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The use of computer assisted instruction with lower achieving students in grades three, four, and five

Catherine Lee Tryer Dulaney

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California State College
San Bernardino

USE OF COMPUTER ASSISTED INSTRUCTION
WITH LOWER ACHIEVING STUDENTS IN
GRADES THREE, FOUR, AND FIVE

A Project Submitted to
The Faculty of the School of Education
In Partial Fulfillment of the Requirements of the Degree of
Master of Arts
in
Education: Elementary Option

By
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San Bernardino, California
1984

APPROVED BY:

Advisor

Committee Member
THE USE OF COMPUTER ASSISTED INSTRUCTION
WITH LOWER ACHIEVING STUDENTS IN
GRADES THREE, FOUR, AND FIVE
Catherine Lee Tryer Dulaney
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Statement of the Problem

A common problem in Education is the lack of justification of specific teaching methods. With computers becoming an obviously accessible tool for teaching and remediating students, it seemed necessary to find some justification for using computers in an elementary school. In particular this study looked at the potential effect of computer assisted instruction on lower achieving students in grades three, four and five in one elementary school in Apple Valley, CA.

Procedure

The study looked at the effect of CAI on students failing at or below the 35th percentile in two areas of mathematics, namely, basic concepts and applied concepts. Both achievement and attitude were analyzed. Pre and post tests were given to all students in the sample. The test used for comparing achievement was the IOWA Test of Basic Skills. To analyze the attitude toward mathematics a questionnaire was given both to the students in the sample and to their teachers. The scores were totaled and a mean found for each group in the study. Finally a standard deviation was found to test for significance. The experimental group was given 20 minutes a day, three days a week for three months of CAI while the control group received only their regular lesson.
Results
The findings showed that there was not a significant difference between those students receiving CAI and their regular mathematics lesson and those students just receiving their regular mathematics lesson, the math lessons being exactly the same within each grade level. There was no significant change in achievement or in attitude toward mathematics.

Conclusions and Implications
While it cannot be concluded that computers do not have a significant impact on all students, it can be said that according to this study, students receiving CAI did not significantly improve in achievement or attitude toward mathematics. It must be kept in mind, however, that a very small sample was used over a short period of time. Many further studies should be done to conclusively say whether or not computers can have a positive effect on student achievement and attitude in the area of mathematics.
TABLE OF CONTENTS

I. INTRODUCTION .............................................. 1
   Statement of the Problem ................................. 1
   Purpose of the Study ...................................... 2
   Statements of the Null Hypotheses ....................... 2
   Definition of Terms ...................................... 2

II. REVIEW OF THE LITERATURE ............................... 4
   Definition of Computer Education ....................... 4
   Effect of Computers on Academic Achievement .......... 6
   Definition of Attitude and Techniques
      For Evaluating Attitude ................................ 9
   Effect of Computers on Attitude
      Toward Mathematics ..................................... 12
   Limitations in the Research ............................ 14
   Suggestions for an Efficient Computer
      Education Program ..................................... 16

III. METHODOLOGY ............................................. 19
   Sampling ................................................. 19
   Research Design and Procedures ......................... 19
   Limitations .............................................. 21

IV. FINDINGS .................................................. 23
   Analytic Techniques ..................................... 23
   Description of Findings .................................. 24
   Other Findings .......................................... 26

V. DISCUSSION AND CONCLUSIONS .......................... 32
   Limitations .............................................. 32
   Implications ............................................. 33

VI. APPENDIX ................................................ 36
   Directions for Questionnaires .......................... 37
   Teacher Survey .......................................... 38
   Student Questionnaire .................................. 40
   List of Software Programs Used in the Study .......... 41

VII. BIBLIOGRAPHY ......................................... 42
LIST OF TABLES

1. Mean Percentage of ITBS Scores, Percent Change, and Standard Deviation of Change .................. 24

2. Mean Percentage of Attitude Questionnaire Scores, Percent Change, and Standard Deviation of Change .................... 25

3. Mean Percentage of ITBS Scores and Percent Change by Grade Level—Grade Three ......................... 26

4. Mean Percentage of ITBS Scores and Percent Change by Grade Level—Grade Four ....................... 27

5. Mean Percentage of ITBS Scores and Percent Change by Grade Level—Grade Five ......................... 27

6. Mean Percentage of ITBS Scores and Percent Change by Sex—Boys versus Girls ......................... 28
INTRODUCTION

The age of computers is already upon us. Computers are seen in several schools and classrooms and their implementation in the already existing curriculum is becoming widespread. However, little research has been done to show the effectiveness of Computer Assisted Instruction in elementary schools.

