THE EFFECTS OF COMPUTER ASSISTED INSTRUCTION
AS A SUPPLEMENT TO CLASSROOM INSTRUCTION
IN READING COMPREHENSION AND ARITHMETIC

DISSERTATION

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

For the Degree of

DOCTOR OF EDUCATION

By

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The present research was an investigation of the effects of computer assisted instruction as a supplement to classroom instruction in reading and arithmetic.

The purposes of this study were to determine the effectiveness of microcomputer usage in supplemental reading comprehension and math instruction.

Utilizing an elaboration of the pre-test, posttest control group design, 66 fifth graders completed the 4-month study. One-way analysis of covariance was used to analyze the data.

The findings include the following.

1. Scores for Reading Comprehension on the California Achievement Test, Level 15, Form C, of the reading experimental group did not differ significantly from scores for Reading Comprehension of the reading control and the control group.

2. Scores for Total Math on the California Achievement Test, Level 15, Form C of the math experimental group did not differ significantly from scores for Total Math for the math control and the control group.
The following conclusions were drawn.

1. Using the SRA Computer Drill and Instruction: Mathematics courseware and the MicroSystem80 Critical Reading Series courseware two fifteen minute sessions weekly for sixteen weeks does not significantly improve the Total Math or Reading Comprehension on the California Achievement Test.

The following recommendations were made.

1. It is recommended that a study be conducted using a larger sample and allowing students more computer time.

2. Further research in the area of CAI as a supplement to classroom instruction is justified.

3. It is recommended that courseware be validated before it is brought into a district for classroom use.

4. It is recommended that other studies include affective measures to gather qualitative data concerning student attitudes toward the computer.

5. It is recommended that other studies include measures of computer literacy to gather quantitative data concerning student knowledge of the computer.
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CHAPTER I

INTRODUCTION

The concept of individualizing instruction has been extensively discussed in the literature for the last century. It is not surprising, then, that with the educational system under constant criticism regarding its unresponsiveness to the needs of individual students, that there should be a renewed attempt to tailor traditional teaching procedures to fit the individual student (Trueblood, 1972).

Due to the rapid, constant change of technology today, CAI (Computer Assisted Instruction) may be an answer to this need for individualization. CAI is a relatively new idea in education, as are computers.

The first electromechanical computer, the Mark I, was developed at Harvard University in 1945. It was large and bulky. By 1950, there were only twelve computers in the United States. By 1960, the number had risen to 6,000. Today, there are more than 75,000 large, general purpose computers (U.S. House, 1978).

The large computer, however, was not a very practical consideration for education. It was not until computers were improved, made smaller, and produced considerably cheaper that they became a possibility for classroom use.
These changes came with the development of the smaller "mini-computer" and finally the microprocessor chip, which made possible the microcomputer.

The chip was developed in 1971, but it was not until several years later that a complete "off-the-shelf" microcomputer was available for educational use. This included the Commodore PET and the Radio Shack TRS-80. These were followed by the TI 99/4, Apple, and Atari. Many applications of these microcomputers can be seen in society, from business to law, to medicine, to industry, and finally to education. Thousands of micros have been purchased by school districts across the country for use in the classroom. Most of these have been purchased for the use of CAI (Poirot, 1980). Cost, availability, and the ease of installation are considerations causing educators to take a close look at micros (Joiner, 1980).

CAI has been utilized in schools as a supplement to different subject matters. It can be used to teach new concepts or to reinforce previously learned experiences (Isaacson, 1980). CAI is divided into several modes: drill-and-practice, tutorial, and simulation. The drill-and-practice mode is widespread, because the lessons are the easiest to prepare and can be used to free the teacher from the drudgery of writing or grading practice sheets. In the tutorial mode, students are presented with instruction
interspersed with appropriate questions. Question formats may be multiple choice, matching, fill-in-the-blank, etc.

The simulation mode is perhaps the most exciting mode, for it allows the student to use the computer as a tool to discover and generate new information. Lessons exist which allow students to simulate science experiments, checking account procedures, driving a car, and many more (Isaacson, 1980).

The great educational promise of CAI lies in its ability to individualize and personalize the instructional process. CAI lessons can serve as a test, a text, and a tutor, while it demands the student to be an active, not passive participant in learning (Magidson, 1978). Students can work at their own pace, while their CAI lessons monitor their progress and commonly prevent them from advanced units until mastery of a certain skill is demonstrated. Students receive immediate feedback on their progress. CAI is also flexible. It is patient with alternative answers and solutions. It can accept misspellings or have students correct such errors.

Though CAI has its advantages, it is not without its problems. These can be divided into two groups: system problems—which are associated with the machine, and people problems.

Probably foremost among system problems is expense. Though technology has decreased the costs of the machine,
software and maintenance are still too expensive for some school budgets to justify. For those who are able to afford computers, there is the question of cost-effectiveness. This brings several questions to mind. Is it worth the cost? Is it reliable or is the system often "down"? Some of these problems can be lessened by a good system, but some still exist with the best of systems.

People problems, where they exist, lie with teachers. Students are generally very accepting when CAI is introduced in the classroom. It is the teachers that sometimes offer resistance. The teachers who are reluctant to use computers are usually those who have not been properly trained in the use of computers. These teachers usually fear the computer and see it as a threat to them as educators. If proper in-service training is offered, many of these teachers see the computer as an enhancement to their efforts.

The past decade of instructional computing experience has convinced educators that the selection of the proper computer for the classroom is only part of the job. The selection of educational software, or courseware, is of equal importance.

