EFFECTS OF COMPUTER-ASSISTED INSTRUCTION ON ATTITUDES
AND ACHIEVEMENT OF FOURTH GRADE STUDENTS
IN READING AND MATHEMATICS

DISSERTATION

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The purpose of this study was to determine the effects of participation in a Computer-Assisted Instructional program (CAI) on fourth grade student attitudes and achievement in reading and mathematics.

This study, based on Campbell and Stanley's quasi-experimental design 10, utilized Diascriptive Reading software for the CAI mathematics group and *Milliken Math Sequences* software for the CAI mathematics group and was completed by 242 students. The time span between pretests and posttests was seven months. *Iowa Tests of Basic Skills*, Level 10, Form 7/8 was used for achievement testing and *Estes Attitude Scale* was used for attitude testing. Analysis of covariance was used to determine significance at the .05 level.

The findings for this study were:

1. Reading Comprehension posttest scores were significantly higher for the control group than for the reading experimental group;
2. Reading Comprehension posttest scores were not significantly higher for boys than for girls within the reading experimental group;

3. Total math posttest scores were significantly higher for the mathematics experimental group than for the control group;

4. Concepts and Computation math subsets posttest scores were significantly higher for the mathematics experimental group than for the control group. There were no significant differences between the posttest scores of the two groups for the Math Problem Solving subset;

5. Total Math posttest scores were not significantly different for boys than for girls within the mathematics experimental group;

6. Attitude toward reading posttest scores were significantly higher for the reading experimental group than for the control group;

7. Attitude toward reading posttest scores were not significantly different for the boys than for girls within the reading experimental group;

8. Attitude toward mathematics posttest scores were significantly higher for the mathematics experimental group than for the control group;

9. Attitude toward mathematics posttest scores were significantly higher for girls than for boys within the mathematics experimental group.
# TABLE OF CONTENTS

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

Chapter

I. INTRODUCTION ........................................ 1

  Purpose of Study
  Hypotheses
  Definition of Terms
  Significance of the Study
  Limitations of the Study
  Procedures for Collecting Data
  Population
  Research Design and Treatment
  Analysis of the Data
  Chapter Bibliography

II. REVIEW OF RELATED LITERATURE ................... 12

  Studies Involving Computer-Assisted
    Instruction in Mathematics
  Studies Involving Computer-Assisted
    Instruction in Reading and Language Arts
  Studies Involving a Combination of
    Reading and Mathematics CAI
    Instruction
  Chapter Summary
  Chapter Bibliography

III. METHODS AND PROCEDURES FOR COLLECTING
    AND ANALYZING THE DATA .......................... 43

  Organization and Implementation of the CAI
    Programs
  Subjects
  Instrumentation
  Treatment
  Analysis of Data
  Chapter Summary
  Chapter Bibliography
TABLE OF CONTENTS--(Continued)

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV. PRESENTATION AND ANALYSIS OF DATA</td>
<td>55</td>
</tr>
<tr>
<td>Results Pertaining to Reading Achievement and Attitudes</td>
<td></td>
</tr>
<tr>
<td>Results Pertaining to Mathematics Achievement and Attitudes</td>
<td></td>
</tr>
<tr>
<td>Discussion</td>
<td></td>
</tr>
<tr>
<td>Chapter Summary</td>
<td></td>
</tr>
<tr>
<td>Chapter Bibliography</td>
<td></td>
</tr>
<tr>
<td>V. FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS</td>
<td>81</td>
</tr>
<tr>
<td>Findings</td>
<td></td>
</tr>
<tr>
<td>Conclusions</td>
<td></td>
</tr>
<tr>
<td>Recommendations</td>
<td></td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>86</td>
</tr>
</tbody>
</table>
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Analysis of Covariance Results for Reading Comprehension Achievement Test Scores of Reading Experimental and Control Groups</td>
<td>56</td>
</tr>
<tr>
<td>II.</td>
<td>Mean Scores and Adjusted Mean Scores on Reading Comprehension Achievement Test Scores of Reading Experimental and Control Groups</td>
<td>57</td>
</tr>
<tr>
<td>III.</td>
<td>Analysis of Covariance Results for Reading Achievement Test Scores of Boys and Girls in the Reading Experimental Group</td>
<td>58</td>
</tr>
<tr>
<td>IV.</td>
<td>Mean Scores and Adjusted Mean Scores on Reading Comprehension Test Scores of Boys and Girls in the Reading Experimental Group</td>
<td>59</td>
</tr>
<tr>
<td>V.</td>
<td>Analysis of Covariance Results for Reading Attitude Test Scores of the Reading Experimental and Control Groups</td>
<td>59</td>
</tr>
<tr>
<td>VI.</td>
<td>Mean Scores and Adjusted Mean Scores on Reading Attitude Test Scores of the Reading Experimental and Control Groups</td>
<td>60</td>
</tr>
<tr>
<td>VII.</td>
<td>Analysis of Covariance Results for Reading Attitude Test Scores of Boys and Girls in the Reading Experimental Group</td>
<td>61</td>
</tr>
<tr>
<td>VIII.</td>
<td>Mean Scores and Adjusted Mean Scores on Attitude Toward Reading Test Scores of Boys and Girls in the Reading Experimental Group</td>
<td>61</td>
</tr>
<tr>
<td>Table</td>
<td>Page</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td>IX. Analysis of Covariance Results for Total Math Achievement Test Scores of Mathematics Experimental and Control Groups</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>X. Mean and Adjusted Mean Scores on Total Math Achievement Test Scores of Mathematics Experimental and Control Groups</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>XI. Analysis of Covariance Results for Math Subtest Concepts Achievement Test Scores of the Mathematics Experimental and Control Groups</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>XII. Mean Scores and Adjusted Mean Scores on Math Subtest Concepts Achievement Test Scores of Mathematics Experimental and Control Groups</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>XIII. Analysis of Covariance Results for Math Subtest Problem Solving Achievement Test Scores of the Mathematics Experimental and Control Groups</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>XIV. Mean Scores and Adjusted Mean Scores on Math Subtest Problem Solving Achievement Test Scores of Mathematics Experimental and Control Groups</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>XV. Analysis of Covariance Results for Math Subtest Computation Achievement Test Scores of Mathematics Experimental and Control Groups</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>XVI. Mean Scores and Adjusted Mean Scores for Math Subtest Computation Achievement Test Scores for the Mathematics Experimental and Control Groups</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Table</td>
<td>Description</td>
<td>Page</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>XVII.</td>
<td>Analysis of Covariance Results for Total Math Achievement Test Scores of Boys and Girls in the Mathematics Experimental Group</td>
<td>68</td>
</tr>
<tr>
<td>XVIII.</td>
<td>Mean Scores and Adjusted Mean Scores for Total Math Achievement Test Scores of Boys and Girls in the Mathematics Experimental Group</td>
<td>68</td>
</tr>
<tr>
<td>XIX.</td>
<td>Analysis of Covariance Results on Attitude Toward Mathematics Test Scores for the Mathematics Experimental and Control Group</td>
<td>69</td>
</tr>
<tr>
<td>XX.</td>
<td>Mean Scores and Adjusted Mean Scores for Attitude Toward Mathematics Test Scores of the Mathematics Experimental and Control Group</td>
<td>70</td>
</tr>
<tr>
<td>XXI.</td>
<td>Analysis of Covariance Results for Attitude Toward Mathematics Test Scores for Boys and Girls Within the Mathematics Experimental Group</td>
<td>71</td>
</tr>
<tr>
<td>XXII.</td>
<td>Mean Scores and Adjusted Mean Scores on Attitude Toward Mathematics Test Scores for Boys and Girls Within the Mathematics Experimental Group</td>
<td>71</td>
</tr>
</tbody>
</table>
CHAPTER I

INTRODUCTION

For many years educators have ranked better instructional materials for teaching reading and mathematics in elementary schools as a high priority need. Innovative programs have come and gone. One of the more recent changes, and perhaps the most powerful change in instructional materials, has evolved as a result of the development of the microcomputer and its courseware.

The microcomputer became a marketable product in 1978 and was far more practical for classroom use than either the maxicomputer or the minicomputer, which were both developed before the microcomputer. The maxicomputer (Mitzel, Best, and Rabonowitz, 1982, p. 356) needed an entire room to house it and had a purchase price of "six or more digits (of dollars)," while the minicomputer filled the corner of a room and had a five digit purchase price. On the other hand, Mitzel, Best, and Rabonowitz (1982) stated that the microcomputer could sit on a desk and had a purchase price of four digits. Holmes (1982) referred to the microcomputer as "the Model T" of the computer industry because of its cheaper cost, its smaller size, and its efficiency.
Computer-Assisted Instruction (CAI) has provided schools with a new means of presenting information and students with a new means of learning (Guerion, 1983). It is a teaching process which has the following modes: the drill-and-practice mode, the tutorial mode, games, and the simulation mode. The drill-and-practice mode provides practice for needed skill development and reinforcement. Thompson (1980, p. 38) expressed belief that CAI drill eliminates the "emotional fear and embarrassment" that often accompanies classroom drill. He also stated that CAI allows more flexibility in sequencing by permitting steps in the program to be accelerated, repeated, or skipped as needed by each individual student. The tutorial mode usually involves programmed instruction which supplies information, then questions about the information. It gives immediate feedback as to the correctness of the student's response, as do other forms of CAI, but in some instances it supplies additional information and review. The games and the simulation modes are not as widely used but do help in reinforcing skills and practicing decision making.

Judd (1983) emphasizes that the use of computers in the classroom will not eliminate the need for teachers. Teachers will be needed to motivate the students, to select the curriculum for the students, to recognize emotional problems the child may be experiencing, and to adjust the program to the student's individual needs. Judd (1983, p. 121) views the
computer as a tool that "can increase the power a teacher can apply to a learning situation, but does not replace the teacher."

Papert (1980, p. 9) states that although technology will play an essential role in making his vision of future education a reality, his "central focus is not on the machine but on the mind . . ." The role Papert (1980, p. 9) assigns to the computer is that of "a carrier of cultural 'germs' or 'seeds' whose intellectual products will not need technological support once they take root in an actively growing mind."

Walker (1983) discussed some ways the microcomputer can contribute to education. Computers can provide more active and more independent learning with less "mental drudgery" involved (p. 103). Computers can also provide better aids to abstraction, more variety as to both sensory and conceptual modes and learning that is better designed for meeting individual needs (Walker, 1983).

