A COMPARISON OF THE ATTITUDE AND ACHIEVEMENT IN MATHEMATICS OF ALGEBRA I STUDENTS USING COMPUTER-BASED INSTRUCTION AND TRADITIONAL INSTRUCTIONAL METHODS

DISSERTATION

Presented to the Graduate Council of the University of North Texas in Partial Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Kathleen Shannon Wohlgehagen, B.S.in Ed., M.Ed.

Denton, Texas

December, 1992
A COMPARISON OF THE ATTITUDE AND ACHIEVEMENT IN MATHEMATICS OF ALGEBRA I STUDENTS USING COMPUTER-BASED INSTRUCTION AND TRADITIONAL INSTRUCTIONAL METHODS

DISSERTATION

Presented to the Graduate Council of the University of North Texas in Partial Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Kathleen Shannon Wohlgehagen, B.S.in Ed., M.Ed.

Denton, Texas

December, 1992

This study investigated the use of computer-based instruction as a means of teaching Algebra I, compared to the teaching of the same topics using traditional methodologies. The achievement level of the two groups, and three aspects of attitude toward mathematics were considered. Achievement and attitude differences by gender were also analyzed.

Students selected for this study were from a large suburban school district in Texas. The students were from eleven established Algebra I classes, five of which were designated as the experimental group, and six as the control group. The sample consisted of 243 students.

The experimental group, using the computer lab daily for the full 55 minute class period, was presented Algebra I topics using *Learning Logic* computer courseware. This is a mastery type computer-based instruction program, which allowed the students to progress at their individual pace. The control group, not using the computer, was taught the same Algebra I topics with traditional instructional methodologies.
Pretest and posttest scores on three Fennema-Sherman Attitude Scales (Mathematics Anxiety, Confidence in Learning Mathematics, and Attitude Toward Success in Mathematics) were analyzed, as well as the scores from the Texas Essential Skills Test for Algebra I (Forms A and B).

Analysis of the data revealed that the experimental group improved significantly on both the Confidence in Learning Mathematics and Mathematics Anxiety Scales, and while they improved on their achievement and attitude toward success scores, they were not significant. The experimental group females, when compared to their males counterparts, increased significantly in their achievement, and although their success, and confidence levels were improved, they were not significant.

It is recommended that further studies be conducted to investigate attitude and achievement of students using computer-based instruction at all levels of instruction. It is also recommended that other variables be investigated.
# TABLE OF CONTENTS

LIST OF TABLES .......................................................... v

Chapter

1. INTRODUCTION ......................................................... 1
   
   Statement of the Problem  
   Hypotheses  
   Limitations  
   Definition of Terms  

2. REVIEW OF THE LITERATURE ....................................... 10
   
   Computer Technology in the Classroom  
   Teaching Mathematics Using the Computer  
   Gender and Mathematical Performance  
   Summary  

3. METHODOLOGY .......................................................... 20
   
   Selection of the Population  
   Demographic Information  
   Instrumentation  
   Research Design  
   Treatment of Data  

4. PRESENTATION AND ANALYSIS OF DATA .......................... 31
   
   Hypothesis One  
   Hypothesis Two  
   Hypothesis Three  
   Hypothesis Four  
   Hypothesis Five  
   Hypothesis Six
5. SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Findings
Conclusions
Recommendations

APPENDIX

REFERENCES
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Variables in Hypotheses One through Six</td>
<td>30</td>
</tr>
<tr>
<td>2. Pretest and Posttest Achievement Items by Treatment Groups</td>
<td>32</td>
</tr>
<tr>
<td>3. Effect of Treatment on Posttest Achievement Items, Controlling for Pretest Knowledge</td>
<td>32</td>
</tr>
<tr>
<td>4. Pretest and Posttest Anxiety Items by Treatment Groups</td>
<td>33</td>
</tr>
<tr>
<td>5. Effect of Treatment on Posttest Anxiety Items, Controlling for Pretest Knowledge</td>
<td>34</td>
</tr>
<tr>
<td>6. Pretest and Posttest Success Items by Treatment Groups</td>
<td>35</td>
</tr>
<tr>
<td>7. Effect of Treatment on Posttest Success Items, Controlling for Pretest Knowledge</td>
<td>36</td>
</tr>
<tr>
<td>8. Pretest and Posttest Confidence Items by Treatment Groups</td>
<td>37</td>
</tr>
<tr>
<td>9. Effect of Treatment on Posttest Confidence Items, Controlling for Pretest Knowledge</td>
<td>37</td>
</tr>
<tr>
<td>10. Female Pretest and Posttest Achievement Items by Treatment Groups</td>
<td>38</td>
</tr>
<tr>
<td>11. Effect of Treatment on Female Posttest Achievement Items, Controlling for Pretest Knowledge</td>
<td>39</td>
</tr>
<tr>
<td>12. Female Pretest and Posttest Anxiety Items by Treatment Groups</td>
<td>40</td>
</tr>
</tbody>
</table>
13. Effect of Treatment on Female Posttest Anxiety Items, Controlling for Pretest Knowledge

14. Female Pretest and Posttest Success Items by Treatment Groups

15. Effect of Treatment on Female Posttest Success Items, Controlling for Pretest Knowledge

16. Female Pretest and Posttest Confidence Items by Treatment Groups

17. Effect of Treatment on Female Posttest Confidence Items, Controlling for Pretest Knowledge

18. Male Pretest and Posttest Achievement Items by Treatment Groups

19. Effect of Treatment on Male Posttest Achievement Items, Controlling for Pretest Knowledge

20. Male Pretest and Posttest Anxiety Items by Treatment Groups

21. Effect of Treatment on Male Posttest Anxiety Items, Controlling for Pretest Knowledge

22. Male Pretest and Posttest Success Items by Treatment Groups

23. Effect of Treatment on Male Posttest Success Items, Controlling for Pretest Knowledge

24. Male Pretest and Posttest Confidence Items by Treatment Groups
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>25.</td>
<td>Effect of Treatment on Male Posttest Confidence Items, Controlling for Pretest Knowledge</td>
</tr>
<tr>
<td>26.</td>
<td>Comparison of Female and Male Experimental Group Posttest Achievement Scores</td>
</tr>
<tr>
<td>27.</td>
<td>Comparison of Female and Male Experimental Group Posttest Anxiety Scores</td>
</tr>
<tr>
<td>28.</td>
<td>Comparison of Female and Male Experimental Group Posttest Success Scores</td>
</tr>
<tr>
<td>29.</td>
<td>Comparison of Female and Male Experimental Group Posttest Confidence Scores</td>
</tr>
</tbody>
</table>
Numerous studies have been published in the last decade concerning the state of mathematics education in the United States. In *The Mathematics Report Card: Are We Measuring Up?*, a report on the trends and achievement based on the 1986 national assessment, it was reported that, although performance has increased since 1978, the improvement was mainly in the lower order mathematical skills (Dossey, Mullis, Lindquist, & Chambers, 1988). Most 17-year-olds did not possess the proficiency needed for advanced study in secondary school mathematics. Additionally, this report stated that mathematics instruction in 1986 continued to be dominated by textbooks, worksheets, teacher, and chalkboard explanations rather than by innovative forms of instruction. The routine use of computers appeared to be limited to small proportions of students in the upper range of ability.

In *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* (1989), the National Research Council reported that, on the average, American students did not master mathematical fundamentals at a level sufficient to sustain our technologically based society, and far too many students were
leaving school without the necessary mathematical skills needed for productive lives. The report further noted that only in mathematics was poor school performance socially acceptable.

The Underachieving Curriculum, a 1987 national report on the Second International Mathematics Study, found that test scores of American students in the study were among the lowest of students from the industrialized nations, with algebra being one of the weakest areas for the American students (McKnight, et al., 1987).

These reports indicate that mathematical instruction in the United States must improve so that American students can compete in our technological society and lead productive lives. Integrating computers into the mathematics curriculum is one method of improving mathematics instruction. In its 1989 publication Curriculum and Evaluation Standards For School Mathematics, the National Council of Teachers of Mathematics stated,

Because technology is changing mathematics and its uses, we believe that a computer should be available in every classroom for demonstration purposes, every student should have access to a computer for individual and group work, and students should learn to use the computer as a tool for processing information and performing calculations to investigate and solve problems. (p. 8)

The National Research Council (1989) noted that the teaching of mathematics was beginning to shift from a primary emphasis on pencil and paper tasks to full use of calculators and computers. In
Reshaping School Mathematics, the National Research Council (1990) pointed out, "Computers enable students to quickly calculate, graph or simulate processes that are simply impossible to carry out by any other means" (p. 37). This has the potential to lead to more understanding than does traditional instruction.