Rapid growth of microcomputer usage by public schools has been accompanied by the entrance of large publishing companies such as Borg-Warner and SRA into the computer software market. These companies have the time, money, and
resources to produce courseware that is tutorial in nature rather than drill and practice. This courseware is very expensive. Schools need information regarding the effectiveness of the new courseware so as to make sound economic decisions.

It was the intent of this study to determine the relative effectiveness of two courseware packages presently on the market for elementary school use. The July 1980 issue of Computer stated,

The ultimate success of microcomputer based learning will depend on a convincing proof of its effectiveness (Aiken, 1980).

Purposes of the Study

The purposes of this study were.

1. to determine the relative effectiveness of microcomputer usage in supplemental reading comprehension;

2. to determine the relative effectiveness of microcomputer usage in supplemental math instruction.

Hypotheses

The following hypotheses were tested.

1. The reading achievement scores of the reading experimental group will be significantly higher than the reading achievement scores of the control group and the experimental math group.
2. There will be no significant difference between the reading achievement scores of the math experimental group and control group.

3. The math achievement scores of the math experimental group will be significantly higher than the math achievement scores of the control group and the experimental reading group.

4. There will be no significant difference between the math achievement scores of the reading experimental group and control group.

Significance of the Study

Although microcomputer usage is increasing in schools today, little is currently known about the effectiveness of the existing courseware for these computers. More empirical research needs to be accomplished.

Numerous studies report the effectiveness of CAI, but most of these have evaluated courseware for minicomputers or even mainframes (Abramson, 1971; Lysiak, 1976; Morgan, 1977; Palmer, 1973; Suppes, 1969; Swinton, 1978; Wells, 1974). Few studies have evaluated courseware for microcomputers.

Most of the courseware that has been tested has been of the drill-and-practice mode. This is probably because there is more of this type available. Another area in which
research is needed is in the evaluation of tutorial course-
ware, that is, courseware that instructs the learner, as
well as provides practice. In the few studies that have
been conducted on tutorial courseware, the students'
computer time was not always accurate (Abramson, 1971;
Lysiak, 1976; Morgan, 1977; Palmer, 1973; Results, 1979;
Suppes, 1969; Wells, 1974).

This study focused on measuring the effectiveness of
the microcomputer courseware packages designed specifically
to supplement reading and math instruction.

Definition of Terms

For the purpose of this study, the following terms
were accepted:

1. **microcomputer** - a small computer whose entire
   computing system is contained on a microprocessor
   chip

2. **hardware** - the machine itself and any of the
   peripheral devices

3. **software** - the instructions for the computer
   which are resident in memory at the time they
   are being executed

4. **courseware** - software with a specific educational
   application

5. **CAI** - Computer Assisted Instruction - the use of
   the computer for the direct instruction of students
6. CRT - Cathode Ray Tube - the video screen on which the typed information from the computer is displayed

7. computer time - actual time the student spends working at the computer

Limitations

The structure of the reading and math courseware may be a limiting factor to the generalizability of the findings of this study to other reading and math courseware products.

Procedures for Collecting Data

Names of the potential subjects were secured from a large, suburban district. Consent to collect the necessary data was obtained from the parents of each of the subjects. This permission letter is displayed in Appendix A.

Permission to conduct the study was granted from the assistant superintendent in the fall of 1981. The proposed study was fully explained and described including the hypotheses to be tested, the population to be used, the data to be gathered, a description of instruments to be used and the procedures for collecting and analyzing the data. Principals were notified and agreed to cooperate.

The pretest was the Total Math and Reading Comprehension scores of the California Achievement Test, Level 15, Form C, administered in October of 1981 by the district. These scores
were collected from student records, after permission letters were returned by the parents.

Research Design

The basic research model was an elaboration of Campbell and Stanley's true experimental design four (Campbell & Stanley, 1966). Stratified random assignments by sex were made to experimental and control groups. The groups were not intact classes, but rather, were drawn from the entire fifth grades at three elementary schools. The pretest and posttest were administered to all groups. A schematic outline of the design follows where R denotes random assignment, O's pre and posttests and X is treatment.

<table>
<thead>
<tr>
<th>Group</th>
<th>Experimental Activity</th>
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<td>Group A</td>
<td>(Experimental Math)</td>
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<td>R O X O</td>
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<td>Group B</td>
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<td>R O X O</td>
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<td>Group C</td>
<td>(Computer Control)</td>
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<td>R O 0</td>
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<tr>
<td>Group A</td>
<td>(Experimental Reading)</td>
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<td></td>
<td>R O X O</td>
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<tr>
<td>Group A</td>
<td>(Reading Control)</td>
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<td>R O X O</td>
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<tr>
<td>Group C</td>
<td>(Computer Control)</td>
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<td>R O 0</td>
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In the first comparison, measuring math achievement, Group A was the experimental math group, using the SRA Computer Drill and Instruction: Mathematics courseware as the treatment. Group B was the control group, using the
MicroSystem80 Critical Reading Skills courseware as treatment. Group C was the independent control group and received no treatment.

In the second comparison, measuring reading comprehension, Group B was the experimental reading group, using the MicroSystem 80 Critical Reading Skills courseware as the treatment. Group A was the control group, using the SRA Computer Drill and Instruction: Mathematics courseware as the treatment. Group C was the independent control group and received no treatment. Campbell and Stanley's design four controls for history, maturation, testing, instrumentation, regression, selection, mortality, and interaction of selection and maturation. Possible sources of invalidity in this design are interaction of testing and x, interaction of selection and x, and reactive arrangements. The researcher typed the posttest to minimize the effects of the interaction of testing and x. The typing of the test made the test as close to an on-going, daily test, as possible. Written permission was granted from McGraw-Hill (See Appendix B).