Some of the limitations of today's computers Walker (1983) identified were complexity of computer use, the short supply of teachers adequately trained to use them and the scarcity of good programs. He states that because new products and systems were being developed so hurriedly and with very little standardization, it was nearly impossible to plan on a long term basis or in a systematic way.
Holmes and Kidd (cited in Holmes, 1982, p. 10) identified possibly the most vital learner need as being quality learning material. Ellis (cited in Thompson, 1980, p. 41) pointed out that "thinking about the computer and its role in instruction does not mean thinking about the computer. It means thinking about instruction."

Visonhaler and Bass (1972) concluded that the advantage of CAI over traditional instruction could be attributed to a number of things including experience with CAI and the novelty of operating the computer which, as they point out, tends to wear off after a period of time. More research needs to be done to assure educators that courseware used for CAI is of a quality that its value as a teaching tool continues after the effect produced by the novelty of the computer is gone.

Purpose of the Study

The purpose of this study is to determine the effects of participation in a Computer-Assisted Instructional program (CAI) on fourth grade student attitudes and achievement in reading and mathematics.

Hypotheses

The hypotheses for this study were as follows.

1. The reading achievement posttest scores of fourth grade students who have participated in a CAI reading program will be significantly higher than the reading achievement posttest scores of the control group.
2. There will be no significant difference in the reading achievement posttest scores of boys and the reading achievement posttest scores of girls within the CAI reading group.

3. The attitude toward reading as a subject posttest scores of fourth grade students who have participated in a CAI reading program will be significantly higher than the attitude toward reading as a subject posttest scores of the control group.

4. There will be no significant difference in the attitude toward reading posttest scores of boys and the attitude toward reading posttest scores of girls within the CAI reading group.

5. The mathematics achievement posttest scores of fourth grade students who have participated in a CAI mathematics program will be significantly higher than the mathematics achievement posttest scores of the control group.

6. There will be no significant difference in the mathematics achievement posttest scores of boys and the mathematics posttest scores of girls with the CAI mathematics group.

7. The attitude toward mathematics as a subject posttest scores of fourth grade students who have participated in a CAI mathematics program will be significantly higher than the attitude toward mathematics as a subject posttest scores of the control group.
8. There will be no significant difference in the attitude toward mathematics as a subject posttest scores of boys and the attitude toward mathematics as a subject posttest scores of girls within the CAI mathematics group.

Definition of Terms

1. **Central Processing Unit (CPU)** - the "brain" of the computer where the information is processed.

2. **Computer-Assisted Instruction (CAI)** - the use of the computer for instructing students.

3. **Computer Based Education (CBE)** - the use of the computer to instruct students. (basically the same as CAI)

4. **Software** - computer programs, the coded instructions that direct the operation of the computer.

5. **Courseware** - software for a particular purpose in education.

6. **Diskette** - floppy disk, small in size and storage capacity, used to store magnetic information.

7. **Drill-and-Practice** - computer instruction that provides practice on skills already introduced by the teacher.

8. **Tutorial** - computer instruction developed to teach initial rules and concepts and to evaluate the students' understanding of the information; operates on the assumption that there has been no prior teaching of the material.
Significance of the Study

This study was felt to be significant in that it would be helpful in future decisions about the use of CAI materials in the Garland Independent School District, Garland, Texas. This district committed itself to at least a one year pilot program in five elementary schools involving the third, fourth, and fifth grade student populations of the pilot schools, the total of which was about 900 students. Thirteen to fifteen computers per pilot school were purchased and placed in these schools in laboratory-type settings. This study should also provide helpful information to other school districts which are considering CAI use.

Limitations of the Study

Due to the fact that the population for this study was limited to members of very similar predominantly white middle class socio-economic groups, the generalizability of the study is limited to only similar socio-economic groups. Another limitation of the study was that time and availability of instructional material permitted the use and evaluation of only two CAI programs.

Procedures for Collecting Data

Permission was requested by the researcher to collect data for this study in the Garland Independent School District, Garland, Texas during the 1983-84 school year.
The district's research committee reviewed the proposal submitted by the researcher and granted permission in early September, 1983.

Population

The entire fourth grade student population of four Garland, Texas elementary schools participated in this study. Of the total population of 302 students, 141 participated in a CAI reading program and acted as a control for the students who participated in a CAI mathematics group. The remaining 161 members of the population participated in a CAI mathematics group and acted as a control for the students who participated in a CAI reading group.

Research Design and Treatment

The design for this study was based on Campbell and Stanley's quasi-experimental design ten (Campbell and Stanley, 1963). This particular design was chosen because of the necessity of using intact class groups. Both groups in this study had very similar populations in socio-economic background, in ethnic composition, and in past achievement test scores. These factors help to assure better control for the study. Following is a schematic design in which the O's represent pretests and posttests and X represents the treatment.
The CAI reading group acted as a control group for the CAI mathematics group and vice versa.

Pretests for achievement, Iowa Tests of Basic Skills, were administered to both groups by the classroom teachers the first week in October, as is the standard practice in the district. Pretests for attitude, Estes Attitude Scale, were administered the third week in September by the researcher and classroom teachers who had been carefully instructed as how to administer the test.

Group I students participated in a CAI supplemental reading program in which each student spent fifteen minutes daily on the computer working with the Diascriptive Reading program. Group II students participated in a supplemental mathematics program in which each student spent fifteen minutes daily on the computer working with the Milliken Math Sequences program.

Posttests for achievement, Iowa Tests of Basic Skills, were administered the last week of April, 1984 by classroom teachers. Posttests for attitude, Estes Attitude Scale, were administered the second week of May by the researcher and classroom teachers.
Analysis of the Data

Analysis of covariance tests were run for each hypothesis to determine if a significant difference existed. The pretest mean, posttest mean, and standard deviation were calculated and recorded.
CHAPTER BIBLIOGRAPHY


CHAPTER II

REVIEW OF RELATED LITERATURE

The first operable computer came into being in the late 1940's. By 1960, International Business Machines (IBM) had developed the first authoring language for use with the computer, Coursewriter, which was simple enough to be used to develop instructional materials without the help of a computer specialist. (Suppes and Macken, 1978).

Two major efforts in CAI were the Stanford Project, a research program which began in 1963 in the Institute for Mathematical Studies (Mitzel and associates, 1982) and PLATO (Programmed Logic for Automatic Teaching Operations), developed by the University of Illinois (Splittgerber, 1979). Of the two, Stanford was the first to experiment with elementary school subjects. Later, their project did include college programs for use with beginning instruction in Russian language classes also (Suppes and Morningstar, 1969). At first elementary school students were transported to the Stanford campus for their CAI lessons, then the experimentation was expanded to include schools in the area around Stanford in California and to schools in Mississippi and Kentucky (Suppes and Macken, 1979).
PLATO, which is now controlled by Control Data Corporation, was especially designed for instruction, and the language designed for use with this system, TUTOR, is very easy to learn to use in developing lessons (McCulloch, 1980). Eisele (1980, p. 5) said of the systems for CAI, "... none have achieved the success of PLATO as an instructional system." PLATO has progressed through five phases of development spanning a period of twenty years, 1959 through 1979. PLATO V, the latest of the systems is a multi-media system, as was PLATO IV, but has the added ability "to interface floppy disks and video disks" (Hirschbuhl, 1980, p. 41).

The programs development done by Stanford University and the University of Illinois, combined with the later development of TICCIT (Time Shared, Interactive Computer Controlled Information Television) by the MITRE Corporation and Brigham Young University, was credited with setting "the stage for others" and providing "a knowledge base which has continued to grow as more and more educators try out the computer as an instructional aid" (Mason, 1980, p. 18). TICCIT can be used in revising programs and monitoring and evaluating student progress (Splittgerber, 1979). This system, like PLATO, has its own special terminal, which can show videotapes (Mason, 1980).
Studies Involving Computer-Assisted Instruction in Mathematics

Stanford's drill-and-practice mathematics program, directed by Patrick Suppes, began in 1965 with forty one fourth grade students utilizing a teletype machine in their classroom (Suppes and Morningstar, 1968). This teletype was connected by telephone with the computer at the Institute for Mathematical Studies in the Social Sciences (Suppes and Macken, 1978).

Statistical evaluation was begun during the 1966-67 school year. The program, by that time, had been enlarged to include first through sixth grades and there were approximately 1,000 students in California involved in the project. The drill content was the same for all students in the class and the difficulty level was adjusted up or down or kept constant depending on the student's performance on the previous day. Mathematical sections of the SAT (Stanford Achievement Test) were given in October and May in four California schools. The experimental school and the control school in each pair of schools were in the same district and the study included matched pairs. The first testing group included students in grades three through six at two schools, with school A the experimental group and school B the control group. The second testing group included students in grades four through six with school C the experimental group and school D the control group. The increase in performance level for the experimental group schools was significantly greater
than for the control group schools for third grade in school A and fourth and sixth grades in school C. The scores of control school B were greater than those of control school D, and also improvement was greater for grades four and five in control school B than these grades in the experimental group A; however, this was attributed to the adding of twenty five minutes extra classroom drill for these students by the teachers of grades four and five at school B. It was concluded that twenty five minutes extra classroom drill did produce more gain in achievement than did the five to eight minutes the student participated in the computer-assisted drill-and-practice program, but it was felt that this did not detract from the effectiveness of the CAI program due to the time saved in using this approach (Suppes and Morningstar, 1969).

Suppes and Morningstar also reported on results of the Stanford CAI program in McComb, Mississippi, for 1967-1968. This group also used drill-and-practice courseware for supplemental mathematics instruction and the same testing materials were used. One difference in test scheduling was that the first grade students were not tested in October as were the others, but instead were pretested in February. In all grades, one through six, the experimental groups showed significantly greater improvement than did the control groups.