The business community recognizes the need for greater improvement in mathematics education. Looking toward the year 2000, Johnston and Packer (1987) explained "the fastest growing jobs require much higher math, language, and reasoning capabilities than current jobs" (p. 99). Kearns & Doyle (1988), reported that industry spends $25 billion annually to reteach basic reading, writing and mathematics to one million new workers, who did not learn it while in secondary school.

According to Steen (1989), because the business world uses technology, students should benefit from instruction utilizing computer technology. Goodson (1989) explained that 21st-century workers will need skills different from those being emphasized in the classrooms of today and that computer technology in mathematics instruction will help to provide those skills. Numerous other sources (Becker, 1986; Ganguli, 1990; Dalton & Hannafin, 1988; Marcoulides, 1990; Scriven, 1986; Zehavi, 1988) have illustrated how computer use assists mathematics instruction in a variety of ways to make that instruction relevant. Given the current situation, the use of computer technology within the mathematics classroom makes sense.
Statement of the Problem

The problem for this study is to compare the attitude and achievement in mathematics of Algebra I students using computer-based instruction and traditional instructional methods.

Hypotheses

1. The mean score on an Algebra I achievement test for a group of Algebra I students taught using computer-based instruction will be significantly higher than will the mean score of a control group of Algebra I students taught without the use of computer-based instruction.

2. The mean score on a mathematics attitude scale for a group of Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a control group of Algebra I students taught without the use of computer-based instruction.

2a. Students taught using computer-based instruction will score significantly higher on the Mathematics Anxiety Scale than students taught without the use of computer-based instruction.

2b. Students taught using computer-based instruction will score significantly higher on the Attitude Toward Success in Mathematics Scale than students taught without the use of computer-based instruction.
2c. Students taught using computer-based instruction will score significantly higher on the Confidence in Learning Mathematics Scale than students taught without the use of computer-based instruction.

3. The mean score on an Algebra I achievement test for a group of female Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a control group of female Algebra I students taught without the use of computer-based instruction.

4. The mean score on a mathematics attitude scale for a group of female Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a control group of female Algebra I students taught without the use of computer-based instruction.

4a. Female students taught using computer-based instruction will score significantly higher on the Mathematics Anxiety Scale than female students taught without the use of computer-based instruction.

4b. Female students taught using computer-based instruction will score significantly higher on the Attitude Toward Success in Mathematics Scale than female students taught without the use of computer-based instruction.

4c. Female students taught using computer-based instruction will score significantly higher on the Confidence in Learning Mathematics Scale than female students taught without the use of computer-based instruction.
5. The mean score on an Algebra I achievement test for a group of male Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a control group of male Algebra I students taught without the use of computer-based instruction.

6. The mean score on a mathematics attitude scale for a group of male Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a control group of male Algebra I students taught without the use of computer-based instruction.

6a. Male students taught using computer-based instruction will score significantly higher on the Mathematics Anxiety Scale than male students taught without the use of computer-based instruction.

6b. Male students taught using computer-based instruction will score significantly higher on the Attitude Toward Success in Mathematics Scale than male students taught without the use of computer-based instruction.

6c. Male students taught using computer-based instruction will score significantly higher on the Confidence in Learning Mathematics Scale than male students taught without the use of computer-based instruction.

7. The mean score on an Algebra I achievement test for a group of female Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a
group of male Algebra I students taught using computer-based instruction.

8. The mean score on a mathematics attitude scale for a group of female Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a group of male Algebra I students taught using computer-based instruction.

8a. Female students taught using computer-based instruction will score significantly higher on the Mathematics Anxiety Scale than male students taught using computer-based instruction.

8b. Female students taught using computer-based instruction will score significantly higher on the Attitude Toward Success in Mathematics Scale than male students taught using computer-based instruction.

8c. Female students taught using computer-based instruction will score significantly higher on the Confidence in Learning Mathematics Scale than male students taught using computer-based instruction.

Limitations

1. This study provides information about the effectiveness of using computer-based instruction for teaching Algebra I concepts. Broad generalizations about the use of computer-based instruction for teaching concepts in Algebra I not possible because of the particular population used. Ninth- and 10th-grade students will be
involved in the study even though Algebra I is a course of study offered to a wide range of students from middle school to college.

2. A second limitation was the involvement of the control and experimental subjects from the same school. Students from the experimental group and the control group may have worked with each other on Algebra I outside of class.

3. The computer-based instruction materials utilized in this study are limited to the Algebra I courseware, Learning Logic, developed by the National Mathematics Center of the National Science Center Foundation.

Definition of Terms

For the purpose of this study, the following definitions were selected:

Algebra I -- a course covering operations on rational numbers and polynomials, linear equations and inequalities in one or two variables, systems of linear equations, and quadratic equations.

Attitude toward mathematics, as used in this study, refers to the extent to which a student has a positive or negative attitude toward mathematics as measured by three Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1976).

Computer-Based Instruction (CBI) -- an instructional delivery system that provides students with instructional experiences using the computer.
Learning Logic— the computer-based instruction system developed by the National Mathematics Center of the National Science Center Foundation for the purpose of teaching Algebra I.
CHAPTER 2

REVIEW OF THE LITERATURE

Enhancing academic performance and increasing the desire to learn are critical issues for American schools, according to Cuban (1989). These tasks must be completed within the mandate presented to the American people in America 2000: An Education Strategy, which described how we must accept the responsibility for educating everyone in America (Alexander, 1991). Traditional instructional methodologies used over the past decades appear to have been unsuccessful, since achievement by American students is at the low end of the spectrum. Computer technology capabilities are commonplace in the business world and would appear to serve students well in the classroom (Goodson, 1989; Hadley & Hadley, 1991; McCarthy, 1988).

Because this study involves using computer-based instruction to teach Algebra I concepts, the review of the literature is divided into three sections: the use of computer technology in the classroom, teaching mathematics using the computer, and gender differences with regard to mathematics.
Computer Technology in the Classroom

The effects of technological innovation on business, government, and industry are finally spreading into the educational realm. Kearns and Doyle (1988) described a picture of high school graduates not yet ready for the workforce. These graduates do not command the academic skills expected of them as they enter the workforce. Numerous facets of society are working to see that computer technology is added to the classroom. Ediger (1988), Goodson (1989), Potter (1986), Rood (1988), and Smith (1987) observed that industry, business, and parents are beginning to emphasize the need for students to master complex technologies that abound in the business world.

According to Bollinger (1989), the computer will be an essential tool of the 21st-century. Steen (1989) observed that computer skills must be mastered in the schools of the 1990s, because 21st-century occupations will require the use of computer technology. Stout (1991) suggested that the use of computer technology will assist in integrating curriculum and improving content mastery. The use of a computer-managed instructional methodology that provides skill instruction and mastery testing will become a common element of education (Sherry, 1990). Smith (1987) described the broadening of the gap between females, minority and lower economic populations, and the majority of high school graduates because of unequal access to computer technology. It was noted that educators cannot afford to waste that amount of human talent in a world already dominated by
computers, a global economy, and an instantaneous worldwide communication network. In a 1988 survey, Preskill (1988) found that 88% of American school districts are investigating the incorporation of computer technology into their curricula. This would indicate an increasing awareness of the need for change.

Power On! New Tools for Teaching and Learning, a report by the Office of Technology Assessment (1988), noted that the preparation of students for the world of technology outside the classroom is paramount for teachers. Moreover, this report observed that teachers want to use the newest tools for classroom instruction, but, for a variety of reasons, including lack of equipment, user anxiety, and poor training, instructors are often hindered in their quest to integrate computer technology into their classrooms. Johnston (1987) described familiarity, educational approach, educational usefulness, documentation, and user-program relationships as significant components for the teacher's consideration when incorporating computer technology within the classroom. According to Scriven (1989), "much of the difficulty of bringing schools nearer to the efficient use of computers is due to the great anxiety which they provoke" (p. 50). When teachers are trained in the use of application, management, and instructional software, they greatly improve their productivity, and reduce their anxiety (Stubbs, 1990).

Much research exists concerning the integration of computers in the educational realm. Kulik, Bangert, and Williams (1983)
evaluated 51 secondary computer-based teaching studies and noted improved test scores immediately following computer-based instruction, as well as on follow-up exams several months later. They observed positive attitudes toward both learning with computers and needing reduced time to learn while using the computers. Kulik, Kulik, and Bangert-Drowns (1985) reported similar results for computerized instruction with elementary students. Johnson, Johnson, and Stane (1985) found that cooperative computer-assisted instruction promoted greater qualitative and quantitative achievement, and Marcoulides (1990) indicated that the learner performance of statistics students improved with computer-aided instruction. Other research (Dalton & Hannafin, 1988; Hall, 1982; Kulik, Kulik, & Bangert-Drowns, 1985; Tomberlin, 1987; Zehavi, 1988) indicated positive results when computer technology was utilized within the context of the classroom.