The variables were as follows:

1. Dependent variable -- student posttest scores on total math and reading comprehension of the California Achievement Test, Level 15, Form C.

2. Independent variable -- student pretest scores on total math and reading comprehension of the California Achievement Test, Level 15, Form C.
Procedures for the Analysis of Data

The basic statistical methodology was one-way analysis of covariance. The resulting $F$ values were tested for significance at the .05 level.

Chapter Summary

Studies reviewed in this chapter indicate that the effectiveness of courseware for the microcomputer still needs to be studied. The purposes of this study were to determine the relative effectiveness of microcomputer usage in supplemental reading comprehension and math instruction. Hypotheses, definition, and limitations were stated. The significance of the study, the procedures for collecting the data, and the research design were presented.
CHAPTER BIBLIOGRAPHY


CHAPTER II

REVIEW OF RELATED RESEARCH

There have been numerous attempts at using CAI in the elementary school classroom. For the last two decades, teachers have implemented various CAI programs in different subject areas, especially in the fields of reading and math. Most of the courseware that has been tested has been drill-and-practice. This is probably because there is more of this type available, due to the fact that drill-and-practice is easiest to construct.

Patrick Suppes has conducted some of these studies. He believes CAI has many potential applications especially at the elementary level. It can teach skill subjects such as math and reading. He believes that computer technology is the only real hope for individualization (Suppes, 1965).

Drill-and-Practice Courseware

One of Suppes' studies was conducted in a California school. It included matched groups. Results using t-tests showed students' progress were positive in mathematics achievement in grades 1-6 for a drill-and-practice program. The Stanford Achievement Test was used for pretest and posttest scores. In this case, as in most, CAI was used as a supplement to traditional classroom instruction.
Students spent five to eight minutes of computer time at Model 33 teletypes connected to PDP-1 computers at Stanford University. However, with machine reliability being a constant problem in this experiment, students' computer times were not always accurate. Also, the fact that students worked on the computer in an unfamiliar environment, at Stanford, was not taken into account (Suppes, 1969).

A similar study by Suppes was conducted in Mississippi. He reported that all experimental groups using CAI had greater improvement than non-CAI students in mathematics. The greatest gain occurred in grade 1. In only three months, the average increase in grade placement was 1.14 as compared with .26 for control students (Suppes, 1969).

A drill-and-practice STRANDS program, developed by the Computer Curriculum Corporation in Palo Alto, California, was used as the treatment in an experiment in California. Palmer (1973) reports from pretest and posttest comparison that the mean gains for the CAI students were greater than the mean gains for the non-CAI students though the differences were not statistically significant. Students received five to ten minutes of computer time daily.

CAI Among the Economically Deprived

Suppes reported, in another study, that in a tutorial math program with first and second graders in a deprived California classroom, CAI had a statistically significant
positive effect on slow learners in grade 1. In this experiment, the pretest and posttest used was the Stanford Binet Test. Lessons in this case were short, as was the computer time.

In reading, when ninety of the first grade students from the deprived California classroom mentioned in the Suppes study above were tested, no significant gains were found for high and medium level students. These groups were ranked according to reading scores on Scholastic Achievement Tests. However, in the low reading group, the experimental portion using the tutorial program, scored significantly higher on the Stanford Achievement Test. One weakness to the study, though, was that students were not randomly selected to groups. This makes comparison of groups difficult (Suppes, 1969).

Roman (1975) reported a study with suburban fourth and fifth grade lower middle class students. Students using CAI scored higher on the Stanford Achievement Tests than did the non-CAI group. Students were randomly selected, with the experimental students using the computer differing amounts of time, along with traditional classroom instruction. The control group, however, received no computer instruction.

A study in the Fort Worth Independent School District involved 2298 educationally deprived students in grades 3-7 in eight elementary and middle schools. The CAI program used in the study was composed of STRANDS in math, reading,
and language arts. Each student worked ten minutes daily in reading and another ten minutes in another subject, language or math. Middle school students worked longer. The Iowa Test of Basic Skills was used for pre- and posttest results. The computer time was not completely supplemental, since some time overlapped with class time. Results were mixed. Both CAI and control groups were equally effective in achieving reading gains. Elementary math gains generally favored CAI students (Lysiak, 1976).

CAI As a Supplement to Instruction

A program in Bath Elementary School in Ohio focused its attention on sixth grade students. One hundred sixth graders used the computer daily for supplemental help in reading, math, and vocabulary. Preliminary scores reported that students gained an average of 2.4 months in reading proficiency during the months they used the computer. This gain was higher than the score of the months the computer was used. The regularity of computer time was carefully monitored, though the actual time spent on the computer was not (Results of Computer, 1979).

Durward (1973) reported on a study in Vancouver that CAI improved math skills for CAI students in a group of 87 sixth and seventh graders. Subjects were not randomly selected, but were volunteers who wished to work with CAI. When CAI was used in addition to traditional classroom
instruction, CAI was found to be superior to the equivalent amount of classroom instruction. None of the results were statistically significant.