Carruth (1970) did a multiple linear regression analysis of computer-assisted elementary arithmetic using as his subjects 890 fourth, fifth, and sixth grade students "who received
the Stanford CAI Drill-and-Practice program in the Fundamentals of Arithmetic during the 1968-69 school year. Tests used were the SAT and Otis Test of Mental Ability. He considered the relations between sixteen variables and a criterion for CAI arithmetic achievement. This criterion was Total Arithmetic Raw Score Computation + Concepts + Application subtests on the SAT. Eight variables were reported as correlating at or above $\pm .50$ with the criterion, including intelligence (.69), race (-.65), socio-economic background (-.50), pretest computation score (.56), pretest concept score (.65), pretest applications score (.74) reading (.69), and average CAI drill scores (.73). As a result of this, Carruth concluded that the student's previous level of achievement in arithmetic, intelligence, and reading ability had the most effect, and that knowledge of arithmetic, intelligence, and reading ability, which accounted for 65% of the criterion variance, were the most effective predictors. Achievement was said to relate more closely to CAI scores than to average CAI drill level. Of no important effect were "sex of pupil, pre-post test experience, and teacher CAI experience." It was also observed that there was sufficient evidence from the effect shown for socio-economic background to suggest that "CAI may be beneficial for the disadvantaged child." Carruth also concluded that needs of "pupils drilling at the lowest level of difficulty" do not appear to be met by drill-and-practice programs and that apparently there are some factors that teachers use in assigning pupil marks that
were not encompassed by CAI drill scores and standardized test scores in arithmetic. Carruth (1970) also stated that it was indicated there might be a possible transfer of learning from the drill-and-practice program indicated by the degree of relationship (.73) between average CAI drill score and the criterion.

Whelchel (1974) examined the effects of some school environmental factors as well as CAI on the achievement of disadvantaged students. The study utilized pre-programmed computer packages and had as its subjects an experimental group of fifth and sixth grade students who received supplemental Computer-Assisted Instruction and a control group of fifth and sixth grade students who received only traditional instruction.

Multiple correlations showed very few significant differences. Posttest scores showed no significant differences and it was concluded that the control group and the experimental group were at the same level of development of arithmetic skills at the time of the final testing for this study.

Burns (1981) in a meta-analysis of forty studies concluded that mathematics instructional programs involving supplemental computer-assisted instruction, both drill-and-practice and tutorial were more effective in producing achievement than programs which were limited to only traditional instruction. Programs involving supplementary drill-and-practice CAI were found to be more effective than programs using only traditional methods in increasing student achievement.
at both elementary and secondary levels among high achieving students, disadvantaged students, and some students whose achievement levels had not been specified in the original studies; however, there was no significant improvement shown for students classified as being of an average level. Boys of intermediate grade level showed much greater achievement gain when instructional plans which included supplemental tutorial CAI were used than instructional plans which only included traditional instruction methods were used.

Two sixth grade classes at an Akron elementary school with a population which was 98 percent Caucasian, were pre-tested with California Achievement Tests in Mathematics, the Sears Self Concept Scale, and Crandall's Intellectual Responsibility Scale. Twenty two randomly selected students, twelve from Class I and ten from Class II, were chosen to participate in a supplemental computer based education program. All students in both classes received traditional mathematics instruction from one teacher. Warner (1981) used a pretest-posttest control group design and used regression analysis on this data to determine whether CBE programs were more effective than the non-CBE programs. The experimental group used CBE for ten minutes a day for thirteen weeks. Warner (1981) found that students who had scored in the upper seventy eight percent of the sample on the pretest achieved significantly more as a result of having participated in CBE. Positive shifts in mathematical
Self-concept were found to be much greater for the group which had participated in CBE than for the group which had not participated in CBE. A significance level of .10 was considered by Warner (1981) as being suggestive that a relationship existed between CBE and the positive shift. A sixteen percent increase in CEE students' degree of internality occurred; whereas, non-CBE students experienced a five percent decrease of internality.

Miller (1984) compared computer-assisted instruction with prescription learning, and the traditional "pull-out" program used in supplementing mathematics instruction of Chapter I (Title I) students and the relative effects of these instructional programs in achievement and retention of mathematics basic skills. All students in the study were pretested prior to their treatment. After one academic year, the students were tested again to determine achievement gains. The following Fall the students were tested again to determine retention. The Chapter I students who had received CAI supplemental mathematics instruction had significantly higher achievement scores than Chapter I students who had received either prescription learning or the traditional "pull-out" program; however, the retention of Chapter I students who had received supplemental CAI instruction was not significantly higher than the retention of the other two groups.

Computer-Assisted Instruction was studied as a means of enhancing remediation for Title I students in the LaFayette Parish of Louisiana. In two low socio-economic area schools which were already making progress through a pull-out math
lab program, CAI was added to the remediation program for the 1980-81 school year. Students from the two schools were matched, then randomly assigned to control group or experimental group. The CAI experimental group received ten minutes of computer drill daily. Meaningful gains were accomplished. CAI was continued for students of the two schools the next school year, 1981-82, but the math pull-out lab was discontinued as a result of funding cuts for Title I programs. Gain scores were even greater than during the experimental year of 1980-81. There was no comparison group in 1981-82. In 1982-83 results derived from testing data and comparison data on a state and national basis, showed gains were remaining stable, were sizeable, and were meaningful for CAI students as compared with non-CAI students in the parish, state, and nation (Hotard and Cortez, 1983).

At the Log Cabin Elementary School, Jackson County, North Carolina, a computer-assisted program utilizing the Hewlett-Packard Math program was begun in the late Fall of 1972. The lower 45 percent of the fourth, fifth, and sixth grade students began receiving ten minutes of computer-assisted instruction daily, whereas, the upper 55 percent only received ten minutes of computer-assisted instruction weekly. The mean computer progress for the lower group was one year nine months; for the higher group the mean computer progress was only seven months. On Iowa Tests of Basic Skills, Math Subtest, the lower group showed a mean gain of one year one month;
the higher group showed only eight months gain on the Iowa Tests of Basic Skills, Math Subtest. The difference in improvement was thought to be the result of difference in CAI time (Delforge and Bloeser, 1977).

Palmer (1973) reported on three CAI experiments carried out in three Los Angeles County schools in California. Strand Drill-and-Practice software marketed by the Computer Curriculum Corporation of Palo Alto, California was used in all three schools. The computer was located in the office of the Los Angeles County Superintendent of Schools. Users were connected by a dial-up or hardware telephone system with a teletype terminal interface. Students at each school site spent five to ten minutes daily at a computer terminal. Each terminal serviced up to fifty students per day. Each school had its own organizational plan for the study. At Washington Elementary school, after the experimental period of four months, the California Arithmetic Tests, which had been used as a pretest was again used to determine gains. Tests scores for only one class group proved to be significantly different from the control group. The Mary E. Bragg Elementary School had a fourth grade experimental group which had thirty six members and one fifth grade experimental group which also had thirty six members. The California Tests of Basic Skills was used as a pretest and as a posttest. After four months the students had good achievement gains but no statistical data were furnished and no control group was
mentioned. At the third school, Will Rogers Elementary, the study was conducted only slightly more than two months, but even with that short time span, achievement gains were evident. Over a period of about two and one half months, eight out of the fifty three completing the study had gains in achievement levels of nine months and eight had gains of five months. The median gain was seven months, with only three students having gains of less than three months.

Sixty four fourth, fifth and sixth grade students who attended a non-public special education school in New York City whose I.Q. scores ranged from 84 through 115, and who were two or more years below grade level in math, were selected to participate in a study investigating the relative effects of CAI and traditional instruction for mastery of learning of multiplication facts among learning-disabled elementary school children who were different as to locus of control. The Bialer Cromwell Locus of Control Scale for Children was used to divide the children into internal or external locus of control groups. The students from both groups were then randomly assigned to the experimental CAI group or the control group which received traditional classroom instruction. A significant interaction was found between the locus of control and the instructional method. Of the students utilizing CAI, those with internal locus of control were able to work more independently with less dependency on the teacher than were
the students possessing external locus of control. On the other hand, students with external locus of control who were instructed by means of traditional techniques seemed to learn more than the members of the CAI group who had external locus of control (Bukatman, 1981).

Dorsey and Burleson (1983) reported on a CAI pilot program at Reagan County elementary school, Big Lake, Texas, which is located sixty miles from the nearest urban center and has a population of about 550 students in grades K-6. Fifty six percent of the students at the school at the time of this study were Spanish surnamed. The program was initiated to help children who were having problems in mathematics but was later expanded to include all students. The software used for the study was a Milliken math series which kept cumulative records of the students' progress. Each student was allowed to work at the computer fifteen minutes per week. SRA tests were given at the end of one year. Impressive gains were reported in mathematics. No statistical procedure was thought necessary by Dorsey and Burleson (1983).

During two semesters, Pasco School District in Washington conducted an experiment in which 500 students in grades three through six received one of three treatments in mathematics: the regular math curriculum of the district, an alternative paper and pencil drill and practice program,
and CAI. All programs produced achievement gains. CAI produced significantly greater achievement gains in total math and computational skills. Achievement gains in concept application skills were greater for the regular curriculum. It was determined that CAI was very effective for remedial programs for migrant children and children with limited proficiency in the English language (McConnell, 1983).

Studies Involving Computer-Assisted Instruction in Reading and Language Arts

Litman (1977) compared reading achievement among a group of fourth, fifth, and sixth grade students who had participated in a CAI drill-and-practice program with a comparable group which did not participate in a CAI program. Comparisons were made after the first and second year and it was concluded that drill-and-practice program participants scored significantly higher in reading and that when the scores were converted to grade-equivalent scores they were considered to be important and desirable. Litman (1977) further stated that these achievements were accomplished by students who had previously been considered hopelessly unsuccessful in special reading programs, and that the cost involved in attaining the increased achievement was relatively low.

The population for Thompson's (1972) study was composed of two hundred randomly chosen Black children from
the inner city area of Waco, Texas. The children were all students in the Waco Independent School District during the 1970-71 school year. All the subjects involved in this study received traditional language arts instruction. The experimental group received an additional fourteen minutes per day of CAI in Word Meaning, Spelling, and General Language Usage. Both the experimental group and the control group were tested in September, 1970 and in May, 1971. It was determined that in the area of Word Meaning both groups had the same average true gains. Girls in the control group had larger true gains than girls in the CAI experimental group at all grade levels. The boys in the CAI experimental group had larger average true gains than girls in the CAI experimental group at all grade levels. In Paragraph Meaning, Thompson (1972) states that average true gains for the experimental CAI group were significantly higher than the average true gains of the control group for each sex and each grade level. In the area of Spelling, CAI students had the same average true gains as the non-CAI students; therefore, no significant difference was shown. In General Language Usage, only in Grade six were the average true gains greater in the CAI group than in the non-CAI group. Thompson (1972) attributed the low average true gain scores of the Grade five CAI group to the girls at that level having a very low I.Q. Thompson concluded that CAI is beneficial in
Paragraph Meaning and General Language Usage, which are at a lower level of abstraction in pretests and posttests than Word Meaning and Spelling; therefore, he stated that it appeared that the average true gains and the level of abstraction were inversely related.