Additionally, Becker (1987) noted "The belief that computers can provide benefits and the optimistic expectation that they are supplying these benefits has fueled a tremendous growth of the use of computers in schools" (p. 162). Creating a sense of personal responsibility, control over learning, and improved self-esteem are discussed by Sturla (1992) as reasons to incorporate technology into the classroom. Concerning the interest of boys and girls in using computers at school, Johnson and Swoope (1987) reported that both genders perceived the boys' interest in using computers as
significantly higher; however, the girls indicated they are just as interested in using computers at school.

Teaching Mathematics Using the Computer

Burns and Bozeman (1981) have noted, "Analysis and synthesis of many studies point to a significant enhancement of learning in instructional environments supplemented by computer aided instruction, at least in one curricular area -- mathematics" (p. 37). Their meta-analysis of 40 studies involving computer-aided mathematics instruction pointed out that student achievement was significantly increased when computer-aided mathematics instruction was used in both the elementary and secondary levels. For the majority of research studies, this continues to be the case; however Gessoel-Green (1987), Hamm (1989), and Wright (1989), who used the computer to study high school Algebra II, calculus, and college algebra, respectively, all found no significant difference between the use of computers and the non-use of computers.

The 4 year Educational Testing Service study, funded by the National Institute of Education, found positive gains in student achievement in kindergarten through sixth-grade mathematics when traditional instruction was supplemented with computer-aided instruction (Bracey, 1982). Kulik et al. (1985) noted similar results with elementary school students using computerized instruction in mathematics. They pointed out that the improved performance associated with computer-aided instruction was probably related to
the capacity for individualizing instruction through use of the computer. The meta-analysis of Niemiec and Walberg (1985) also favorably examined the improved performance in elementary mathematics achievement when computer-aided instruction was a variable. Hativa and Shorer (1989) described improved achievement for advantaged over disadvantaged, for high achievers over low achievers, and for boys over girls when computer-aided instruction was added to the mathematics program of 211 elementary students.

In addition to these studies indicating positive effects for using computer technology in the classroom, other variables besides achievement factor into some of the research. As described by Dalton and Hannafin (1988), students receiving computer-based instruction report more favorable attitudes toward learning mathematics. Munger and Loyd (1989) reported that attitudes toward mathematics and technology in the mathematics classroom were directly related.

The speed of learning mathematics was a factor in some of the research. Goetzfried and Hannafin (1985) observed that more efficient learning resulted from a computer-aided instruction linear control strategy for learning mathematics rules. Using computer-based teaching, Kulik, Bangert, and Williams (1983) noted reduced instructional time while mathematics performance increased. Ganguli (1990) described the use of a microcomputer as a demonstration tool for large group mathematics instruction with very favorable results.
Another area of research to consider is the transfer of mathematics anxiety and attitudes toward mathematics to the use of the computer. According to Hawkins (1987) and Collis (1987), females often transferred mathematics anxiety directly to the use of the computer. Damarin (1989) noted that many computer-based instruction programs are based upon competition, which is often perceived by females as a burden. Damarin indicated that "the unnecessary and discriminatory use of competition in relation to learning may lead to greater mathematics anxiety and avoidance among young women" (p. 18).

The research indicated numerous studies completed in elementary-level mathematics. Becker (1987) found minimal use of computers in mathematics classes, beginning with algebra, and even fewer in the upper level classes.

Gender and Mathematical Performance

In spite of much research completed in the area of gender differences in mathematics performance, Fennema (1985) noted that there has not been much agreement on the extent of such differences. At the elementary level, she found very few consistent gender-related differences; at the secondary level, however, there is much more evidence to indicate that boys frequently perform better than girls do. Additional research concurred with Fennema's findings (Dossey et al., 1988; Fennema & Carpenter, 1981; National Assessment of Educational Progress, 1975, 1983. However, Hart (1989), reported no gender differences in how males and females
engage in higher level thinking in seventh-grade mathematics classes, whereas a meta-analysis completed by Freeman (1985) found that no strong support exists for overall gender differences in mathematics.

The basis of the gender differences are probably social and cultural in nature, according to Fennema (1985). Gender-appropriate behavior and achievement are reflected in the expectations of parents, peers, school, and society. Fennema noted that sons are encouraged to pursue mathematics more often than are daughters, thus increasing the disparity in mathematical performance. Leder (1986) suggested, "A clear recognition of the values, expectations, and beliefs of the wider society within which learning takes place is required for a full appreciation of the currently found sex differences in mathematics participation and performance" (p.6). A 1991 American Association of University Women (AAUW) report described family and school rather than peers as the primary factors concerning adolescent self-esteem and mathematics performance. Grossman (1992) reported that the Teen Talk Barbie Doll™, which speaks the phrase "math class is tough," disturbed some women educators who are struggling to continue interesting girls in mathematics and science.

Noting that boys seem to prefer activities involving mastery, while girls seem to seek out activities involving social relationships, Fennema (1985) reported that these areas of competence develop into career choices that result in girls' not taking advanced
mathematics coursework. As early as 1979, Fennema indicated that fewer girls choose to study mathematics, because they found that subject not as useful to them and they lacked the confidence in their ability to do well in mathematics. This finding continued into 1991, as noted in the AAUW report, which indicated that half of all elementary school boys, but only one-third of all elementary school girls say they are good in mathematics. By high school, one in four males, but only one in seven females still report they are good in mathematics. There appears to be a circular relationship between liking math and science, self-esteem, and career interests, a relationship which favors males and their increased mathematics performance.

Badger (1981) also described societal attitudes as the probable determining factor in female success in mathematics. He noted that until adolescence there are minimal differences in mathematical achievement between boys and girls. With the beginning of the junior high school years, there is a noticeable difference in the level of performance. He attributed this to several factors: spacial ability, which appeared to be in the boys’ favor; societal connotations of mathematics as a male subject; lack of general self-confidence by adolescent females; and the increased attention given males in mathematics classes. Signorella and Jamison (1986) concurred with Kirschner (1982) concerning the preferential treatment given to males in a mathematics classroom. They indicated that a girl with a masculine self-concept has a much better chance of competing in
mathematics. Strauss (1988) stated that mathematics educators must take a critical look at the factors that seem to hinder mathematically capable female students in the classrooms of America. She observed, "We must be vigilant in assuring equal opportunity for all our students. Girls need to be encouraged to be assertive in the mathematics classroom" (p. 536).

Summary

The studies cited in this chapter yield mixed results. Increased use of computer technology will continue in the educational realm to further delineate the findings presented in this review of the literature. Mathematics lends itself to computer-based instruction because of its objectiveness as a discipline. This study is one attempt to use computer-based instruction to improve the mathematics achievement and attitudes of 9th - and 10th - grade Algebra I students.
CHAPTER 3

METHODOLOGY

Selection of the Population

The population for this study consisted of all of the students (9th- or 10th- graders) from 11 established Algebra I classes in a large suburban school district in North Central Texas. The high school was selected because it was the home school of the two experimental group teachers, who agreed to attend a week of training in Learning Logic computer-based instruction provided by the National Mathematics Center at their site in Augusta, Georgia. The two experimental group teachers taught a total of five classes, whereas the three control group teachers taught a total of six Algebra I classes.

The final number of students in the experimental group was 106, of which 66 were female and 50 were male. In the control group the final number of students was 137, of which 70 were female and 67 were male.

The experimental group originally was made up of 137 students, but 3 of the students transferred to the control group at the beginning of the study because they were frustrated by the computer-based instruction format. Seventeen of the students were dropped from the study because they left the school before the
completion of the study. Although 11 students were added to the classes of the control group during the semester, they were dropped from the study because they did not have pretest data.

The control group originally was made up of 176 students, but 3 students were added when they transferred out of the experimental teachers' classes at the beginning of the semester. Twenty students were dropped from the study because they left the school before the study was completed, and 22 additional students were dropped from the study because they were added to the classes of the control group during the semester and did not have pretest data.