In a New York study, Abramson and Weiner reported that elementary students' achievement test scores in grades two through six showed no consistent pattern favoring CAI or non-CAI groups. However, in the fifth grade, significant scores favored CAI pupils. Otherwise, scores were scattered with no consistent pattern. The design of the study was unclear in the report. This and the lack of control of student computer control were the weaknesses of the study (Abramson, 1971).

Morgan reported a study using OWN, a CAI approach to the four arithmetic operations, used in nine elementary schools in 1975-76. The largest schools in Maryland were used to compare the nine schools in the experimental group with the four in the control group. These schools were not chosen at random, but by size. CAI students in each grade, third through sixth, made statistically greater improvement than the control group, averaging from 1.1 to 3.6 months greater gains than the control group after 14 months. Analysis of covariance was used to examine pre- and posttest scores. Each student worked 20-30 minutes per week (Morgan, 1977).
A five-year evaluation on the Elementary Education Demonstration of the PLATO system at the University of Illinois, included CAI in reading and math. Preliminary results indicated that the math lessons were more readily used than the reading lessons. Perhaps this was due to more acceptance of computers from math teachers as opposed to reading teachers. The math group reported large gains in CAI groups among fourth through sixth graders (Swinton, 1978).

CAI for Remediation

A small study in the Log Cabin Elementary School in North Carolina involved students, using the computer ten minutes daily. Analysis shows that students in the lower 45 per cent had greater gains on the Iowa Test of Basic Skills than did those in the upper 55 per cent who received CAI only 10 minutes per week. The number of students in the lower and upper groups were 27 and 32 respectively. The higher group showed an 8 month improvement, as opposed to the 1 year 9 month improvement of the lower group. No statistics were run on the raw scores, however. Results were reported from use of raw scores only (Delforge, 1977).

Wells (1974) reported that CAI had a significant and positive effect on achievement with 446 fifth and sixth graders scoring below norm on the California Test of Basic Skills (CTBS) in most cases. Students were reported to
have worked five to ten minutes daily to weekly on math
 drill-and-practice. This computer time was not clearly
defined in the study. Students in the experimental and
control groups were also located in different school
buildings, which created some sources of invalidity which
could not be controlled, such as different teachers and
possibly different methods of instruction.

Weaknesses of Existing Research

Though numerous studies have been conducted in the area
of CAI effectiveness, many are not well-controlled as
mentioned. One of the common weaknesses is the failure to
control the amount of computer time the students spend on
the computer. In Roman's study (1975) the control group did
not even work on the computer at all. Randomization of
subjects was lacking in the Morgan (1977) and Durward (1973)
studies. Scores were not always adjusted to account for
initial differences, as was the case in the study in North
Carolina (Delforge, 1977). Another weakness is that most
of the reports of CAI effectiveness were based on studies
done with the drill-and-practice mode only.

Because of these weaknesses in many of the studies, it
is important to plan and conduct quality controlled research.
As is true of any new technology being applied to an area
where many existing skills and much knowledge is already
present, the results will be necessarily mixed. More research
is needed to clearly determine the effect of CAI in the elementary classroom.

Chapter Summary

In this chapter, studies were reviewed which indicate that CAI has been shown effective when used as a supplement to regular classroom instruction. Most of the studies have used CAI to supplement reading and mathematics instruction. Most of these studies used software of the drill-and-practice type. Few tested software of the tutorial type. Many of these studies report the effectiveness of software used on large computers, not microcomputers. These studies also did not carefully monitor the computer time of students. Times varied greatly from one subject to another.
CHAPTER BIBLIOGRAPHY


CHAPTER III

METHODS AND PROCEDURES OF THE STUDY

This study focused on the effectiveness of two courseware packages on the achievement of students in reading and math. Information regarding the methods and procedures of the investigation is subdivided into the following topics: description of the subjects, description of the software used as treatments, implementation of the treatment, collection of the data, and analysis of the data.

Description of the Subjects

Seventy-two subjects were selected for this study. The fifth grade students were from three different schools in a large suburban school district. Six boys and six girls were randomly selected from three schools. These students were matched according to sex, reading comprehension and total math scores to twelve additional students at the same school. In two schools, the matched pairs were then randomly assigned to one of the two treatments.

One group received the SRA math courseware as the treatment. The other group received the MicroSystem80 reading courseware as the treatment. The experimental group using the SRA math courseware served as
the control for the students using the MicroSystem80 reading courseware. In the same manner, the students using the MicroSystem80 courseware served as the control group for the students using the SRA math courseware.

The students in the third school served as the independent control with no treatment. Only sixty-six students actually completed the full length of the experiment, due to attrition.

Students were trained on the use of the microcomputer by the researcher, on a one-to-one basis in January of 1982. The entry level of each student was assessed by the diagnostic SRA and MicroSystem80 courseware.

All sixty-six subjects received regular classroom instruction in mathematics and reading. In addition, the two treatment groups spent two fifteen minute sessions per week using supplemental courseware in either reading or mathematics. A specific sign-up sheet was positioned beside the computer. The student signed in and out on the sheet each time he worked on the computer. A stick-on clock was attached to the computer so that students could record time-in and time-out when they used the computer. The researcher checked the sign-up sheets weekly at the two schools and also interviewed each child individually to confirm that the sign-in time was accurate. Make-ups were scheduled as needed on a one-to-one basis, if a student
missed for some reason. At the conclusion of the experiment in May, students had worked on the computer a total of four hours each.

Description of the Software

Two software packages designed for the Apple II Plus microcomputer were used as the treatments in this experiment. A description of each follows.