Anelli (1977) investigated the relationships between time spent on CAI and reading improvement and attitudes. Involved in the study were 121 third and fourth grade children who were attending three urban elementary schools in Newark, New Jersey. The children were grouped so as to permit each group to receive various time periods of CAI instruction. It was concluded at the end of the study that neither total CAI time nor length or frequency of the CAI sessions seemed to affect reading achievement according to SAT test results. Students who received three to four hours total CAI time over a three month period made the greatest progress in the program in proportion to the time spent. Girls made more progress in the CAI program, which Anelli (1977) said might be the result of girls being more inclined to adjust their responses to meet the requirements of CAI rather than to respond according to their own convictions. Anelli (1977) also stated that students seemed enthusiastic about CAI but that their enthusiasm diminished some after about seven or eight hours accumulated time on the machine. In her opinion, CAI drill material was not as effective as anticipated by its proponents and perhaps needed to be modified to include more complex reading tasks and more interesting content.
Levy (1982) compared three instructional methods for reading used in the Port Arthur Independent School District, Port Arthur, Texas. These methods were computer-assisted reading instruction, traditional reading instruction, and prescriptive reading instruction. Three hundred students randomly selected from six Port Arthur elementary schools made up the population for this study. The ethnic composition of the population was 70 percent black, 20 percent white, 5 percent Hispanic and 5 percent Vietnamese. Levy (1982) used a pretest-posttest, control group design and used the Comprehensive Tests of Basic Skills to pretest in the Spring of 1979 and to posttest in the Spring of 1980. Levy (1982) concluded that for increasing both total reading and reading vocabulary scores of fourth and fifth grade students, the traditional reading method was more efficient than either the computer-assisted method or the prescriptive method. Levy (1982) found no difference in the traditional reading method and the computer-assisted reading method as to efficiency in increasing reading comprehension scores of fourth and fifth grade students, but on the other hand, Levy (1982) found that the traditional method was more efficient than the prescriptive method in increasing reading comprehension scores of fourth and fifth grade students. Levy (1982) also found that no differences existed between the computer-assisted
reading method and the prescriptive reading method in increasing total reading, vocabulary, or comprehension scores of fourth and fifth grade students.

Grocke (1982) reported on two computer-based reading programs used at the City Educational Clinic in Canberra, Australia with children who were "reading disabled." In both programs, children interacted with the computer through a graphic display, a touch sensitive screen, and synthesized speech. One of the programs taught a basic sight vocabulary and permitted the child to construct sentences from word lists provided them. The other program involved a modified cloze procedure in which the child chose the missing word in a paragraph from a list of alternatives presented for him or her to select from. If a child could not read a word he or she could push the "help" button and the computer would speak it for him or her. The child's responses all received visual and/or spoken feedback.

The sight-word program involved an experimental group of thirteen children (twelve boys and one girl) who had been referred by remedial reading teachers or the counselor from their schools to participate in the program during the summer vacation. The criteria for eligibility for the program were that the child's reading level was at least one year below his or her chronological age, and that the child's recognition of sight words from the Dolch sight word list was
below 90 percent. Seven children who received regular classroom instruction and were given the same pretests and posttests with the same time span between, and who were tested during the school year served as a comparison group. Pretests and posttests given included the ACER sight vocabulary, the Dolch sight word list, and the Neale Comprehension Test.

The children in the experimental group each received three individual computer-based sessions weekly; each session was twenty minutes long. The experimental group scored significantly higher than the comparison group on posttests. Additional posttests were given to the experimental group fourteen weeks after the program began and twenty six weeks after the program began. All three posttests showed significant gains on the Dolch, ACER, and Neale tests. Further gains were observed during the next school term also.

The cloze program included two groups of ten and twelve children respectively. These children had also been referred by remedial reading teachers and counselors. Pretests and posttests used for this group were: the ACER sight vocabulary test, the Edinburg Reading Test (State 1; Section D - Comprehension), and a Cloze Test. Experimental Group I, with a population of ten children, was re-tested at the end of the five week program which involved three individual twenty minute sessions per week, again eight weeks later which
was the beginning of the following school year, and again thirty two weeks after the beginning of the program. One of the ten children was included only in the first retest. The retest immediately following the computer-based instructional period showed that the group had made significant gains in sight vocabulary and reading comprehension. There was an increase in the group's mean cloze scores but not enough to show a significant difference. On the subsequent posttests significant gains were again shown for sight vocabulary and comprehension. There was an increase in cloze mean scores as before, but not a significant difference.

Experimental Group II, with a population of twelve children, had the same pretests and the same posttests as Group I at the end of the instructional period (five weeks from the beginning) and again eight weeks later. This group showed significant gains on both posttests for all three areas tested: sight vocabulary, comprehension and cloze procedures.

Mravetz (1980) examined the effects of computer-assisted instruction on students' self-concept, locus of control, level of aspiration, and reading achievement. Thirty rural Caucasian junior high students, twenty of whom were assigned to a CAI experimental group and ten of whom were assigned to a control group, were all one or more grade levels in reading below their actual grade placements.
Both groups had the same teacher. The control group received no CAI. After the experimental period, the groups showed no significant differences in self-concept or reading self-concept. Differences in feelings of locus of control in reading were statistically significant, but Mravetz (1980) attributed this to a negative shift in the control group. Level of aspiration, which was measured in November, 1979, January, 1980, and February, 1980, according to Mravetz (1980) showed a shift that indicated more realistic learning choices were developing. Differences in reading achievement scores were also statistically significant.

Studies Involving a Combination of Reading and Mathematics

CAI Instruction

Swinton, Amarel, and Morgan (1978) report that during 1975-76, pilot and demonstration years of PLATO, a naturalistic rather than randomized experiment was carried out in about 100 elementary schools in the Champaign/Urbana region of Illinois in which not only changes in achievement level but other factors, even teacher traits, were closely scrutinized and analyzed. It was observed that there was a rather wide variance in time needed to become familiar with the terminals. The average time needed was one week, with more time being required for students in the lower grades than for students in the upper grades. Teachers felt that the brighter students benefited most from PLATO, largely because this group
was able to master the new method of learning offered by PLATO more easily (Swinton, et al, 1978). Teacher's familiarity with the PLATO lessons varied widely and so did their opinions of the lessons. Math teachers had more favorable attitudes toward PLATO than did reading teachers. Most teachers felt there was need for system and lesson improvement. Teacher's reactions were documented through six case studies prepared from observations, teacher interviews, and teacher logs (Swinton, et al, 1978). There was a positively significant gain in mathematics achievement for the students involved, however, kindergarten and first grade students had a negatively significant change in reading achievement. Swinton, et al (1978) attribute this partly to machine and materials problems and the fact that both program and hardware development were being carried on at the same time. Attitudes improved toward reading and mathematics significantly.

Sandman and Welch (1978) evaluated a CAI program involving Title I students in three correctional institutions in Minnesota: (1) the State Reformatory for Men, St. Cloud, for males seventeen to twenty one, (2) the Minnesota Home School, Sauk Centre, for males and females ages twelve through eighteen, and (3) The State Training School, Red Wind, for males thirteen through eighteen. Curriculum packages
designed for use with this group included PLATO Basic Skills Curriculum for both reading and mathematics as well as PLATO Corrections Project Mathematics Curriculum, a program especially designed for use with young people in correctional institutions. A total of 192 Title I students contributed to both pretest and posttest data. Students at all three institutions showed some improvement in reading and mathematics skills, but the improvement was significant only at Sauk Centre. Students' attitudes toward reading and mathematics showed improvement, but the improvement was not related to instructional time or use of the computer. Most of the students had positive attitudes towards CAI.

Easterling (1982) conducted a study which involved two CAI treatment groups which acted as control groups for each other and an additional non-CAI control group. Computer software programs, Microsystem 80 Critical Reading Series (Borg-Warner) and SRA Computer Drill and Instruction: Mathematics (Science Research Associates) were used to supplement classroom instruction. Students for the study were randomly selected from three elementary schools in the Hurst-Euless-Bedford Independent School District in Texas, then they were matched in pairs and randomly assigned to experimental or control groups. Each student spent two fifteen minute periods per week from January until May. Sixty six
students completed the study. The California Achievement Test, Level 15, Form C was the testing instrument used to ascertain achievement gains. Analysis of covariance showed that the reading CAI group's reading achievement test scores were not significantly different from the CAI mathematics group (reading control group) or the non-CAI control group. No significant differences were found between the math achievement scores of the CAI math group and the two control groups. Easterling (1982) expressed the opinion that a larger sample and more time spent in CAI might produce different results.

Of the studies reviewed, none were found that evaluated the effects of the Diascriptive Reading CAI program used in the present study and only one, Dorsey and Burleson (1983), was found in which the effects of the Milliken Math Sequences software was studied. Attitude changes are seldom measured, particularly changes in attitude toward subjects. The CAI study done by Swinton, Amarel, and Morgan (1978) was the only one found that examined attitude toward reading and mathematics.

Further research and evaluation of CAI is needed and will need to be continued as new software is developed. Also, software developers need to utilize research findings in the production of new materials.
Chapter Summary

Slightly more than two decades ago experimentation was begun in the use of computer-assisted instruction. Early developmental research at Stanford University and the University of Illinois, followed by the work done at Brigham Young University kindled the interest of others. Results of the experimentation involved in the Stanford project and the PLATO project (University of Illinois) were good enough to indicate that this type of instruction had merit.

Of the CAI mathematics studies reviewed, many have had excellent results. Impressive or meaningful achievement gains were reported by Dorsey and Burleson (1983) and Hotard and Cortez (1984). Significant gain differences in achievement of the experimental group and the control group were reported for some grade levels by Suppes and Morningstar (1969). Warner (1981) found that students who had scores in the upper seventy eight percent of the sample on the pretest achieved significantly more as a result of having participated in a computer-based education program. Miller's (1984) Chapter I (Title I) students showed significant gains in mathematics achievement but not in retention of the improvement. McConnell (1984) found that CAI produced significant gains in achievement in total math and computational skills. Palmer (1973) reviewed experiments in three California
elementary schools. One of these schools showed significant achievement in mathematics in one class only, with meaningful gains for the other two schools. Whelchel (1974) found no differences in achievement gains of students who had participated in a CAI mathematics program and of students who had received no computer-assisted instruction. Bukatman (1982) investigated the relative effectiveness of CAI and traditional instruction among learning-disabled elementary school students who were different as to locus of control. Students with external locus of control did better in traditional instruction groups than in CAI groups. Students with internal locus of control were able to work more independently in CAI than were the students with external locus of control. Carruth (1970) did a multiple linear regression analysis of computer-assisted elementary arithmetic, considering the relationship between sixteen variables and a criterion for CAI arithmetic achievement and concluded that the student's previous level of achievement in arithmetic, intelligence, and reading ability had the most effect.