Demographic Information

The school district selected for this study is located in North Texas and has approximately 31,984 students. The city extends over a 66 square mile area; however, the school district itself covers a 114 square mile area, including two adjacent towns and reaching into three surrounding cities. The ethnic composition of this suburban school district, which is classified as middle to upper-middle class, is 89.5% Anglo, 4.0% African-Americans, 3.1% Hispanic, and 3.4% other nationalities. Twenty-three elementary schools, 8 middle schools, 4 high schools (grades 9 and 10), and 2 senior high schools (grades 11 and 12) comprise the school district. About 60% of the teachers in the district hold master's degrees, and 82.8% of the students in the school district are college bound.
Four of the teachers involved in the study were female, and one was male. The two female experimental group teachers had each taught Algebra I for their one year of teaching prior to the study. One had a master's degree. Of the three control group teachers, one female was a first-year teacher with a bachelor's degree; the other female, also with a bachelor's degree, had been teaching Algebra I for 7 of her 8 years of teaching; and the male teacher, with a master's degree had taught Algebra I for 6 of his 13 years of teaching.

Instrumentation

Three attitude scales, an Algebra I achievement test, and an anecdotal diary for the teachers of the experimental group were used to collect the data for this study: (a) the Mathematics Anxiety Scale; (b) the Attitude Toward Success in Mathematics Scale; (c) the Confidence in Learning Mathematics Scale; (d) the Texas Essential Skills Test, Algebra I, (Forms A and B); and (e) an anecdotal diary.

The attitude scales selected for this study were three of the Fennema-Sherman Mathematics Attitude Scales. Items from the three scales were randomly incorporated into one instrument, which consisted of 36 items (12 per scale), 18 of which were stated positively and 18 negatively. Each item had five response selections, and each selection was given a score: strongly agree (2), agree (1), undecided (0), disagree (-1), and strongly disagree (-2).
was weighted if it was a negatively stated item, and the scores were totalled for each scale. The lowest possible score on each of the Fennema-Sherman scales is -24, and the highest is +24. A high score indicates a trait that has a positive effect on the learning of mathematics. A high score on the Mathematics Anxiety Scale reflects a low anxiety level; a high score on the Attitude Toward Success in Mathematics Scale indicates the desirability for success in mathematics; and a high score on the Confidence in Learning Mathematics Scale demonstrates a high confidence level.

The content validity was established by each author's writing of items that represented each scale dimension, and then judging the validity of the other authors' items. Items that were agreed upon as measuring an aspect of the dimension were selected. Eighteen to 22 items per scale were selected for the initial test. Half of the items were stated positively, and half were stated negatively. The scales were administered to 367 subjects, grades 9-12, in a middle class, suburban/rural high school, with both mathematics students and non-mathematics students serving as subjects. Several criteria were used in selecting 6 positive and 6 negative items to be included in the final versions for each of the attitude scales. In order of importance, they were as follows: (a) items that correlated highest with the total score for each gender; (b) items with higher standard deviations for each gender; (c) items that yielded results consistent with the theoretical construct of a scale; and (d) items that differentiated mathematics and non-mathematics students. The final
versions of the three scales used in this study have split half reliabilities, as follows: Attitude Toward Success in Mathematics -- 0.87; Confidence in Learning Mathematics -- 0.93; and Mathematics Anxiety -- 0.89 (Fennema & Sherman, 1976).

Mathematics Anxiety Scale

Developed by Fennema and Sherman (1976), this instrument has 12 items listed on a Likert-type scale from strongly disagree to strongly agree. It has been described by the authors as follows:

The Mathematics Anxiety Scale is intended to measure feelings of anxiety, dread, nervousness, and associated bodily symptoms related to doing mathematics. The dimension ranges from feeling at ease to those of distinct anxiety. The scale is not intended to measure confidence in or enjoyment of mathematics (p. 4)

All students who participated in the study completed this questionnaire at both the beginning and the end of the semester of Algebra I instruction. The data were used in comparing the groups of students to see if there was any difference in the level of anxiety toward mathematics after completing a semester of Algebra I using the computer or with traditional instruction.
Attitude Toward Success in Mathematics Scale

Also developed by Fennema and Sherman (1976), this instrument follows the 12-item Likert-scale format, as described above.

This scale was designed to measure the degree to which students anticipate positive or negative consequences as a result of success in mathematics. They evidence this fear by anticipating negative consequences of success, as well as, by lack of acceptance or responsibility for the success, e.g., "It was just luck." (p. 2)

This attitude scale was administered as a pretest and posttest to all of the Algebra I students for the purpose of measuring any change in attitude toward success in mathematics after a semester of Algebra I instruction.

Confidence in Learning Mathematics Scale

This instrument, also developed by Fennema and Sherman (1976), continues in the 12-item Likert-scale format. The authors have indicated the following:

Confidence in oneself is related to what one is willing to attempt. This scale is intended to measure confidence in one's ability to learn and to perform well on mathematical tasks. The dimension ranges from distinct lack of confidence to definite confidence. The scale is not intended to measure
anxiety or mental confusion, interest, enjoyment or zest in problem solving. (p. 4)

This instrument was completed before and after the semester of Algebra I instruction for the purpose of measuring any change in the student's confidence in learning mathematics.

**Texas Essential Skills Test, Algebra I (Forms A and B)**

The achievement test selected for this study was the Texas Essential Skills Test, Algebra I (Forms A and B), Riverside Publishing Company, 1988. This is a 36 multiple-choice-question test covering the Essential Elements and Supporting Skills objectives listed in the Texas State Board of Education Rules for Curriculum for Algebra I. The test validity was established by an item analysis, and those items not technically sound were revised or eliminated by the curriculum experts developing the test. Using a KR-20 estimate of reliability, the coefficient for Form A of the test is 0.85, whereas Form B has a reliability of 0.84 as listed in the test handbook (Research and Implementation Handbook, 1988). This achievement test was administered to all students in the study before and after the semester of Algebra I instruction for the purpose of comparing the two methods of instruction used in this study.

**Anecdotal Diary**

The two teachers of the experimental group were given copies of an anecdotal diary to be completed for each week of the study.
Because of time constraints, neither teacher completed more than one weekly diary; thus, the anecdotal diary is presented only in the Appendix and was not analyzed.

Research Design

This study involved a pretest and posttest with an experimental and a control group. All of the students in the study were taught the units from the regular district curriculum covering first semester Algebra I. The experimental group used the computer lab daily for the full 55-minute class period. These students were presented the Algebra I topics using the Learning Logic computer courseware. This is a mastery type, computer-based instruction program, which allows the students to progress at their individual pace.

Learning Logic is a widely acclaimed computer based instruction system developed by the National Mathematics Center of the National Science Center Foundation. It has been tested at various sites across the country and was endorsed by the school board of the school district in which this research was completed.

In order to facilitate movement through the curriculum in a timely manner, time guidelines were established on a 6-week basis to allow students to set obtainable weekly goals. The less gifted students benefitted from regular updates of their mastery of the Algebra I concepts. As needed, the students received remediation from lower level presentations which offered incremental,
explanatory material and moving gradually to more difficult points. The gifted students who completed the required Algebra I topics received enrichment topics. The status of the students as they moved through the program topics was detailed in a computer profile that specified concept mastery.

The control group covered the same Algebra I units as the experimental group, but did not use the computer lab. This group was taught using traditional instructional methodologies. Both groups received the achievement test and the attitude questionnaires both before and after the semester of Algebra I instruction.

The experimental classes involved in this study were observed by the researcher during the course of the semester. No observations were made while the achievement and attitude pretests and posttests were being administered. All observations were made for entire class periods.

Treatment of Data

To evaluate the Learning Logic computer-based instruction as a means of teaching Algebra I, four variables were investigated: achievement, mathematics anxiety, attitude toward success in mathematics, and confidence in learning mathematics. Data were collected two times during the study. Achievement and attitude pretests were administered to all of the students the day before the teachers began the first semester of Algebra I. Achievement and
attitude posttests were given to the students during the last week of school in December.

Hypotheses 1 through 6 were tested using analysis of covariance (ANCOVA) with the pretest scores as the covariate. Analysis of covariance was used because the study involved existing intact groups of students who may have differed in their previous background of Algebra I concepts, their attitudes toward success in mathematics, their confidence in learning mathematics, and their level of mathematics anxiety. Analysis of covariance adjusts the scores statistically to account for the possibility of preexisting conditions. The covariates, dependent variables, and independent variables for each of the hypotheses are presented in Table 1. For each hypothesis, two tables were prepared. The first table presented contains the means and standard deviations; the second table is an ANCOVA table showing the significance of the difference between adjusted means.

Hypotheses 7 and 8 were tested using two-tailed t-tests of independent samples, which compared the posttest scores of the females and males in order to assess the effect of the Learning Logic computer-based instruction treatment on these same four variables. The analysis for each hypothesis is presented in a table.

Hypotheses seven and eight were tested using two-tail t-tests of independent samples, which compared the posttest scores of the females and males in order to assess the effect of the Learning Logic
computer based instruction treatment on these same four variables. The analysis for each hypothesis is presented in a table.