SRA Computer Drill and Instruction: Mathematics

The SRA Computer Drill and Instruction: Mathematics (Science Research Associates, 1981) is a software package that provides practice in basic arithmetic skills. It offers immediate feedback to the student and even tutorial instruction for the students upon request. A management program records student progress, continually diagnosing and providing exercises at appropriate levels of difficulty.

Organization

SRA CDIM is divided into three levels. The level used in this experiment is Level C, designed to teach skills practiced in grades 5 and 6. Level C provides practice in these areas:

- Addition
- Subtraction
- Multiplication
- Division
- Whole Numbers
- Fractions
- Decimals
The SRA package consists of eleven 5 1/4" drill and practice diskettes and 2 management diskettes. The drill-and-practice diskettes provide practice in the seven areas above. The two management disks, the STUDENT and TEACHER diskette, provide the record keeping capabilities.

Use of the Diskettes

The student inserts the STUDENT diskette and follows the instructions on the screen. The student is instructed to insert one of the eleven drill and instruction disks; the computer then calls up the appropriate lesson. When the student finishes a lesson, he may sign off or continue to the next lesson.

While working on a lesson, the student may request HELP by holding down the shift key and pressing the ? simultaneously. The HELP procedure is a short, instructional sequence. It shows the student how to work the problems in that particular lesson. When the HELP is finished, another problem will appear on the screen for the student. The student will continue in the progress mode. To finish, the student inserts the STUDENT diskette and records the work.

The TEACHER diskette is the second management diskette. It enables the teacher to view student records. To do this, the teacher inserts the STUDENT diskette and asks for records. Then, the teacher inserts the TEACHER diskette and follows directions.
The STUDENT diskette will also give the user other options, such as using the edit mode, the print mode, or the run mode. The edit mode can be used to add users to the system, delete users, or modify the number of the lesson which a student is working. The print option allows the user to print hard copies of reports, such as student position reports, class lists, graphic reports, and others. The reports can also be viewed on the screen. Seatwork can be specified and printed for extra student drill.

Operational Modes

The student can work in any of the three different modes provided in each of the seven areas of instruction. These three modes are: placement, progress, or practice. The placement mode determines the lesson on which the student will start. Once placed on a lesson, the student automatically moves from lesson to lesson on the basis of performance. If a student scores 80% or better, he advances to the next lesson. If the student scores less than 50%, he is given another chance. A second failure results in movement to a previous lesson, or a request to "see your teacher". Scores between 50% and 80% cause a repetition of the lesson. The third mode, the practice mode, is recorded, but does not affect the students' overall standing. It may be called up at different times, whenever the student needs extra practice on a particular lesson.
MicroSystem80 Critical Reading Series

The MicroSystem80 Critical Reading Series (Borg-Warner, 1980) is a software package that can be used as a supplement to any classroom reading program. The program introduces students to basic rules of logic and provides practice in reasoning skills. It offers immediate feedback for the students. These skills taught will help the student in overall reading comprehension. A management system maintains student records.

Organization

The MicroSystem80 reading program is appropriate for students at or beyond the third grade level, including middle grade students. Skills are arranged hierarchically, from simple to complex.

This program is divided into four units, with each unit directed toward the use of one of the following basic rules of logic:

- Unit 1-Rule for "Or" Elimination
- Unit 2-Rule for "All" Elimination
- Unit 3-Conditional Statements
- Unit 4-Inductive Reasoning

The contents of each of these units is divided between two 5 1/4" floppy diskettes; Unit 1 is contained on disks A & B; Unit 2 is contained on disks C & D; Unit 3 is contained on disks E & F; and Unit 4 is contained on disks G & H. Therefore, the entire MicroSystem80 reading package is contained on eight disks.
Each of the disks contains the following: a pretest, a set of lessons, a progress check, and a posttest. The pretest determines the student's entry point. The student's score will determine the appropriate lesson for him. The progress check checks the student's understanding of the material. It also provides instruction on the items the student misses. At the end of the progress check, the student is automatically assigned a lesson for his next session on the computer. A posttest is administered at the end of each disk. All test results are recorded by the management system.

**Use of the Diskettes**

The student begins with disk A. A pretest is given and the student is assigned to one of the six lessons on disk A, or is instructed to pass to disk B. This procedure continues until the student is placed in the appropriate lesson.

Once the entry lesson has been determined, the student begins working on the lesson assigned. There are three possible patterns for subsequent lesson assignments. The pattern is selected on the basis of his performance on the progress check following the lessons. The three options are.

1. If the student obtains a perfect score on a Lesson 1 or a Lesson 4, the first time, the next sequential lesson is passed. For example, if B1 is passed, B3 is assigned;
2. If the student does not obtain a perfect score on a Lesson 1 or a Lesson 4, the lessons will be assigned in sequence, with no passing of following lessons. For example, if a perfect score is not obtained on Lesson 1, Lesson 2 is assigned;

3. If a score on a Lesson 3 or a Lesson 6 is less than 80%, then the lesson will be reassigned. The student will work through the lesson again.

The student is tested at the conclusion of each disk. The following lesson assignment is prescribed. Scores are recorded by the management system.

Operational Modes

The six teaching lessons on each disk are presented in the instructional mode. After each statement, the student is given a maximum of two chances to respond with the correct answer. This is followed by "reinforcement" for the correct answer or "an explanation" for incorrect answers. The "explanation" uses words from the selection to help the student understand the statement. The "reinforced" response acknowledges that the student has responded correctly to the statement. An example of both types of responses is shown below:

STATEMENT: 1. The wall is green or white. The wall is not white. B) The wall is rough.