Thompson (1972) in a Language arts program involving CAI found that the experimental group showed significantly higher gains than the control group in Paragraph Meaning for each sex and grade level. In only Grade six, gains were significantly greater for the experimental group in the area
of General Language Usage. No significant differences were found in Spelling and Word Meaning.

Some studies have been done which involved both reading and mathematics. Easterling (1982) reported in regard to one of these studies that no significant differences were found between the experimental and the control groups in either reading or mathematics. Swinton, et al (1978) stated that in a naturalistic experiment carried out in about 100 elementary schools in the Champaign/Urbana region of Illinois, there was a positively significant mathematics achievement gain for the students involved; however, at the kindergarten and first grade level a significantly negative shift in reading achievement occurred. This was thought to be partly attributable to machine and materials problems. Sandman and Welch (1978) evaluated a CAI reading mathematics program conducted in three correctional institutions in Minnesota involving Title I students who were inmates at these institutions. No significant differences were found except at the Minnesota Home School, Sauk Centre, a correctional institution for males and females ages twelve through eighteen.

There seems to be some indication that CAI is especially effective with the disadvantaged child (Carruth, 1970; Burns, 1981; Hotard and Cortez, 1983; McConnell, 1983) and/or the learning disabled child (Grocke, 1982; and Miller, 1984).
Some schools with high minority populations have profitted from CAI use also (Thompson, 1972; Dorsey and Burleson, 1983).
CHAPTER BIBLIOGRAPHY


CHAPTER III

METHODS AND PROCEDURES FOR COLLECTING AND ANALYZING DATA

This study was designed to investigate the effects of supplemental computer-assisted instruction in reading and mathematics and the drill-and-practice courseware used in the program on students' achievement in and attitudes toward these academic subjects. Included in this chapter is a description of the organization and implementation of the programs, a description of the subjects, a description of the treatments, collection of data, and analysis of data.

Organization and Implementation of the CAI Programs

At the beginning of the 1983-1984 school year, the Garland Independent School District, Garland, Texas located north of Dallas, began implementation of a pilot program involving supplemental computer-assisted instruction in reading and mathematics in third, fourth, and fifth grades at five of the district's thirty one elementary schools.

Principals were given an opportunity to submit a proposal if interested in his or her school participating in the programs. The proposal was to include such things as what space was available in the school for a computer lab,
why the school of which he or she was principal would benefit from such a program, why the students of the school would be good subjects, what preparation teachers had that would enable them to help conduct a CAI program, along with any other pertinent data that would aid the district in deciding which schools would serve as pilot schools.

Four of the schools selected had predominantly white populations, the fifth school had a predominantly black population. Two schools were assigned to the CAI reading program and three were assigned to the CAI mathematics program. The programs were supplemental in nature.

Computers were installed in laboratory-type settings in the pilot schools prior to the beginning of the school year. In-service training programs had been offered for teachers who wished to participate in the Spring of 1983, and on a required basis for teachers in the pilot schools (grades three through five) during the in-service period immediately prior to the beginning of the 1983-84 school year.

Diagnostic testing of the students was carried out during the first two weeks of the school year. Subsequently, the students were assigned to appropriate levels in the program.

Subjects

For the purposes of this study, the four predominantly white schools which were very similar, were chosen to aid in
the control of the study. The two large schools used in the study, which were located in the same geographic section of Garland, within two miles of one another, had populations with very similar socio-economic backgrounds and very similar prior testing results. The two small schools used in this study were in the same geographic section of Garland within one and one-half miles of one another on the opposite side of Garland from the large schools, and also had populations with very similar socio-economic backgrounds and similar prior testing results.

At the beginning of the study, there were 302 fourth grade students enrolled at the above schools. The fourth grade population of two schools, one large and one small, made up the CAI reading group which was composed of seventy four boys and sixty seven girls. The CAI reading group served as a control group for the CAI mathematics group. The fourth grade population of two other schools, one large and one small, made up the CAI mathematics group and included eighty one boys and eighty girls. The CAI mathematics group served as a control group for the CAI reading group.

The ethnic composition of the CAI reading group was 91.2 percent Anglo, 5.67 percent Black, and 3.13 percent Hispanic. The CAI mathematics group had an ethnic composition of 87.14 percent Anglo, 5.26 percent Black, 5.26 percent Oriental, and 2.34 percent Hispanic.
Instrumentation

The Reading and Mathematics Sections, Iowa Tests of Basic Skills, Level 10, Form 7/8 were administered as pre-tests of achievement the first week in October, 1983 and again the last week of April, 1984 as posttests. The Administrator's Manual (Hieronymus, et al, 1978) for this test shows a reliability coefficient for this level of .90 for both Reading and Mathematics Computation, .83 for both Mathematics Concepts and Mathematics Problems, and .93 for Mathematics Total. Herrick (1959) reported that Iowa Tests of Basic Skills have reliability coefficients ranging from .84 to .96 on major tests and composite reliabilities for the whole test ranging from .97 to .98. Herrick (1959, p.31) viewed these correlations as being "sufficiently high for individual diagnosis and prediction." Morgan (1959, p.59) stated that reliability coefficients seemed to be "satisfactory in relation to the length of the tests."

As to validity, the test manual states that "all the commonly used principles have been supplied in the preparation of the test," (p. 7) and points out that the tests were designed and constructed by the College of Education at the University of Iowa. According to the manual, the contents of the tests were carefully selected to represent the basis of curriculum practices. The behavioral objectives represented in the tests were said to have been obtained through "systematic consideration of courses of study,
statements of authorities, and recommendations of national curriculum groups," (p. 7). The manual further states that in the construction of the test of Forms 1-8 over 30,000 items were tried and analyzed. Herrick (1959) and Morgan (1959) commended the careful process used in preparing these tests in order to assure validity. Herrick (1959) stated that the curricular validation was a major strength of the Iowa Tests of Basic Skills. This test was chosen to be used in the district by a committee which deemed it most nearly suited to the curriculum of the district.

The Estes Attitude Scale was administered the third week of September to determine beginning attitudes toward reading and mathematics and was then administered again the second week in May to determine changes in attitude during the experimental period. Estes, et al (1980) reported that the content validity for the elementary form (Grades three through six) was checked by presenting sixty items to small groups of third graders in Virginia and Iowa and by asking the children if they understood. Then by having the children tell what the statements meant in their own words, investigators were able to eliminate or revise items that were too hard. The sixty item scale included twenty items for each of three subjects. It was later revised to fourteen items for each subject. Since this study only involved the reading and mathematics sections, reporting did not include the science section.
Factorial validity was also checked and reported as being satisfactory as was the internal consistency. Reliability coefficients were reported on the scale for three sample groups of third, fourth, and fifth grade students to which the scale was administered. For Sample C, consisting of 90 boys and girls from predominantly rural areas of Virginia, a reliability coefficient of .77 was reported in mathematics and .86 in reading. Sample D, made up of 115 boys and girls, most of whom were above average in ability, from urban communities in central Iowa, showed reliability coefficients for the scale as being .87 in mathematics and .85 in reading. Sample E, consisting of 923 urban and rural children of Virginia was administered the revised 14 item per subject scale whereas the other groups were given the older 20 item per subject scale. This group was reported as reflecting reliability coefficients for the scale of .76 for mathematics and .86 for reading.

Treatment

Courseware

The software program used for the CAI reading group was Diascriptive Reading, (Educational Activities, Inc., 1982). The program was contained on seven diskettes and was used with the Apple II Plus microcomputer. There were three diagnostic tests covering the skill areas in this program. The
skill areas, all of which included grade levels three through eight were: vocabulary, sequence, main idea, fact/opinion, details, and inference. A multiple-choice format was used in all skill areas.

The program used in the CAI mathematics group was Milliken Math Sequences, (Milliken Publishing Company, 1980) and consisted of twelve diskettes which also were used with the Apple II Plus microcomputer. The skill areas in this program included basic skills taught in pre-high school grades. Some areas covered grade levels one through eight, while a few covered only grades six through eight. The material is described in the manual as being "a basic drill-and-practice software program" which contains material that correlates with most basic mathematics texts. Generally two chances were given to solve the problem correctly, then if after two tries the answer was still incorrect, the correct answer appeared on the screen, step-by-step, while the student pressed the return key after each step. Some help was available to the student; for example, when subtracting, if the child was unable to manage borrowing, he could press the space bar and then the problem would be marked as to how the top numerals would be when borrowing was complete. The child then could subtract.

Activities

Classes were set up in the CAI reading pilot schools according to the students' levels of ability in reading
and the reading teacher was in charge of the CAI sessions for the group she taught. In the CAI mathematics schools, classes were set up according to the students' levels of ability in mathematics and the mathematics teacher was in charge of the CAI sessions for the group she taught. Each ability group class went intact to the computer lab during thirty minutes which had been added to the time usually allotted for teaching reading or mathematics. Some classes went to the computer lab before their regular reading or mathematics instructional time, some classes went to the computer lab after the regular reading or mathematics instructional time, and some classes had a part of their reading or mathematics instructional time before going to the computer lab and part of it after the CAI session.

All children were pretested and assigned to what was deemed an appropriate level of the courseware. Two children were then assigned to each computer. Each child was allotted fifteen minutes computer time daily. At first, some children needed more than fifteen minutes to complete a reading skill lesson. The child was allowed the extra time needed and the other child who was assigned to the same computer as nearly as possible was given the same amount of extra time the following day. Soon the children were able to complete the reading skill lessons in fifteen minutes. The children were better able to manage the CAI mathematics lessons
within the given time from the beginning; however, near the end of the school year, at least one teacher had her low math group work thirty minutes each on alternate days.

The CAI reading skills program could not be organized in such a way as to allow practice to immediately follow the direct instruction of that skill in the classroom because of the small amount of software available. There were only four disks on each reading skill in the larger CAI reading school and three disks on each reading skill in the smaller CAI reading school. The software was not designed so that an entire reading skill lesson could be loaded into a computer and the disk moved to another computer, so a maximum of only four students could work on a given skill at one time. The other students had to work on other skills in which they had not received recent classroom instruction, or in some cases, had received no classroom instruction. Software problems were extensive in the CAI reading program with all the disks of one skill sometimes being out of order at once. At one point, so many disks had been sent in for repair from the larger CAI reading school, that the lab had to be closed for about two weeks.