Table 1

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Sample</th>
<th>Covariate</th>
<th>Dependent variable</th>
<th>Independent variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Full</td>
<td>pretest-ACH</td>
<td>posttest-ACH</td>
<td>treatment</td>
</tr>
<tr>
<td>2a</td>
<td>Full</td>
<td>pretest-ANX</td>
<td>posttest-ANX</td>
<td>treatment</td>
</tr>
<tr>
<td>2b</td>
<td>Full</td>
<td>pretest-SUC</td>
<td>posttest-SUC</td>
<td>treatment</td>
</tr>
<tr>
<td>2c</td>
<td>Full</td>
<td>pretest-CON</td>
<td>posttest-CON</td>
<td>treatment</td>
</tr>
<tr>
<td>3</td>
<td>Female</td>
<td>pretest-ACH</td>
<td>posttest-ACH</td>
<td>treatment</td>
</tr>
<tr>
<td>4a</td>
<td>Female</td>
<td>pretest-ANX</td>
<td>posttest-ANX</td>
<td>treatment</td>
</tr>
<tr>
<td>4b</td>
<td>Female</td>
<td>pretest-SUC</td>
<td>posttest-SUC</td>
<td>treatment</td>
</tr>
<tr>
<td>4c</td>
<td>Female</td>
<td>pretest-CON</td>
<td>posttest-CON</td>
<td>treatment</td>
</tr>
<tr>
<td>5</td>
<td>Male</td>
<td>pretest-ACH</td>
<td>posttest-ACH</td>
<td>treatment</td>
</tr>
<tr>
<td>6a</td>
<td>Male</td>
<td>pretest-ANX</td>
<td>posttest-ANX</td>
<td>treatment</td>
</tr>
<tr>
<td>6b</td>
<td>Male</td>
<td>pretest-SUC</td>
<td>posttest-SUC</td>
<td>treatment</td>
</tr>
<tr>
<td>6c</td>
<td>Male</td>
<td>pretest-CON</td>
<td>posttest-CON</td>
<td>treatment</td>
</tr>
</tbody>
</table>

Note: ACH = Achievement; ANX = Anxiety; SUC = Success; CON = Confidence.
CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

Hypothesis 1

Hypothesis 1 states that the mean score on an Algebra I achievement test for a group of Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a control group of Algebra I students taught without the use of computer-based instruction. The hypothesis was tested using ANCOVA. The pretest score on the achievement test was the covariate, and the posttest score on the achievement test was the dependent variable. The means and standard deviations of the scores on the achievement test are presented in Table 2. The observed means for the achievement items on the posttest, controlling for the pretest, are presented as the adjusted means.

The results of the ANCOVA are presented in Table 3. ANCOVA tests the significance of the difference between the adjusted means. Although there was a significant difference, it does not support hypothesis 1.
Table 2

Pretest and Posttest Achievement Items by Treatment Groups

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest achievement</th>
<th>Posttest achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard Mean</td>
<td>Observed Mean</td>
</tr>
<tr>
<td>Control</td>
<td>11.42</td>
<td>4.06</td>
</tr>
<tr>
<td>Experimental</td>
<td>11.48</td>
<td>2.93</td>
</tr>
<tr>
<td>Total</td>
<td>11.44</td>
<td>3.60</td>
</tr>
</tbody>
</table>

Table 3

Effect of Treatment on Posttest Achievement Items, Controlling for Pretest Knowledge

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>357.73</td>
<td>178.87</td>
<td>12.78</td>
<td>.0001</td>
</tr>
<tr>
<td>Error</td>
<td>240</td>
<td>3358.70</td>
<td>13.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td>3716.43</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hypothesis 2

Hypothesis 2 states that the mean score on a mathematics attitude scale for a group of Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a control group of Algebra I students taught without the use of computer-based instruction.

Hypothesis 2a states that students taught using computer-based instruction will score significantly higher on the Mathematics Anxiety Scale than students taught without the use of computer-based instruction. This hypothesis was tested using ANCOVA. The pretest score on the anxiety scale was the covariate, and the posttest score on the anxiety scale was the dependent variable. The means

Table 4
Pretest and Posttest Anxiety Items by Treatment Groups

<table>
<thead>
<tr>
<th></th>
<th>Pretest anxiety</th>
<th>Posttest anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>Control</td>
<td>0.18</td>
<td>8.40</td>
</tr>
<tr>
<td>Experimental</td>
<td>0.19</td>
<td>8.50</td>
</tr>
<tr>
<td>Total</td>
<td>0.18</td>
<td>8.42</td>
</tr>
</tbody>
</table>
and standard deviations of the scores on the anxiety scale are presented in Table 4. The observed means for the anxiety scale items on the posttest, controlling for the pretest, are presented as the adjusted means.

The results of the ANCOVA are presented in Table 5. ANCOVA tests the significance of the difference between the adjusted means. There was a significant difference ($p < .0001$) between the adjusted mean anxiety scores for the control and experimental groups, as shown in Table 5.

Table 5

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>8601.20</td>
<td>4300.60</td>
<td>79.73</td>
<td>.0001</td>
</tr>
<tr>
<td>Error</td>
<td>240</td>
<td>129465.87</td>
<td>53.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td>21547.06</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis 2b states that students taught using computer-based instruction will score significantly higher on the Attitude Toward Success in Mathematics Scale than students taught without
the use of computer-based instruction. This hypothesis was tested using ANCOVA. The pretest score on the success scale was the covariate, and the posttest score on the success scale was the dependent variable. The means and standard deviations of the scores on the success scale are presented in Table 6. The observed means for the success scale items on the posttest, controlling for the pretest, are presented as the adjusted means.

Table 6

**Pretest and Posttest Success Items by Treatment Groups**

<table>
<thead>
<tr>
<th></th>
<th>Pretest success</th>
<th></th>
<th>Posttest success</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard deviation</td>
<td>Observed mean</td>
<td>Adjusted mean</td>
</tr>
<tr>
<td>Control</td>
<td>10.20</td>
<td>7.57</td>
<td>12.10</td>
<td>4.48</td>
</tr>
<tr>
<td>Experimental</td>
<td>11.67</td>
<td>6.21</td>
<td>12.56</td>
<td>3.84</td>
</tr>
<tr>
<td>Total</td>
<td>10.84</td>
<td>7.03</td>
<td>12.30</td>
<td>4.20</td>
</tr>
</tbody>
</table>

The results of the ANCOVA are presented in Table 7. ANCOVA tests the significance of the difference between the adjusted means. Although there was a significant difference, it does not support hypothesis 2b.
Table 7

Effect of Treatment on Posttest Success Items, Controlling for Pretest Knowledge

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>3877.54</td>
<td>1938.77</td>
<td>67.50</td>
<td>.0001</td>
</tr>
<tr>
<td>Error</td>
<td>240</td>
<td>6893.73</td>
<td>28.72</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td>10771.27</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis 2c states that students taught using computer-based instruction will score significantly higher on the Confidence in Learning Mathematics Scale than students taught without the use of computer-based instruction. This hypothesis was tested using ANCOVA. The pretest score on the confidence scale was the covariate, and the posttest score on the confidence scale was the dependent variable. The means and standard deviations of the scores on the confidence scale are presented in Table 8. The observed means for the confidence scale items on the posttest, controlling for the pretest, are presented as the adjusted means.

The results of the ANCOVA are presented in Table 9. ANCOVA tests the significance of the difference between the adjusted means. There was a significant difference ($p < .0001$) between the adjusted
Table 8

**Pretest and Posttest Confidence Items by Treatment Groups**

<table>
<thead>
<tr>
<th></th>
<th>Pretest confidence</th>
<th>Posttest confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard mean</td>
<td>Observed mean</td>
</tr>
<tr>
<td>Control</td>
<td>3.82</td>
<td>3.71</td>
</tr>
<tr>
<td>Experimental</td>
<td>3.36</td>
<td>5.41</td>
</tr>
<tr>
<td>Total</td>
<td>3.62</td>
<td>4.45</td>
</tr>
</tbody>
</table>

Table 9

**Effect of Treatment on Posttest Confidence Items, Controlling for Pretest Knowledge**

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>8061.73</td>
<td>4030.87</td>
<td>80.08</td>
<td>.0001</td>
</tr>
<tr>
<td>Error</td>
<td>240</td>
<td>12079.92</td>
<td>50.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td>20141.65</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
mean confidence scores for the control and experimental groups, as can be seen in Table 9.