STUDENT RESPONSE: Answer: T Wrong! THINK! Green or white.
"explained" I am not told if it is rough or smooth.
STATEMENT: 1. Jane rode her bicycle to see her friend Susan in Basser City. Susan was in front of her house to greet Jane. Susan had on a red coat or a blue coat. Jane had on a black scarf or a gray scarf. When Jane arrived, she saw Susan in front of the house. Susan did not have on a red coat. Jane did not have on a gray scarf.

A) Susan had on a gray coat.

STUDENT RESPONSE: "reinforced" Answer: F RIGHT! GOOD WORK, TOM.

Upon completion of a lesson, a lesson review is administered. Any statement to which a student did not respond correctly has been stored for this review. Statements not answered correctly will be recycled a maximum of two times. At the conclusion of the lesson review, the student enters the test mode. This mode is used for the progress check. In the text mode, the student has only one opportunity to respond with the correct answer. There is no reinforcement for his response. The score for the progress check is stored by the management system and a new lesson is prescribed.

At the conclusion of all six teaching lessons on the disk, a posttest is given. The posttest is given in the test mode. There is a pass/fail criterion for the test. The criteria for passing is zero or one error for the material on lessons 1-3 and zero or one error on lessons 4-6. As soon as two errors are encountered, the testing ends. Scores for each level (lessons 1-3 or lessons 4-6) are stored in the management system. For any level of the test that
is bypassed, due to the student bypassing the lessons, a score of 100% is assumed.

Collection of the Data

The California Achievement Test, Level 15, Form C was administered by the school district in October. This test served as the pretest. It was professionally scored. The posttest was administered the third week in May by the school district. This test was the same test, but was hand-typed by the researcher, with written permission from McGraw-Hill, to minimize the test and interaction of X effect. Composite scores in Reading and Total Math were tabulated for group analysis. Data in the form of grade equivalent scores were used for analysis.

Analysis of the Data

An analysis of covariance was used to statistically reduce the effects of initial group differences. This procedure will make compensation adjustments of the final means on the dependent variable.

The statistical data was analyzed by the researcher at Texas Instruments using the SAS (Statistical Analysis System) package, which runs on the IBM 4341 computer. The results were presented in Table Form. From the findings, conclusions were drawn, implications stated, and recommendations made.
Chapter Summary

The purpose of Chapter III was to outline and clarify the methods and procedures used to conduct the investigations of this study. In this chapter, a description of the subjects and the courseware used as treatments was included.

The sixty-six subjects of this study were fifth grade students in a large suburban school district. They were not intact classes, but were representative of three different schools from the district. A stratified random assignment by sex was made to each of two treatments.

Two courseware packages were used as treatments: the SRA Computer Drill and Instruction Mathematics and the MicroSystem80 Critical Reading Series packages. A detailed description of each of these is included in this chapter.

The instrument used for the pretest and posttest was the California Achievement Test, Level 15, Form C. Data gained from these tests was analyzed using the analysis of covariance.
CHAPTER BIBLIOGRAPHY


CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

The major function of this study was to investigate the effects of computer assisted instruction as a supplement to classroom instruction in reading comprehension and arithmetic. An original population of 72 students was reduced to 66, due to students withdrawing from the schools. The dependent variables were the posttest scores on the total math and reading comprehension of the California Achievement Test, Level 15, Form C. Independent variables were the student grade level and the pretest scores on the total math and reading comprehension of the California Achievement Test, Level 15, Form C.

Through one-way analysis of covariance, the tenability of each hypothesis was decided. The hypotheses were stated in a null form and the 5 per cent level of confidence was used to determine rejection. One analysis of covariance was used to compare the math scores of the three groups; a second analysis of covariance was used to compare the reading comprehension scores of the three groups.

The chapter format for presenting and analyzing the data follows: the initial presentation includes analysis of adjusted mean scores for the reading achievement of the
three groups. Second, the analysis of adjusted mean scores for the math achievement of the three groups is presented. Third, a summary of the findings is presented. A discussion of the findings concludes the chapter.

Presentation and Analysis of the Data

Hypothesis One

Hypothesis one was restated in two parts to read:

1A - There will be no significant difference in reading achievement scores between the reading experimental group and the experimental math group.

1B - There will be no significant difference in reading achievement scores between the reading experimental group and the control group.

No significant difference existed between the adjusted mean scores of the reading experimental group and the experimental math group on reading comprehension, as shown by the F value of .4 in Table I. The reading experimental group's score was 8.29 and the experimental math group's score was 8.28, as seen in Table II. The hypothesis 1A was retained, since the differences were not significant. Hypothesis 1B was also retained on the basis of insignificant differences between the adjusted mean scores of the reading experimental group, 8.29 and the control group, 8.65.
Hypothesis Two

Hypothesis two was restated to read: There will be no significant difference in reading achievement scores between the math experimental group and control group.

There was no significant difference between 8.28, the adjusted mean score of the math experimental group, and 8.65, the adjusted mean score of the control group, as seen in Table II. Since the difference in the values was not significant, the null hypothesis was retained.