The CAI mathematics program had much less software problems than the CAI reading group. It was also possible to follow-up direct classroom instruction with CAI drill in the same skill because about twenty five problems could be loaded
from the disk into as many computers as necessary of any level or levels needed in a certain skill.

Each child, during the time between the pretest and the posttest, spent about thirty three hours in Computer-Assisted Instruction drill-and-practice work with the exception of the children at the larger CAI reading school who only received thirty and one half hours of CAI drill work due to the time lost with software problems.

Analysis of Data

Analysis of covariance was used to examine posttest differences in math and reading achievement and attitudes between the experimental group and control group, as well as between boys and girls within the experimental group. Pretest scores on the Iowa Tests of Basic Skills (Level 10, Form 7/8) and on the Estes Attitudes Scale (Elementary Level) were used as covariants and posttest scores on these tests were used as the criterion variable.

Chapter Summary

Chapter III provides detailed description of the subjects involved in this study and of the courseware and the methods and procedures used in the study.

The fourth grade students from four elementary schools in Garland, Texas made up the two treatment groups which
served as control groups for each other. The CAI treatment spanned the entire school year, and included 302 students at its onset.

The drill-and-practice courseware used as treatments in this study: Diascriptive Reading and Milliken Math Sequences were described in detail in this chapter.

Statements concerning the reliability of the testing instruments used for data collection were also included. These instruments were the Iowa Tests of Basic Skills, Level 10, Forms 7/8 and the Estes Attitude Scale, Elementary Level. Analysis of covariance was identified as the means of analyzing the results of the testing.
CHAPTER BIBLIOGRAPHY


CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The effects of Computer-Assisted Instruction used as a supplement to traditional classroom instruction in reading and mathematics on fourth grade students' achievement and attitude toward reading and mathematics were analyzed. An original population of 302 students was reduced to 242 because of absences, moving, or incomplete test scores. Thirteen students who were absent twenty days or more were dropped in order to better equalize the students' time on task. Twenty students had no posttest scores for both the Iowa Tests of Basic Skills and the Estes Attitude Scale; therefore, they were assumed to have moved. Four students had no reading posttest scores on the Iowa Tests of Basic Skills. The remaining twenty three students who were dropped from the original population were not present for one or more of the four tests given (pretest and posttest for ITBS and Estes Attitude Scale).

Analysis of covariance was applied to each hypothesis as stated in Chapter I and the five percent level of significance was used to determine rejection.

55
Results Pertaining to Reading Achievement and Attitude

Hypothesis One

Hypothesis one stated: The reading achievement posttest scores of fourth grade students who have participated in a CAI reading program will be significantly higher than the reading achievement posttest scores of the control group. When this hypothesis was tested in the null form, a significant difference was found in favor of the control group instead of in favor of the experimental group as hypothesized.

Analysis of covariance results presented in Table 1 indicate an F of 12.74 which was significant at the .001 level. The hypothesis was therefore rejected.

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As shown in Table II, the posttest means of the control group were greater in reading comprehension than the posttest means of the experimental group.

**TABLE II**

**MEAN SCORES AND ADJUSTED MEAN SCORES ON READING COMPREHENSION ACHIEVEMENT TEST SCORES OF READING EXPERIMENTAL AND CONTROL GROUPS**

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th></th>
<th>Posttest</th>
<th></th>
<th>Adjusted</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Obtained Mean</td>
<td>SD</td>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Experimental</td>
<td>119</td>
<td>32.47</td>
<td>8.71</td>
<td>35.08</td>
<td>8.75</td>
<td>34.76</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>123</td>
<td>31.57</td>
<td>8.91</td>
<td>36.83</td>
<td>7.59</td>
<td>37.14</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td>32.02</td>
<td>8.82</td>
<td>35.96</td>
<td>8.21</td>
<td>...</td>
<td></td>
</tr>
</tbody>
</table>

**Hypothesis Two**

Hypothesis two was stated to read: There will be no significant difference in the reading achievement posttest scores of boys and the reading achievement posttest scores of girls within the Computer-Assisted Instruction reading group.

Analysis of covariance results indicated that no significant difference existed between the adjusted mean scores of the boys and the adjusted mean scores of the girls within the experimental reading group as shown in Table III. There was an F of 3.84 and a significance level of .052 which was
greater than the .05 level set for rejection. The hypothesis was therefore retained.

TABLE III

ANALYSIS OF COVARIANCE RESULTS FOR READING ACHIEVEMENT TEST SCORES OF BOYS AND GIRLS IN THE READING EXPERIMENTAL GROUP

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1</td>
<td>117.09</td>
<td>117.09</td>
<td>3.84</td>
<td>.052</td>
</tr>
<tr>
<td>Within Groups</td>
<td>116</td>
<td>3533.63</td>
<td>30.46</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Total</td>
<td>117</td>
<td>3650.69</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

As indicated in Table IV there was a difference in the posttest means for boys and the posttest means for girls. The girls' posttest means were greater, although not significantly greater.

TABLE IV

MEAN SCORES AND ADJUSTED MEAN SCORES ON READING COMPREHENSION TEST SCORES OF BOYS AND GIRLS IN THE READING EXPERIMENTAL GROUP

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Obtained Mean</td>
</tr>
<tr>
<td>Boys</td>
<td>61</td>
<td>30.92</td>
<td>9.26</td>
<td>32.95</td>
</tr>
<tr>
<td>Girls</td>
<td>58</td>
<td>34.10</td>
<td>8.20</td>
<td>37.33</td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
<td>32.10</td>
<td>8.87</td>
<td>35.14</td>
</tr>
</tbody>
</table>
Hypothesis Three

Hypothesis three stated: The attitude toward reading as a subject posttest scores of fourth grade students who have participated in a CAI reading program will be significantly higher than the attitude toward reading as a subject posttest scores of the control group.

As shown in Table V an F of 5.13, significant at the .024 level, was obtained in favor of the experimental group, therefore, the hypothesis was retained.

TABLE V

ANALYSIS OF COVARIANCE RESULTS FOR READING ATTITUDE TEST SCORES OF THE READING EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1</td>
<td>187.02</td>
<td>187.02</td>
<td>5.13</td>
<td>.024</td>
</tr>
<tr>
<td>Within Groups</td>
<td>239</td>
<td>8718.73</td>
<td>2517.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
<td>8905.75</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table VI indicates that the posttest mean scores of the reading experimental group were greater than the posttest mean scores of the reading control group on the reading portion of the Estes Attitude Scale.
TABLE VI

MEAN SCORES AND ADJUSTED MEAN SCORES ON READING ATTITUDE TEST SCORES OF THE READING EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Reading Experimental</td>
<td>119</td>
<td>19.08</td>
<td>7.25</td>
</tr>
<tr>
<td>Reading Control (Mathematics</td>
<td>123</td>
<td>21.71</td>
<td>6.08</td>
</tr>
<tr>
<td>Experimental)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td>20.38</td>
<td>6.80</td>
</tr>
</tbody>
</table>

Hypothesis Four

Hypothesis four stated: There will be no significant difference in the attitude toward reading as a subject posttest scores of boys and the attitude toward reading as a subject posttest scores of girls within the CAI reading experimental group.

As indicated in Table VII the F of .153 was not significant, therefore, the hypothesis was retained.
TABLE VII

ANALYSIS OF COVARIANCE RESULTS FOR READING ATTITUDE TEST SCORES OF BOYS AND GIRLS IN THE READING EXPERIMENTAL GROUP

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1</td>
<td>56.17</td>
<td>56.17</td>
<td>1.53</td>
<td>.218</td>
</tr>
<tr>
<td>Within Groups</td>
<td>116</td>
<td>4253.85</td>
<td>36.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>117</td>
<td>4310.02</td>
<td>92.84</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table VIII presents the pretest-posttest mean scores of boys and girls. The boys' adjusted mean score was slightly higher than the girls' adjusted mean score.

TABLE VIII

MEAN SCORES AND ADJUSTED MEAN SCORES ON ATTITUDE TOWARD READING TEST SCORES OF BOYS AND GIRLS IN THE READING EXPERIMENTAL GROUP

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th></th>
<th></th>
<th></th>
<th>Posttest</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Obtained</td>
<td>Mean</td>
<td>SD</td>
<td>Adjusted</td>
<td>Mean</td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>61</td>
<td>17.21</td>
<td>7.02</td>
<td>20.93</td>
<td>5.91</td>
<td>21.89</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girls</td>
<td>58</td>
<td>20.90</td>
<td>7.07</td>
<td>21.48</td>
<td>9.18</td>
<td>20.47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>119</td>
<td>19.06</td>
<td>7.25</td>
<td>21.20</td>
<td>7.08</td>
<td></td>
<td>...</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hypothesis Five

Hypothesis five stated: The mathematics achievement posttest scores of fourth grade students who have participated in a CAI mathematics program will be significantly higher than the mathematics achievement posttest scores of the control group.

A total math score, which was arrived at by adding the raw scores for the three subtests of the Iowa Tests of Basic Skills (Concepts, Math Problem Solving, and Computation), was used in the testing for this hypothesis.

Analysis of covariance yielded an F of 7.69, which represents a significance level of .006. Since these results, as shown in Table IX, represent a significant difference in the total math adjusted mean scores of the Computer-Assisted mathematics experimental group and the mathematics control group, the hypothesis was retained.

TABLE IX

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1</td>
<td>918.73</td>
<td>918.73</td>
<td>7.68</td>
<td>.006</td>
</tr>
<tr>
<td>Within Groups</td>
<td>239</td>
<td>28578.11</td>
<td>119.57</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
<td>29496.84</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
Table X shows that the mathematics experimental group's posttest means were greater than the control group's posttest means.

TABLE X

MEAN AND ADJUSTED MEAN SCORES ON TOTAL MATH ACHIEVEMENT TEST SCORES OF MATHEMATICS EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest Mean</th>
<th>SD</th>
<th>Posttest Obtained Mean</th>
<th>SD</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Experimental</td>
<td>123</td>
<td>60.02</td>
<td>17.28</td>
<td>75.63</td>
<td>5.05</td>
<td>75.15</td>
</tr>
<tr>
<td>Mathematics Control</td>
<td>119</td>
<td>58.70</td>
<td>16.21</td>
<td>70.74</td>
<td>4.81</td>
<td>71.24</td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td>59.37</td>
<td>16.24</td>
<td>72.68</td>
<td>4.96</td>
<td>. . .</td>
</tr>
</tbody>
</table>

Since the total math score was obtained from the total of the raw scores of the three mathematics subtests and a significant difference was found for total math scores, each of these subtests was analyzed separately. The results for each subtest are presented below.