**Hypothesis 3**

Hypothesis 3 states that the mean score on an Algebra I achievement test for a group of female Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a group of female Algebra I students taught without the use of computer-based instruction. This hypothesis was tested using ANCOVA. The pretest score on the achievement test was the covariate, and the posttest score on the achievement test was the

Table 10

**Female Pretest and Posttest Achievement Items by Treatment Groups**

<table>
<thead>
<tr>
<th></th>
<th>Pretest female achievement</th>
<th>Posttest female achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard deviation</td>
<td>Observed mean</td>
</tr>
<tr>
<td>Control</td>
<td>11.18</td>
<td>4.12</td>
</tr>
<tr>
<td>Experimental</td>
<td>11.25</td>
<td>2.88</td>
</tr>
<tr>
<td>Total</td>
<td>11.21</td>
<td>3.60</td>
</tr>
</tbody>
</table>
dependent variable. The means and standard deviations of the scores on the achievement test are presented in Table 10. The observed means for the achievement test items on the posttest, controlling for the pretest, are presented as the adjusted means.

The results of the ANCOVA are presented in Table 11. ANCOVA tests the significance of the difference between the adjusted means. Although there was a significant difference, it does not support hypothesis 3.

Table 11

Effect of Treatment on Female Posttest Achievement Items, Controlling for Pretest Knowledge

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>206.55</td>
<td>103.28</td>
<td>8.85</td>
<td>.0003</td>
</tr>
<tr>
<td>Error</td>
<td>121</td>
<td>1412.37</td>
<td>11.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>123</td>
<td>1618.92</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis 4

Hypothesis 4 states that the mean score on a mathematics attitude scale for a group of female Algebra I students taught using computer-based instruction will be significantly higher than the
mean score of a group of female Algebra I students taught without the use of computer-based instruction.

Hypothesis 4a states that female students taught using computer-based instruction will score significantly higher on the Mathematics Anxiety Scale than female students taught without the use of computer-based instruction. This hypothesis was tested using ANCOVA. The pretest score on the anxiety scale was the covariate, and the posttest score on the anxiety scale was the dependent variable. The means and standard deviations of the scores on the anxiety scale are presented in Table 12. The observed means for the

Table 12
Female Pretest and Posttest Anxiety Items by Treatment Groups

<table>
<thead>
<tr>
<th></th>
<th>Pretest female anxiety</th>
<th>Posttest female anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>Control</td>
<td>-2.00</td>
<td>8.83</td>
</tr>
<tr>
<td>Experimental</td>
<td>-1.03</td>
<td>9.22</td>
</tr>
<tr>
<td>Total</td>
<td>-1.56</td>
<td>8.98</td>
</tr>
</tbody>
</table>
anxiety scale items on the posttest, controlling for the pretest, are presented as the adjusted means.

The results of the ANCOVA are presented in Table 13. ANCOVA tests the significance of the difference between the adjusted means. There was a significant difference ($p < .0001$) between the adjusted mean anxiety scores for the females of the control and experimental groups as shown in Table 13.

### Table 13

**Effect of Treatment on Female Posttest Anxiety Items, Controlling for Pretest Knowledge**

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>5237.35</td>
<td>2618.67</td>
<td>45.84</td>
<td>.0001</td>
</tr>
<tr>
<td>Error</td>
<td>122</td>
<td>6968.83</td>
<td>57.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>124</td>
<td>12206.18</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis 4b states that female students taught using computer-based instruction will score significantly higher on the Attitude Toward Success in Mathematics Scale than female students taught without the use of computer-based instruction. This hypothesis was tested using ANCOVA. The pretest score on the
success scale was the covariate, and the posttest score on the success scale was the dependent variable. The means and standard deviations of the scores on the success scale are presented in Table 14. The observed means for the success scale items on the posttest, controlling for the pretest, are presented as the adjusted means.

Table 14
Female Pretest and Posttest Success Items by Treatment Groups

<table>
<thead>
<tr>
<th></th>
<th>Pretest female success</th>
<th>Posttest female success</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard Mean</td>
<td>Observed Mean</td>
</tr>
<tr>
<td>Control</td>
<td>11.07</td>
<td>7.32</td>
</tr>
<tr>
<td>Experimental</td>
<td>12.09</td>
<td>6.04</td>
</tr>
<tr>
<td>Total</td>
<td>11.53</td>
<td>6.77</td>
</tr>
</tbody>
</table>

The results of the ANCOVA are presented in Table 15. ANCOVA tests the significance of the difference between the adjusted means. Although there was a significant difference, it does not support hypothesis 4b.
Table 15

**Effect of Treatment on Female Posttest Success Items, Controlling for Pretest Knowledge**

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>1175.44</td>
<td>587.72</td>
<td>26.54</td>
<td>.0001</td>
</tr>
<tr>
<td>Error</td>
<td>122</td>
<td>2701.76</td>
<td>22.15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>124</td>
<td>3877.20</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis 4c states that female students taught using computer-based instruction will score significantly higher on the Confidence in Learning Mathematics Scale than female students taught without the use of computer-based instruction. This hypothesis was tested using ANCOVA. The pretest score on the confidence scale was the covariate, and the posttest score on the confidence scale was the dependent variable. The means and standard deviations of the scores on the confidence scale are presented in Table 16. The observed means for the confidence scale items on the posttest, controlling for the pretest, are presented as the adjusted means.
Table 16

**Female Pretest and Posttest Confidence Items by Treatment Groups**

<table>
<thead>
<tr>
<th></th>
<th>Pretest Female Confidence</th>
<th>Posttest Female Confidence</th>
<th>Standard Mean</th>
<th>Standard Deviation</th>
<th>Observed Mean</th>
<th>Adjusted Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>1.65</td>
<td>8.07</td>
<td>2.76</td>
<td>1.53</td>
<td>7.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Experimental</strong></td>
<td>2.60</td>
<td>9.54</td>
<td>5.28</td>
<td>3.34</td>
<td>6.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2.08</td>
<td>8.73</td>
<td>3.89</td>
<td>2.34</td>
<td>7.11</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 17

**Effect of Treatment on Female Posttest Confidence Items, Controlling for Pretest Knowledge**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>4917.12</td>
<td>2458.56</td>
<td>48.71</td>
<td>.0001</td>
</tr>
<tr>
<td>Error</td>
<td>122</td>
<td>6157.83</td>
<td>50.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>124</td>
<td>11074.96</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The results of the ANCOVA are presented in Table 17. ANCOVA tests the significance of the difference between the adjusted means. There was a significant difference (p < .0001) between the adjusted mean confidence scores for the females of the control and experimental groups, as can be seen in Table 17.

**Hypothesis 5**

Hypothesis 5 states that the mean score on an Algebra I achievement test for a group of male Algebra I students taught using computer-based instruction will be significantly higher than the mean score for a group of male Algebra I students taught without the use of computer-based instruction. This hypothesis was tested using ANCOVA. The pretest score on the achievement test was the covariate, and the posttest score on the achievement test was the dependent variable. The means and standard deviations of the scores on the achievement test are presented in Table 18. The observed means for the achievement test items on the posttest, controlling for the pretest, are presented as the adjusted means.

The results of the ANCOVA are presented in Table 19. ANCOVA tests the significance of the difference between the adjusted means. Although there was a significant difference, it does not support the acceptance of hypothesis 5.
Table 18

Male Pretest and Posttest Achievement Items by Treatment Groups

<table>
<thead>
<tr>
<th></th>
<th>Pretest male achievement</th>
<th>Posttest male achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>Control</td>
<td>11.65</td>
<td>4.01</td>
</tr>
<tr>
<td>Experimental</td>
<td>11.74</td>
<td>2.99</td>
</tr>
<tr>
<td>Total</td>
<td>11.69</td>
<td>3.61</td>
</tr>
</tbody>
</table>

Table 19

Effect of Treatment on Male Posttest Achievement Items, Controlling for Pretest Knowledge

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>E</th>
<th>Significance of E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>186.60</td>
<td>93.30</td>
<td>5.95</td>
<td>.0035</td>
</tr>
<tr>
<td>Error</td>
<td>116</td>
<td>1826.10</td>
<td>15.74</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>118</td>
<td>2012.70</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hypothesis 6

Hypothesis 6 states that the mean score on a mathematics anxiety attitude scale for a group of male Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a group of male Algebra I students taught without the use of computer-based instruction.

