early Childhood Supervisor for Watauga County's Eight Elementary Schools

December, 1969-June, 1974  Teacher, Cove Creek Elementary School, Sugar Grove, North Carolina

August, 1973-June, 1974  Third, Fourth, Fifth and Sixth Grade Team Teaching

August, 1971-June, 1973  Fourth and Fifth Grade Team Teaching

August, 1970-June, 1971  Fifth Grade

December, 1969-June, 1970  Seventh and Eighth Grades

UNPUBLISHED PAPERS:

"Theories of How a Child Acquires Language." Paper written at Appalachian State University, 1977

PUBLISHED PAPERS:

"CYBERNETICS and Its Relationship to Education." The Communicator, a quarterly publication of the advanced graduate studies programs at East Tennessee State University
MEDIA PRODUCTIONS:

"Early Childhood Educational Centers in Central European Countries," Slide/Tape Presentation

"Watauga County," Slide/Tape Presentation

"Slide Projector: Operation, Maintenance and Utilization," Slide/Tape Presentation

PROFESSIONAL ORGANIZATION MEMBERSHIP:

National Education Association

National Association for Supervision and Curriculum Development

North Carolina International Reading Association

Alpha Delta Kappa

North Carolina Association of Classroom Teachers
1. President-elect for Watauga Unit-1972-73
2. President for Watauga County Unit-1973-74
3. Nominated for Teacher of the Year, 1971

North Carolina Association of Educators
1. Vice President for Watauga County Unit-1974-75
2. Nominated for Jaycees Outstanding Young Educator, 1972 and 1979

Phi Delta Kappa

SPECIAL WORKSHOPS:

Workshop, Early Childhood as Related to Piaget's Theory, conducted for Watauga County, K-3 teachers and administrators, 1975

Workshop, Design for Math Curriculum, Dudley Shoals Elementary School, Hudson, North Carolina, 1976

PROFESSIONAL TRAVEL:

Study tour of Central European Early Childhood Education Centers, England, France, Denmark, Belgium, Switzerland, Summer, 1975

Children's Literature Conference, University of Tennessee, Knoxville, Tennessee, 1976

ASCD National Conference, March, 1975, New Orleans, Louisiana
PROFESSIONAL TRAVEL (CONT'D):

N. C. International Reading Association, March, 1975
and March, 1978

Delegate to the North Carolina Association of Classroom
Teachers, 1972, 1973, and 1974

Delegate to the North Carolina Education Association,
1972, 1973, and 1974

Upper East Tennessee Supervisors Conference,
October, 1979

Upper East Tennessee Supervisors and Administrators
Conference, March, 1980

Ninth Annual East Tennessee Education Conference,
University of Tennessee, Knoxville, March, 1980

Health and School Law Conference, Johnson City,
Tennessee, March, 1980

PROFESSIONAL ACTIVITIES:

Participated in a Pilot Reading Program for
Prentice-Hall, 1973

Designed math curriculum learning packets for
Cove Creek Elementary School, 1976

Designed math curriculum for fourth, fifth and
sixth grades at Parkway Elementary School, 1976

Designed math curriculum for fourth and fifth
grades at Green Valley School, 1976

Designed K-8 math curriculum for Mabel Elementary
School, 1975. Prepared health units for eighth
grade.

Served on the committee which designed the county-wide
reading curriculum for Watauga County Schools, 1977

Chairman of the Evaluation Committee for Southern
Association, Mabel Elementary School, 1978

Member of the Watauga County Student Teacher and
Intern Advisory Committee to Appalachian State
University
PROFESSIONAL ACTIVITIES (CONT'D)

Designed math individualized program for West Pines Elementary School - Fourth grade; and Jefferson Elementary School - Third grade, 1980

Served as an Administrative intern, Cove Creek Elementary School, 1978-1979

Served as a Doctoral Fellow, Assistant Supervisor for MAT Program, 1979-1980

Supervised student teachers at East Tennessee State University, 1980