For the Concepts subtest, the F of 7.97 shown in Table XI was significant at the .005 level. This indicates that at least a part of the overall difference in math achievement test scores was due to the Concepts subsection.
TABLE XI

ANALYSIS OF COVARIANCE RESULTS FOR MATH SUBTEST CONCEPTS ACHIEVEMENT TEST SCORES OF THE MATHEMATICS EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1</td>
<td>92.24</td>
<td>92.24</td>
<td>7.97</td>
<td>.005</td>
</tr>
<tr>
<td>Within Groups</td>
<td>239</td>
<td>2765.18</td>
<td>. .</td>
<td>. .</td>
<td>. .</td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
<td>2857.42</td>
<td>. .</td>
<td>. .</td>
<td>. .</td>
</tr>
</tbody>
</table>

The adjusted mean scores on the Concepts subtest were greater for the CAI experimental mathematics group than for the control group. Table XII shows an adjusted mean score for the experimental group of 34.16 as compared with 31.72 for the control group.

TABLE XII

MEAN SCORES AND ADJUSTED MEAN SCORES ON MATH SUBTEST CONCEPTS ACHIEVEMENT TEST SCORES OF MATHEMATICS EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Obtained Mean</td>
</tr>
<tr>
<td>Mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>123</td>
<td>19.37</td>
<td>5.35</td>
<td>34.32</td>
</tr>
<tr>
<td>Mathematics</td>
<td>119</td>
<td>19.38</td>
<td>4.98</td>
<td>31.55</td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Reading Experimental)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td>19.37</td>
<td>5.16</td>
<td>32.94</td>
</tr>
</tbody>
</table>
As shown in Table XIII, the F obtained as a result of covariance on the math subtest Problem Solving was .86, which was not significant. This suggests that the overall difference in math achievement test scores was not due to the Problem Solving subsection.

**TABLE XIII**

ANALYSIS OF COVARIANCE RESULTS FOR MATH SUBTEST PROBLEM SOLVING ACHIEVEMENT TEST SCORES OF THE MATHEMATICS EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1</td>
<td>12.88</td>
<td>12.88</td>
<td>.86</td>
<td>.356</td>
</tr>
<tr>
<td>Within Groups</td>
<td>239</td>
<td>3593.08</td>
<td>15.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
<td>3605.96</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For the mathematics subtest Problem Solving, the posttest means for the CAI mathematics experimental group were slightly higher than the posttest means for the mathematics control group. Table XIV lists the adjusted means for the experimental group as 17.56 and the adjusted means for the control group as 17.10.
TABLE XIV

MEAN SCORES AND ADJUSTED MEAN SCORES ON MATH SUBTEST PROBLEM SOLVING ACHIEVEMENT TEST SCORES OF MATHEMATICS EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean  SD</td>
<td>Obtained Mean SD</td>
</tr>
<tr>
<td>Experimental Mathematics</td>
<td>123</td>
<td>14.72 5.01</td>
<td>17.74 5.13</td>
</tr>
<tr>
<td>Mathematics Control (Reading Experimental)</td>
<td>119</td>
<td>14.21 5.26</td>
<td>16.92 5.57</td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td>14.47 5.13</td>
<td>17.33 5.36</td>
</tr>
</tbody>
</table>

For Computation, the third math subtest, the F reported in Table XV was significant at the .004 level. This indicates that at least a part of the overall difference in math achievement scores was due to the Computation subsection.

TABLE XV

ANALYSIS OF COVARIANCE RESULTS FOR MATH SUBTEST COMPUTATION ACHIEVEMENT TEST SCORES OF MATHEMATICS EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1</td>
<td>358.78</td>
<td>358.78</td>
<td>8.52</td>
<td>.004</td>
</tr>
<tr>
<td>Within Groups</td>
<td>239</td>
<td>10061.13</td>
<td>42.10</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
<td>10419.91</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
Posttest mean scores shown in Table XVI were higher for the CAI experimental group. The experimental group's adjusted mean score was 34.72, while the control group's adjusted mean score was 31.55.

**TABLE XVI**

MEAN SCORES AND ADJUSTED MEAN SCORES FOR MATH SUBTEST COMPUTATION ACHIEVEMENT TEST SCORES OF THE MATHEMATICS EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th></th>
<th></th>
<th>Posttest</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Adjusted Mean</td>
</tr>
<tr>
<td>Mathematics</td>
<td>123</td>
<td>25.76</td>
<td>8.84</td>
<td>34.32</td>
<td>7.96</td>
<td>34.16</td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mathematics</td>
<td>119</td>
<td>25.20</td>
<td>8.01</td>
<td>31.55</td>
<td>8.35</td>
<td>31.72</td>
<td></td>
</tr>
<tr>
<td>Control (Reading</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td>25.48</td>
<td>8.43</td>
<td>32.94</td>
<td>8.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Hypothesis Six**

Hypothesis six was stated: There will be no significant difference in the total mathematics achievement posttest scores of the boys and the total mathematics achievement posttest scores of the girls within the Computer-Assisted Instruction mathematics group.

The F reported in Table XVII for total math was .319 which was not significant at the .05 level; therefore, the hypothesis was retained.
TABLE XVII

ANALYSIS OF COVARIANCE RESULTS FOR TOTAL MATH ACHIEVEMENT TEST SCORES OF BOYS AND GIRLS IN THE MATHEMATICS EXPERIMENTAL GROUP

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1</td>
<td>32.70</td>
<td>32.70</td>
<td>.319</td>
<td>.573</td>
</tr>
<tr>
<td>Within Groups</td>
<td>239</td>
<td>12311.50</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
<td>12344.20</td>
<td>.</td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>

The adjusted mean scores for both boys and girls for total math are presented in Table XVIII. The boys’ adjusted mean scores of 76.14 was slightly higher than the girls' adjusted mean score of 75.10.

TABLE XVIII

MEAN SCORES AND ADJUSTED MEAN SCORES FOR TOTAL MATH ACHIEVEMENT TEST SCORES OF BOYS AND GIRLS IN THE MATHEMATICS EXPERIMENTAL GROUP

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Obtained Mean</td>
</tr>
<tr>
<td>Boys</td>
<td>63</td>
<td>58.02</td>
<td>18.42</td>
<td>77.56</td>
</tr>
<tr>
<td>Girls</td>
<td>60</td>
<td>61.94</td>
<td>15.89</td>
<td>73.62</td>
</tr>
<tr>
<td>Total</td>
<td>123</td>
<td>60.38</td>
<td>17.28</td>
<td>75.59</td>
</tr>
</tbody>
</table>
Since no significant difference was found for total math, individual analysis of the subtests was not necessary.

**Hypothesis Seven**

Hypothesis seven stated: The attitude toward mathematics as a subject posttest scores of fourth grade students who have participated in a CAI mathematics program will be significantly higher than the attitude toward mathematics as a subject posttest scores of the control group.

Analysis of covariance results presented in Table XIX produced an F of .0904 which was not significant at the .05 level; therefore the hypothesis was rejected.

**TABLE XIX**

ANALYSIS OF COVARIANCE RESULTS ON ATTITUDE TOWARD MATHEMATICS TEST SCORES FOR THE MATHEMATICS EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1</td>
<td>2.64</td>
<td>2.64</td>
<td>.090</td>
<td>.764</td>
</tr>
<tr>
<td>Within Groups</td>
<td>239</td>
<td>6986.72</td>
<td>29.23</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Total</td>
<td>240</td>
<td>6989.36</td>
<td></td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

As shown in Table XX the adjusted mean scores on the attitude scale of the CAI mathematics group was 19.14 and the adjusted mean scores of the control group was 19.35.
TABLE XX

MEAN SCORES AND ADJUSTED MEAN SCORES FOR ATTITUDE TOWARD MATHEMATICS TEST SCORES OF THE MATHEMATICS EXPERIMENTAL AND CONTROL GROUPS

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest Mean</th>
<th>SD</th>
<th>Posttest Obtained Mean</th>
<th>SD</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Experimental</td>
<td>123</td>
<td>18.82</td>
<td>5.63</td>
<td>18.98</td>
<td>4.44</td>
<td>19.14</td>
</tr>
<tr>
<td>Mathematics Control (Reading Experimental)</td>
<td>119</td>
<td>19.62</td>
<td>5.74</td>
<td>19.50</td>
<td>7.04</td>
<td>19.35</td>
</tr>
<tr>
<td>Total</td>
<td>242</td>
<td>19.22</td>
<td>5.69</td>
<td>18.74</td>
<td>6.20</td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis Eight

Hypothesis eight stated: There will be no significant difference in the posttest scores on attitude toward mathematics as a subject of boys and the posttest scores of attitude toward mathematics as a subject of girls within the experimental group.

As shown in Table XXI, the F of 10.02 obtained as a result of analysis of covariance was significant at the .002 level; therefore, the hypothesis was rejected.
TABLE XXI

ANALYSIS OF COVARIANCE RESULTS FOR ATTITUDE TOWARD MATHEMATICS TEST SCORES FOR BOYS AND GIRLS WITHIN THE MATHEMATICS EXPERIMENTAL GROUP

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>1</td>
<td>307.24</td>
<td>307.24</td>
<td>10.02</td>
<td>.002</td>
</tr>
<tr>
<td>Within Groups</td>
<td>120</td>
<td>3679.05</td>
<td>30.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>121</td>
<td>3986.29</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The adjusted mean score on attitude toward mathematics as a subject was higher for girls than for boys within the CAI experimental mathematics group as indicated in Table XXII. The adjusted mean for the boys was 17.42 and the adjusted mean for the girls was 20.63.