Hypothesis 6a states that male students taught using computer-based instruction will score significantly higher on the Mathematics Anxiety Scale than male students taught without the use of computer-based instruction. This hypothesis was tested using ANCOVA. The pretest score on the anxiety scale was the covariate, and the posttest

Table 20

Male Pretest and Posttest Anxiety Items by Treatment Groups

<table>
<thead>
<tr>
<th></th>
<th>Pretest male anxiety</th>
<th>Posttest male anxiety</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard deviation</td>
<td>Observed mean</td>
</tr>
<tr>
<td>Control</td>
<td>2.38 7.37</td>
<td>1.77</td>
</tr>
<tr>
<td>Experimental</td>
<td>1.56 7.46</td>
<td>3.42</td>
</tr>
<tr>
<td>Total</td>
<td>2.03 7.39</td>
<td>2.47</td>
</tr>
</tbody>
</table>
score on the anxiety scale was the dependent variable. The means and standard deviations of the scores on the anxiety scale are presented in Table 20. The observed means for the anxiety scale items on the posttest, controlling for the pretest, are presented as the adjusted means.

The results of the ANCOVA are presented in Table 21. ANCOVA tests the significance of the difference between the adjusted means. There was a significant difference ($p < .0001$) between the adjusted mean anxiety scores for the males of the control and experimental groups as Table 21 indicates.

### Table 21

**Effect of Treatment on Male Posttest Anxiety Items, Controlling for Pretest Knowledge**

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>3087.85</td>
<td>1543.92</td>
<td>29.91</td>
<td>.0001</td>
</tr>
<tr>
<td>Error</td>
<td>115</td>
<td>5935.52</td>
<td>51.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>117</td>
<td>9023.36</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis 6b states that male students taught using computer-based instruction will score significantly higher on the
Attitude Toward Success in Mathematics Scale than students taught without the use of computer-based instruction. This hypothesis was tested using ANCOVA. The pretest score on the success scale was the covariate, and the posttest score on the success scale was the dependent variable. The means and standard deviations of the scores on the success scale are presented in Table 22. The observed means for the success scale items on the posttest, controlling for the pretest, are presented as the adjusted means.

Table 22

Male Pretest and Posttest Success Items by Treatment Groups

<table>
<thead>
<tr>
<th></th>
<th>Pretest male success</th>
<th>Posttest male success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>Mean: 9.32 Standard deviation: 7.77</td>
<td>Observed mean: 10.69</td>
</tr>
<tr>
<td>Experimental</td>
<td>Mean: 11.20 Standard deviation: 6.42</td>
<td>Observed mean: 11.54</td>
</tr>
<tr>
<td>Total</td>
<td>Mean: 10.12 Standard deviation: 7.26</td>
<td>Observed mean: 11.05</td>
</tr>
</tbody>
</table>

The results of the ANCOVA are presented in Table 23. ANCOVA tests the significance of the difference between the adjusted means.
Although there was a significant difference, it does not support hypothesis 6b.

Table 23
Effect of Treatment on Male Posttest Success Items. Controlling for Pretest Knowledge

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>E</th>
<th>Significance of E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>2626.67</td>
<td>1313.33</td>
<td>38.64</td>
<td>.0001</td>
</tr>
<tr>
<td>Error</td>
<td>115</td>
<td>3909.23</td>
<td>33.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>117</td>
<td>6535.89</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis 6c states that male students taught using computer-based instruction will score significantly higher on the Confidence in Learning Mathematics Scale than male students taught without the use of computer-based instruction. This hypothesis was tested using ANCOVA. The pretest score on the confidence scale was the covariate, and the posttest score on the confidence scale was the dependent variable. The means and standard deviations of the scores on the confidence scale are presented in Table 24. The observed means for the confidence scale items on the posttest, controlling for the pretest, are presented as the adjusted means.
### Table 24

**Male Pretest and Posttest Confidence Items by Treatment Groups**

<table>
<thead>
<tr>
<th>Source</th>
<th>Pretest male confidence</th>
<th>Posttest male confidence</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>Control</td>
<td>6.02</td>
<td>7.75</td>
</tr>
<tr>
<td>Experimental</td>
<td>4.22</td>
<td>8.15</td>
</tr>
<tr>
<td>Total</td>
<td>5.26</td>
<td>7.94</td>
</tr>
</tbody>
</table>

### Table 25

**Effect of Treatment on Male Posttest Confidence Items, Controlling for Pretest Knowledge**

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>DF</th>
<th>Sum of squares</th>
<th>Mean square</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>2</td>
<td>3134.65</td>
<td>1567.33</td>
<td>30.80</td>
<td>.0001</td>
</tr>
<tr>
<td>Error</td>
<td>115</td>
<td>5852.80</td>
<td>50.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>117</td>
<td>8987.46</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The results of the ANCOVA are presented in Table 25. As can be seen in Table 25, there was a significant difference (p<.0001) between the adjusted mean confidence scores for the males of the control and experimental groups.

Hypothesis 7

Hypothesis 7 states that the mean score on an Algebra I achievement test for a group of female Algebra I students taught using computer-based instruction will be significantly higher than the mean score for a group of male Algebra I students taught using computer-based instruction. This hypothesis was tested using a two-tailed t-test of independent samples. The results are summarized in Table 26. The p-value of .024 is below the .05 significance level (.025 for each tail), indicating that there was a significant difference.

Table 26

Comparison of Female and Male Experimental Group Posttest Achievement Scores

<table>
<thead>
<tr>
<th>Experimental group</th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>56</td>
<td>12.79</td>
<td>3.43</td>
</tr>
<tr>
<td>Male</td>
<td>50</td>
<td>11.26</td>
<td>3.43</td>
</tr>
</tbody>
</table>

Note: p-value = .024.
in mathematics achievement between the female group of Algebra I students and the male group of Algebra I students when both groups were taught using computer-based instruction.

Hypothesis 8

Hypothesis 8 states that the mean score on a mathematics attitude scale for a group of female Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a group of male Algebra I students taught using computer-based instruction.

Hypothesis 8a states that female students taught using computer-based instruction will score significantly higher on the Mathematics Anxiety Scale than male students taught using

Table 27
Comparison of Female and Male Experimental Group Posttest Anxiety Scores

<table>
<thead>
<tr>
<th>Experimental group</th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>56</td>
<td>0.95</td>
<td>9.64</td>
</tr>
<tr>
<td>Male</td>
<td>50</td>
<td>3.42</td>
<td>7.91</td>
</tr>
</tbody>
</table>

Note: p-value = .16.
computer-based instruction. This hypothesis was tested using a two-tailed $t$-test of independent samples. The results are summarized in Table 27. The $p$-value of .16 is above the .05 significance level (.025 for each tail), indicating that there was no significant difference in mathematics anxiety between the female group of Algebra I students and the male group of Algebra I students when both groups were taught using computer-based instruction.

Hypothesis 8b states that female students taught using computer-based instruction will score significantly higher on the Attitude Toward Success in Mathematics Scale than male students taught using computer-based instruction. This hypothesis was tested using a two-tailed $t$-test of independent samples. The results are

Table 28
Comparison of Female and Male Experimental Group Posttest Success Scores

<table>
<thead>
<tr>
<th>Experimental group</th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>56</td>
<td>13.46</td>
<td>5.28</td>
</tr>
<tr>
<td>Male</td>
<td>50</td>
<td>11.54</td>
<td>6.64</td>
</tr>
</tbody>
</table>

Note: $p$-value = .10.
summarized in Table 28. The p-value of .10 is above the .05 significance level (.025 for each tail), indicating that there was no significant difference in attitude toward success in mathematics between the female group of Algebra I students and the male group of Algebra I students when both groups were taught using computer-based instruction.

Hypothesis 8c states that female students taught using computer-based instruction will score significantly higher on the Confidence in Learning Mathematics Scale than male students taught using computer-based instruction. This hypothesis was tested using a two-tailed t-test of independent samples. The results are summarized in Table 29. The p-value of .88 is above the .05 significance level (.025 for each tail), indicating that there was no significant difference in confidence scores between female and male students.

Table 29

<table>
<thead>
<tr>
<th>Experimental group</th>
<th>N</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>56</td>
<td>5.28</td>
<td>9.02</td>
</tr>
<tr>
<td>Male</td>
<td>50</td>
<td>5.55</td>
<td>7.95</td>
</tr>
</tbody>
</table>

Note: p-value = .88.
significant difference in confidence in learning mathematics between the female group of Algebra I students and the male group of Algebra I students when both groups were taught using computer-based instruction.
Chapter 5

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This study investigated the use of computer-based instruction as a means of teaching Algebra I concepts compared to the teaching of the same topics using traditional methodologies. The study, using the achievement levels of these two groups as one basis for comparison, also investigated the attitudes about mathematics of the two groups. Achievement and attitude differences by gender were considered, as well as differences in achievement and attitude of the experimental group between females and males.