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<td>.4</td>
<td>.67</td>
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<td>2.47</td>
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<td>64</td>
<td>154.92</td>
<td>2.42</td>
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### TABLE II
MEAN SCORES AND ADJUSTED MEAN SCORES ON READING COMPREHENSION

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<tr>
<th>Group</th>
<th>N</th>
<th>Pretest Mean</th>
<th>Pretest SD</th>
<th>Posttest Mean</th>
<th>Posttest SD</th>
<th>Adjusted Means</th>
<th>Adjusted SD</th>
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<td>Reading Experimental</td>
<td>21</td>
<td>6.84</td>
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<td>2.37</td>
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<tr>
<td>Reading Control (Math Experimental)</td>
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<td>6.74</td>
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<td>Control Group_2</td>
<td>24</td>
<td>7.37</td>
<td>2.25</td>
<td>8.93</td>
<td>2.18</td>
<td>8.65</td>
<td>.32</td>
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<tr>
<td>Total</td>
<td>66</td>
<td>7.00</td>
<td>2.03</td>
<td>8.42</td>
<td>1.57</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Hypothesis Three**

Hypothesis three was restated in two parts to read:

3A - There will be no significant difference in math achievement scores between the math experimental group and the experimental reading group.

3B - There will be no significant difference in math achievement scores between the math experimental group and control group_2.

No significant difference existed between the adjusted mean scores of the math experimental groups' score and the experimental reading groups' score as seen
by the $F$ value of .72 in Table III. The adjusted means of the math scores, displayed in Table IV, show the math experimental groups' adjusted score of 7.85 to be numerically greater than the experimental reading groups' score of 7.80. Table IV also shows the math experimental groups' adjusted score of 7.85 to be numerically greater than the control group$_2$'s adjusted score of 7.47. Since the differences reported were not significant, as seen in Table III, the null hypotheses 3A and 3B were retained.

Hypothesis Four

Hypothesis four was restated to read: There will be no significant difference in the math achievement scores between the reading experimental group and control group$_2$.

The adjusted means of the math scores, shown in Table IV, show the reading experimental groups' score of 7.80 to be numerically greater than the control group$_2$'s adjusted score of 7.47. Since the difference was not significant, the null hypothesis 4 was retained.
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<td>.49</td>
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<td>Within Groups</td>
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<td></td>
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<tr>
<td>Total</td>
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<td>78.27</td>
<td>1.22</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Pretest</th>
<th>Posttest</th>
<th>Adjusted Means</th>
<th>SD</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Math Experimental</td>
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<td>5.73</td>
<td>1.21</td>
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<td>7.48</td>
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<td>6.51</td>
<td>1.02</td>
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<tr>
<td>Total</td>
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<td>6.00</td>
<td>1.18</td>
<td>7.70</td>
<td>1.59</td>
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</tbody>
</table>
Discussion of Findings

The data on the effects of computer assisted instruction as a supplement to classroom instruction in reading comprehension are shown in Tables I, II, III, and IV. When the scores for the group of students using the math courseware package were compared with those using the reading courseware package, the differences were not significant. Likewise, the differences between the scores of the groups using the courseware and those not using the courseware were not significant. Numerically, however, the reading scores of the students using the reading courseware was slightly greater than the reading scores of the students using the math courseware. The students using the math courseware scored numerically higher than the students using the reading courseware and the students who were not using courseware.

These findings contradict the findings of Suppes (1969), Roman (1975), Lysiak (1976), and Wells (1974). This study, however, carefully monitored the computer time of each student, confirming that all students spent equal amounts of time using the computer. Time on the computer for the students in the Suppes, Roman, Lysiak, and Wells studies was not carefully monitored. Therefore, some students could have worked on the computer more than other students, which could affect the results. Machine reliability was also a problem in the Suppes study, which could have caused some students to miss their computer time. This study provided make-up
sessions for all students who missed their computer time. In the Lysiak study, the computer time was not completely supplemental, since some computer time overlapped with class time. This overlap of instruction could have affected the results.

This study supports the findings of Palmer (1973) who reports that mean gains for CAI students were greater than the mean gains for the non-CAI students though the differences were not statistically significant. The Palmer study had five to ten minutes of computer time daily, while this study had thirty minutes weekly.

Observing the raw data of this study, it appears to support the findings of Suppes (1969) which indicated that the lower group using the tutorial courseware scored higher on the posttest. One weakness in the Suppes study, though, was that students were not randomly selected. In this study, students were randomly selected and matched.

The findings of this study were also contrary to the findings of Morgan (1977). However, the schools in the Morgan study were chosen by size, not at random. Computer time was 20-30 minutes weekly, as it was in this study, but was not carefully monitored.

This study supports the findings of Durward (1973) who reported improved math skills for CAI students, though results were not statistically significant. One weakness of
the Durward study was that subjects were volunteers who wanted to use CAI. Subjects were randomly selected and matched in this study.

Observation of the raw data also indicates that this study supports the findings of Delforge (1977) and Durward (1973) which reported improved achievement scores though results were not significant in either case. Durward, however, used volunteers who wanted to use CAI. The Delforge study was small, with only 57 subjects. This study randomly selected and matched the 66 subjects.

Observation of the mean scores reveal the high pretest scores of the fifth grade students. The mean on reading comprehension was 7.00. The mean on math achievement was 6.00. The chances for significant gains is less with such high pretest scores.

Although results did not indicate significant statistical gains in achievement, student attitudes toward school and toward the use of computers were positive. Students were eager to use the computer at their assigned times and were very inquisitive about the operations of the machine. The teachers, also, were very supportive in the use of the computer in the schools and were anxious to learn more about its uses in the classroom.
There is a possibility that failure of the groups using CAI to score significantly higher may have been caused by the students only spending four hours of actual time on the computer. Perhaps more time on the computer would have improved their reading and math scores.