TABLE XXII

MEAN SCORES AND ADJUSTED MEAN SCORES ON ATTITUDE TOWARD MATHEMATICS TEST SCORES FOR BOYS AND GIRLS WITHIN THE MATHEMATICS EXPERIMENTAL GROUP

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Boys</td>
<td>63</td>
<td>17.97</td>
<td>6.22</td>
<td>17.10</td>
</tr>
<tr>
<td>Girls</td>
<td>60</td>
<td>19.72</td>
<td>4.83</td>
<td>20.97</td>
</tr>
<tr>
<td>Total</td>
<td>123</td>
<td>18.84</td>
<td>5.63</td>
<td>19.03</td>
</tr>
</tbody>
</table>
Discussion

Reading

Analysis of the data for this study shows that for reading comprehension the control group's adjusted mean score was significantly higher than the CAI experimental reading group's adjusted mean scores. The CAI experimental reading group experienced extensive software problems. The software problems may have hampered the experimental reading group's achievement gains which might have otherwise resulted from the computer instruction. No other reading studies were found in which the control group scored significantly higher. Suppes and Morningstar (1969) did report that in one control school in Stanford's CAI Math Program, grades four and five did significantly better than those grades for the experimental school, but in that case the control group had been given extra classroom drill. No evidence was found in this study to indicate that anything unusual was done in the control group's reading classrooms to account for the students' scoring higher in reading comprehension than the experimental group. Swinton, et al (1978) reported a negatively significant CAI result with reading in the primary grades which he attributed at least partially to machine and material problems. Hardware problems were experienced in the present study but not extensively in either the CAI reading group or the CAI mathematics group. It was
felt that the CAI Reading group's software problems could be a major factor in the posttest results. There was only a very limited amount of software available and the reading experimental group was further hampered by the software constantly having to be sent in for repair. About two weeks prior to the Christmas holidays, the lab at the larger CAI reading school had to be closed down until after the holidays because so much software was out of order. This not only lessened the total time on task for the CAI experimental group but made the time span between computer sessions almost a month for that particular school; whereas, the other schools only had the two week holiday period between computer sessions. The students in the mathematics experimental group had about thirty three hours of CAI as did the smaller reading experimental school. The students of the larger experimental reading school had only about thirty and one half hours of CAI.

The needs of the brighter students were probably not met by the CAI reading program. When diagnostic testing was done at the beginning of the school year, quite a few students scored mastery at the top level, but since no advanced material was available, the students were moved down several levels in order to give them something to do.

Since the software was of the drill-and-practice mode, ideally a skill should have been taught in the classroom, then immediately followed up with use of software on that same skill. Due to the scarce supply of software, compounded
by problems with the software, this was impossible since the structure of this particular software would not permit loading an entire lesson from a disk into other computers. While waiting for other children to finish a certain CAI skill lesson which had been taught in the classroom, some students had to use disks on skills which had not yet been taught or which had not been taught recently. Since the software was not tutorial in nature, some of the students were often frustrated, and it is possible that some of this frustration carried over into the classroom causing the students to not do their best.

No significant difference was found in the reading comprehension posttest scores of boys and the reading comprehension posttest scores of girls within the CAI reading group. The girls scored higher than the boys and analysis of covariance showed a significance level of .052 which was only slightly beyond the .05 level set for rejection of the hypothesis. Anelli reported that girls did better than boys in her CAI reading study. No other studies in reading were found which compared differences in girls' scores and boys' scores.

The results of this study do not agree with the results of Grocke (1982), Sandman and Welch (1978) in the Sauk Centre Program, and Litman (1977), all of which showed significant differences in reading comprehension posttest scores in favor
of the experimental groups, nor, on the other hand do they agree with Easterling (1982), Levy (1982), Sandman and Welch (1978) for the St. Cloud and Red Wing programs, all of which showed no significant differences.

There was a significant difference in posttest scores on attitude toward reading in favor of the experimental group. Since attitude improvement seems often to foster achievement improvement then perhaps in subsequent years CAI in Garland Independent School District will improve reading comprehension if adequate software is provided. Swinton, et al (1978) reported attitude improvement towards reading but no other studies were found to affirm or refute these findings. Anelli (1977) reported diminished enthusiasm after a few hours of CAI.

There was no significant difference between reading attitude posttest scores of boys and reading attitude post-test scores of girls within the experimental group.

**Mathematics**

There seem to have been more studies done in mathematics than in reading and there also seems to have been more success with CAI mathematics experiments than with CAI reading experiments. The present study affirms the pattern of greater success in the CAI mathematics group. There is the possibility that the results of this study can be partly attributed to the fact that the math software was more durable than the reading software and much less repair was needed. The
courseware also could be used effectively for immediate follow up of classroom teaching. The program was structured so that about twenty five problems could be loaded from the disk into other computers, thus enabling all students to work on the same skill at the same time.

For total math (Concepts + Math Problem Solving + Computation ITBS subtest raw scores) the CAI experimental group scored significantly higher on the posttest than the control group. These results concurred with those of Suppes and Morningstar with the exception of one school, (1969), Warner (1981), Palmer (1973) in one school, Mc Connell (1984), Miller (1984), and Sandman and Welch (1979) for the Sauk Centre program. Also showing meaningful gains in mathematics achievement in CAI experiments were Dorsey and Burleson (1983), Hotard and Cortez (1983) and Delforge and Bloeser (1977). The results did not agree with Easterling (1982), and Sandman and Welch (1978) for the Red Wing and St. Cloud programs, which showed no significant differences in posttest scores.

When subtests were individually analyzed, it was found that the experimental group also scored significantly higher on posttests for the Concepts and Computation subtests. On the Math Problem Solving subtests there was no significant difference in the posttest scores.
No significant difference was found in the total math achievement posttest scores of boys and the total math achievement posttest scores of girls within the CAI mathematics experimental group.

There was no significant difference in attitude toward mathematics posttest scores of the experimental group and attitude toward mathematics posttest scores of the control group. This does not concur with Swinton, et al (1978) whose study showed a significant attitude improvement in favor of the experimental group. There was, however, a significant difference within the CAI mathematics experimental group in the mathematics attitude posttest scores of girls and the mathematics attitude posttest scores of boys with the girls scoring higher. This seems to indicate that the CAI mathematics drill-and-practice program, by improving the mathematics skills of girls, may have in turn improved the girls' self concepts regarding their mathematics ability and thus improved their attitude towards mathematics. Warner (1981) reported positive shifts in mathematics self concept but did not address attitude toward mathematics as a subject.

Chapter Summary

In Chapter IV the data was presented and analyzed both in writing and in tables. Each hypothesis was stated
and statements were made as to the retaining or the rejecting of each hypothesis. A discussion of the findings concluded the chapter.
CHAPTER BIBLIOGRAPHY


CHAPTER V

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to determine the effects of Computer-Assisted Instruction on reading comprehension and mathematics achievement as well as on attitudes toward these subjects. The study was conducted in the Garland Independent School District, Garland, Texas, during the 1983-1984 school year.

The population for this study included the entire fourth grade classes of four elementary schools in Garland. A total of 302 students made up the initial population, but this number diminished to 242 due to excessive absences, moving or missing one of the pretests or posttests.

The fourth grade students of two Garland elementary schools made up the CAI mathematics experimental group and used Milliken Math Sequences courseware. The fourth grade students of two other Garland elementary schools made up the CAI reading experimental group and used Diascriptive Reading courseware. The CAI mathematics group acted as a control for the CAI reading group and vice versa.
The students were pretested for achievement in reading comprehension and mathematics achievement the first week in October, 1983, and were posttested the last week of April, 1984. The Iowa Tests of Basic Skills, Level 10, Form 7/8 was the testing instrument used for this purpose.

Attitude toward reading and toward mathematics was pretested the third week in September, 1983, and posttested the first week of April, 1984. The Estes Attitude Scale (Elementary Level) was used to evaluate attitudes.

The data collected from these tests was analyzed using analysis of covariance. The results obtained from this analysis of data was used as a basis for retaining or rejecting the null hypothesis. The null hypothesis was rejected if the significance level shown in the analysis of covariance was equal to or less than .05.

Findings

The findings for this study were as follows.

1. The posttest scores on Reading Comprehension, as measured by the Iowa Tests of Basic Skills, were significantly higher for the control group than for the CAI reading experimental group.

2. There was no significant difference on Iowa Tests of Basic Skills posttest scores in Reading Comprehension of boys and Iowa Tests of Basic Skills posttest scores of girls in Reading Comprehension within the CAI reading group.
3. For total math scores (Concepts + Math Problem Solving + Computation subtests ITBS raw scores) there was a significant difference in the posttest scores of the experimental group and posttest scores of the control group in favor of the experimental group.

4. On the mathematics subtests of the Iowa Tests of Basic Skills there was a significant difference in the posttest scores of the CAI experimental group and the control group for the subtests Concepts and Computation with the experimental group scoring higher. There was no significant difference between posttest scores of the two groups for the Math Problem Solving subtest.

5. For total math scores there was no significant difference in posttest scores of boys and posttest scores of girls within the experimental group.

6. There was a significant difference in the attitude toward reading posttest scores of the CAI reading experimental group and the reading control group, with the experimental group scoring higher.

7. There were no significant differences in reading attitude posttest scores of boys and reading attitude posttest scores of girls within the reading experimental group.

8. There was a significant difference in attitude toward mathematics posttest scores of the CAI mathematics experimental group and the control group, with the experimental group scoring higher.
9. There was a significant difference in posttest scores for attitude toward mathematics of boys and posttest scores for attitude toward mathematics of girls within the CAI mathematics group, with the girls scoring higher.

Conclusions

The findings for this study led to the following conclusions.

1. The Milliken Math Sequences courseware did produce significant gains in mathematics achievement.

2. The mathematics courseware (Milliken Math Sequences) was more durable than the reading courseware (Diascriptive Reading) and the structure of the math courseware permitted wider use of the material.

3. The drill-and-practice mode of CAI does not appear to be as well suited for teaching reading as for teaching mathematics.

4. Diascriptive Reading courseware apparently had a positive effect on the students' attitudes toward reading.

5. Milliken Math Sequences courseware seemed to be especially effective in influencing the attitudes of girls toward mathematics.

Recommendations

Based on the findings and conclusions of this study the following recommendations are made.
1. It is recommended that selection of CAI courseware include very careful consideration of how well the program can be correlated with the regular classroom instructional program.

2. It is recommended that drill-and-practice software not be used for reading instruction unless adequate disks are available to allow immediate follow-up of classroom instruction.

3. It is recommended that CAI courseware be carefully reviewed before it is purchased to ascertain that all levels of students are provided with material appropriate to their needs.

4. Further research is needed on an ongoing basis as more CAI software is produced to determine relative effects of various courseware as to achievement, and follow-up studies are needed to determine whether attitude gains such as those shown in this study subsequently lead to achievement gains.
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