Summary of Findings

Included in the study were all of the Algebra I students (9th- and 10th-graders) enrolled at a high school in a middle to upper-middle class school district in North Central Texas. The two experimental group teachers taught a total of five classes, while the three control group teachers taught a total of six Algebra I classes. Completing the study were 106 students in the experimental group and 137 in the control group.
Data were collected two times during the study, using the same attitude scales each time, but changing from Form A to Form B for the achievement test. Initially the data were collected with achievement and attitude pretests, which were administered to all of the students before the first semester of Algebra I instruction. Posttest data were collected for all students the last week of school in December. After the machine scoring of the achievement tests, the raw scores were statistically analyzed with the SAS statistical program using an analysis of covariance (ANCOVA) to examine hypotheses 1, 3, and 5. For hypotheses 2, 4, and 6, the attitude response selections were converted to numerical scores, weighted for positively and negatively stated items, and also statistically analyzed by the computer using an ANCOVA. A two-tailed t-test of independent samples was used on the data for hypotheses 7 and 8.

Findings

The major findings resulting from the analysis of the statistical data presented in this study were the following:

1. Statistical analysis does not support hypothesis 1, which states that the mean score on an Algebra I achievement test for a group of Algebra I students taught using computer-based instruction will be significantly higher than the mean score of a control group of Algebra I students taught without the use of computer-based instruction. Although hypothesis 1 was rejected, the results were significant in the opposite direction. The control group adjusted
mean was significantly higher than the experimental group adjusted mean.

2. There was a significant difference (p-value = .0001) between the mean mathematics anxiety scores for all of the students who were taught Algebra I using computer-based instruction and a control group of students taught without the use of computer-based instruction. This difference was identified as an increase in the anxiety scores, which indicates lower mathematics anxiety. This supports hypothesis 2a.

3. Statistical analysis does not support hypothesis 2b, which states that students who were taught Algebra I using computer-based instruction will score significantly higher on the Attitude Toward Success in Mathematics Scale than students taught without the use of computer-based instruction. Although hypothesis 2b was rejected, the results were significant in the opposite direction. The control group adjusted mean was higher than the experimental group adjusted mean.

4. There was a significant difference (p-value = .0001) between the mean confidence in learning mathematics scores for all of the students who were taught Algebra I using computer-based instruction and a control group of students taught without the use of computer-based instruction. This difference was identified as an increase in the experimental group's confidence in learning mathematics scores, which supports hypothesis 2c.
5. Statistical analysis does not support hypothesis 3, which states that students who were taught Algebra I using computer-based instruction will score significantly higher on the Attitude Toward Success in Mathematics Scale than students taught without the use of computer-based instruction. Although hypothesis 3 was rejected, the results were significant in the opposite direction. The control group adjusted mean was higher than the experimental group adjusted mean.

6. There was a significant difference ($p$-value = .0001) between the mean anxiety scores for all of the female students who were taught Algebra I using computer-based instruction and a control group of female students taught without the use of computer-based instruction. This difference was identified as an increase in the anxiety scores of the experimental group, which indicates lower mathematics anxiety for this group, thus supporting hypothesis 4a.

7. Statistical analysis does not support hypothesis 4b, which states that female students who were taught Algebra I using computer-based instruction will score significantly higher on the Attitude Toward Success in Mathematics Scale than female students taught without the use of computer-based instruction. Although hypothesis 4b was rejected, the results were significant in the opposite direction. The control group adjusted mean was higher than the experimental group adjusted mean.

8. There was a significant difference ($p$-value = .0001) between the mean confidence in learning mathematics scores for all
of the female students who were taught Algebra I using computer-based instruction and a control group of female students taught without the use of computer-based instruction. This difference was identified as an increase in the confidence in learning mathematics scores for the experimental group. This supports hypothesis 4c.

9. Statistical analysis does not support hypothesis 5, which states that the mean score on Algebra I achievement test for a group of male Algebra I students taught using computer-based instruction will be significantly higher than the mean score for a group of male Algebra I students taught without the use of computer-based instruction. Although hypothesis 5 was rejected, the results were significant in the opposite direction. The control group adjusted mean was higher than the experimental group adjusted mean.

10. There was a significant difference (p-value = .0001) between the mean anxiety scores for all of the male students who were taught Algebra I using computer-based instruction and a control group of male students taught without the use of computer-based instruction. This difference was identified as an increase in the anxiety scores, which indicate lower mathematics anxiety for the experimental group. These results support hypothesis 6a.

11. Statistical analysis does not support hypothesis 6b, which states that male students who were taught Algebra I using computer-based instruction will score significantly higher on the Attitude Toward Success in Mathematics Scale than male students taught without the use of computer-based instruction. Although
hypothesis 6b was rejected, the results were significant in the opposite direction. The control group adjusted mean was higher than the experimental group adjusted mean.

12. There was a significant difference ($p$-value = .0001) between the mean confidence in learning mathematics scores for all of the male students who were taught Algebra I using computer-based instruction and a control group of male students taught without the use of computer-based instruction. This difference was identified as an increase in the experimental group’s confidence in learning mathematics scores. These results support hypothesis 6c.

13. There was a significant difference ($p$-value = .024) between the mean scores on an Algebra I achievement test for all of the female students who were taught Algebra I using computer-based instruction and a group of male students taught using computer-based instruction. This difference was identified as an increase in mathematics achievement scores for the females of the experimental group. This supports hypothesis 7.

14. No significant difference was found between the mean scores on the Mathematics Anxiety Scale of the female students who were taught Algebra I using computer-based instruction and the mean scores of the male students who were taught Algebra I using computer-based instruction. Therefore, hypothesis 8a was rejected, and the null hypothesis was accepted.

15. No significant difference was found between the mean scores on the Attitude Toward Success in Mathematics Scale of the
female students who were taught Algebra I using computer-based instruction and the mean scores of the male students who were taught Algebra I using computer-based instruction. Therefore, hypothesis 8b was rejected, and the null hypothesis was accepted.

16. No significant difference was found between the mean scores on the Confidence in Learning Mathematics Scale of the female students who were taught Algebra I using computer-based instruction and the mean scores of the male students who were taught Algebra I using computer-based instruction. Thus, hypothesis 8c was rejected, and the null hypothesis was accepted.

Conclusions

This study investigated the use of computer-based instruction as a means of teaching Algebra I concepts and improving attitudes toward mathematics. In general, computer-based instruction improved the attitude toward mathematics for the experimental group. Mathematics anxiety was reduced and confidence in learning mathematics improved for both male and female 9th- and 10th-grade Algebra I students when compared to the control groups.

Computer-based instruction is more beneficial to females than to males. Although not significantly higher, the attitudinal scores were higher on 2 of the 3 subscales (increased confidence in learning mathematics, and improved attitude toward success in mathematics), when compared to their male counterparts. In addition, they scored
significantly higher than the control group females on 2 of the 3 attitude subscales.

Computer-based instruction appears to be beneficial to Algebra I achievement for females. They scored significantly higher than their male counterparts, and although it was not significant, they still scored higher than the females not using computer-based instruction.

A positive relationship may exist between the level of teacher experience and student success in mathematics. The students who were taught by teachers (3) with 21 years of combined experience achieved significantly more than those students taught by teachers (2) with a combined experience of 2 years.

The lack of teacher interaction does not appear to have a negative impact on student attitudes toward mathematics. In 6 out of 9 comparisons, the attitudes toward mathematics of the computer-based instruction group were significantly higher than those of students who were teacher directed.

As school districts implement more computer technology in the schools and, particularly, in the mathematics classroom, greater increases in mathematics achievement and improved attitudes toward mathematics will likely be evidenced.
Suggestions for Further Research

Results from the study's findings suggest the following further research:

1. Increase the period of study to a full school year rather than a semester in order to allow students to become completely familiar with the computer and the program.

2. Investigate whether computer-based instruction is more beneficial for low achieving students than for higher achievers.

3. Utilize the computer for the achievement and attitude tests rather than paper/pencil tests and compare the results.

4. Because Learning Logic profiles the amount and kind of remediation offered as progress is made through the topics, investigate student achievement in light of the Learning Logic remediation profile.

5. Develop a study to investigate computer anxiety as well as mathematics anxiety.

6. Another study might use computer based instruction for mathematics classes other than Algebra I or for other subject areas, such as social studies or science.

7. Investigate the effect of computer based instruction on the achievement and attitudes of elementary and junior high mathematics students.
DIARY

Week #

Class reactions:

Problems/questions:

Solutions/answers:

Time involved outside of class day (round to quarter hours and summarize activities):

Instructor comfort level with Learning Logic:

1  2  3  4  5
uncomfortable comfortable

Apparent student comfort level with Learning Logic:

1  2  3  4  5
uncomfortable comfortable

Other comments/questions:
REFERENCES