It is also possible that the scores on the posttest could have been due to the time the test was administered. The posttest was administered during the last week of school. This time of the school year is busy and students are anxious for the school year to end, which could have influenced their performance on the test.

Chapter Summary

In Chapter IV, the findings of this study are presented. The hypotheses were restated in the null form. Hypotheses one and three were divided into A and B parts to support statistical analysis. The one-way analysis of covariance was used to analyze the data. The chapter is concluded with a discussion of the findings reported from the data analysis.
CHAPTER V

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

This study was undertaken to investigate the effects of computer assisted instruction as a supplement to classroom instruction in reading comprehension and arithmetic. This chapter presents a summary of the methods and procedures used to collect and analyze the data, the findings and conclusions derived from the study, and the implications and recommendations suggested by the results of this study.

Summary of Methods and Procedures Used to Collect and Analyze the Data

Seventy-two fifth graders were randomly selected from three schools for this study. Six boys and six girls were randomly selected from each school and matched by sex and achievement scores to twelve other students in their school. In two schools, the matched pairs were than randomly assigned to one of two treatments. The students at the third school received no treatment. Only sixty-six students completed the study, due to attrition.

Two courseware packages designed for the Apple II Plus microcomputer were used as treatments. One group used the SRA Computer Drill and Instruction: Mathematics; the second group used the MicroSystem80 Critical Reading Series.
Students were trained on the use of the microcomputer by the researcher, on a one-to-one basis in January of 1982. The entry level of each student was assessed by the diagnostic SRA and MicroSystem80 courseware.

All sixty-six subjects received regular classroom instruction in mathematics and reading. In addition, the two treatment groups spent two fifteen minute sessions per week using supplemental courseware in either reading or mathematics. A specific sign-up sheet was positioned beside the computer. The student signed in and out on the sheet each time he worked on the computer. A stick-on clock was attached to the computer so that students could record time-in and time-out when they used the computer. The researcher checked the sign-up sheets weekly at the two schools and also interviewed each child individually to confirm that the sign-up time was correct. Make-ups were scheduled as needed on a one-to-one basis, if a student missed for some reason. At the conclusion of the experiment in May, students had worked on the computer a total of four hours each.

The data collected from the pretest and posttest were transposed into a form compatible with computer analysis. The one-way analysis of covariance was applied to analyze the data. Results were used to reject or retain the null hypotheses.
Findings

Statistical treatment of the data presented in Chapter IV comprised the basis for the rejection or retention of the null hypotheses. A null hypothesis was rejected when the probability level computed by the analysis of covariance was equal to or less than .05. In contrast, probability levels greater than .05 were considered insignificant, thereby justifying the retention of the null hypotheses. The analysis and interpretation of the data resulted in the following findings.

1. The scores for Reading Comprehension on the California Achievement Test, Level 15, Form C, of the reading experimental group did not differ significantly from the scores for Reading Comprehension of the reading control and the control group.

2. The scores for Total Math on the California Achievement Test, Level 15, Form C of the math experimental group did not differ significantly from the scores for Total Math of the math control or the control group.

Conclusions

Based on the findings of this study and subject to the limitations posed by the research sample, the following conclusions were drawn.

1. Using the SRA Computer Drill and Instruction: Mathematics courseware or the MicroSystem80 Critical Reading
Series courseware for two fifteen minute sessions weekly for sixteen weeks does not significantly improve scores on the Total Math or Reading Comprehension of the California Achievement Test, Level 15, Form C.

Recommendations

On the basis of the findings and conclusions of this study, the following recommendations were made.

1. It is recommended that a study be conducted using a larger sample and allowing students more time weekly on the computer to increase quantitative gains from the students.

2. Further research in the area of CAI as a supplement to classroom instruction is justified, due to the limited number of studies in the literature.

3. It is recommended that courseware be validated before it is brought into a school district for classroom use, since computer courseware is so expensive.

4. It is recommended that other studies include affective measures in order to gather qualitative data concerning student attitudes toward the computer as an instructional medium.

5. It is recommended that other studies include measures of computer literacy in order to gather quantitative data concerning student knowledge of the computer as an instructional medium.
January 7, 1982

Dear Fifth Grade Parent:

The school district is considering expanding use of computers in our instructional programs. To do this properly, we must have information concerning the effectiveness of using computers as an instructional tool.

It is possible that your child will have the opportunity to participate in a pilot project testing the effectiveness of two highly sophisticated computer courseware programs--SRA Scope and Sequence Mathematics and Borg-Warner Critical Reading Skills.

A limited number of fifth graders will be selected. In the event that your child is chosen, we request your permission to make use of his/her California Achievement Test scores for the purpose of pre- and post-testing the effectiveness of these computer materials. These test scores will not be made public on an individual basis.

Please sign below, check the appropriate box, and return this letter to your child's teacher as soon as possible.

Thank you,

Principal

☐ I give my permission for my child to participate in this project.

☐ I prefer that my child not participate in this project.

Signature of Parent or Guardian
APPENDIX B
June 16, 1982

Ann Easterling
5881 Preston View #122
Dallas, Texas 75240

Dear Ms. Easterling:

Thank you for writing of your plans for using the CALIFORNIA ACHIEVEMENT TESTS in your doctoral research program.

Providing no students to be tested have taken or will be taking the California Achievement Tests, Form C, Level 15, CTB/McGraw-Hill is pleased to grant you permission to reproduce in typewritten form the following material:

California Achievement Tests, Form C, Level 15

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<td>Mathematics Concepts and Applications</td>
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