Statement of the Problem

Many school districts have begun or are continuing to purchase computers and computer software with special funds. The primary reason for purchasing them is for Computer Assisted Instruction particularly with lower achieving students. However, in these districts where computers are being used, little is being done to justify their use in the educational setting. The potential effect of computer education on student achievement and attitude toward specific areas of the curriculum is as yet not fully understood because of scarce research. Few districts have yet to analyze the differences in standardized test scores between students utilizing computers as a regular part of the curriculum and those not participating in a computer education program. Since computers are inevitably a reality of present and future educational systems, it is important to research and evaluate these existing programs so that corrections can be made which will maximize students' learning potential on the computer.


**Purpose and Significance of the Study**

The purpose of this study was to analyze whether or not the computer can be used to raise standardized test scores of lower achieving students in the area of mathematics. The study also looked at the potential effect of computer education on attitudes toward mathematics. The significance of this study was to find some justification for Computer Assisted Instruction in elementary school classrooms.

**Statements of the Null Hypotheses**

**Hypothesis I:** The introduction of computers into the existing curriculum will have no significant effect on the academic achievement of children in two areas of mathematics, namely, basic concepts and applied concepts.

**Hypothesis II:** The introduction of computers into the existing curriculum will have no significant effect on the students' attitude toward two areas of mathematics, namely, basic concepts and applied concepts.

**Definitions of Terms**

**Basic Concepts**: Those concepts which involve direct use of one of the four operations: addition, subtraction, multiplication, and division, without requiring the child to decide which operation is to be used, how the problem is to be done, or without requiring the child to apply an operation to a situation.
Applied Concepts: Those concepts which require the child to use his knowledge of the basic concepts in order to solve problems. This includes reading graphs, solving problems written in various styles of terminology, interpreting information, and using the basic concepts to determine an answer.
REVIEW OF THE LITERATURE

When reviewing the literature on the topic of computer education, it is important first to define the various areas of computer education. Then it is important to discuss research and the limitations of this research done on the effects of the computer on academic achievement and attitudes in various subject areas. Finally, problems associated with the present use of computers and suggestions for making a computer education program work efficiently and effectively in a school setting should be discussed.

Definition of Computer Education

Keith Hall gives an extensive overview of all aspects of what is termed Computer Based Education (CBE). Computer Based Education refers to those programs which are developed around the use of computers. CBE can be divided into three areas according to Hall: Computer Managed Instruction (CMI), Computer Assisted Instruction (CAI), and computer based instructional simulations and inquiry. Computer Managed Instruction uses the computer to score and keep track of individual student progress. The computer starts the student at the section of the computer program where he left off. The teacher can get an account of progress at any given time for any given student. Computer Assisted Instruction refers to the teaching and learning activities aided directly by a computer. Computer based instructional simulations and inquiry covers learning by discovery in which the subject matter
and underlying theory are progressively revealed to the student as he proceeds through the Computer Assisted Learning (CAL) package.¹

Nicholas Rushby breaks down CAI into two paradigms: Instructional and Emancipatory. The Instructional paradigm consists of two types of programs, a tutorial program and a drill and practice program. In a tutorial program, the computer provides the student with material, monitors the student's responses, and controls the student's progress. A tutorial program also provides remediation if necessary. In a drill and practice program, the student receives individual instruction according to need. The program also provides for immediate reinforcement.²

The Emancipatory paradigm reduces the amount of non-essential work the student must do to reach his learning objectives. The computer responds to student questions by repeating relevant prestored facts or indicates the whereabouts of appropriate sources of information. For example, if a student is doing a report the computer can be used for aiding him as to where he can find information. Therefore, the student need not recreate the wheel, so to speak, but can start with the already created wheel and continue on to meet the objectives set out for him.³

³Ibid., pp. 33-36.
Rushby also divides the computer based instructional simulations and inquiry into two paradigms: Revelatory and Conjectural. In the Revelatory paradigm, the computer mediates between the student and a hidden model or simulation or real-world or series of real-world events. For example, given data in statistics, the student finds validity of the different methods used. In the Conjectural paradigm, the computer helps the student formulate and test his own hypotheses. This paradigm is based on the concept that knowledge can be created through the student's experience. The student instructs the computer as to what to do and then has to make choices and evaluate decisions on a particular subject. This is commonly used in the teaching of shapes on the computer whereby the student instructs the computer to draw lines on the screen and to turn at particular angles thus making a square appear on the screen.  

It is important to note that in most computer education programs, only drill and practice programs, tutorial programs, and sometimes simulations are integrated in the curriculum, particularly at the elementary school level. The use of the computers for the other kinds of instruction is only slowly making its way into the existing curriculum.

Effect of Computers on Academic Achievement

 Few studies have focused specifically on the effect of CMI on academic achievement. Two studies which do address

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this area were done individually by Boas and Baltz. Boas analyzed the instructional delivery systems in vocational education by comparing CMI to the teacher delivered module (paper) and the lecture-demonstration module to teach the same information. Baltz looked at the effect of computer graphics as an aid to teaching mathematics. Both researchers concluded that CBE is potentially useful in the areas of CMI and math instruction, although Baltz stated that this usefulness was limited to certain topics in mathematics.

Contrary to research in CMI, several studies have been done which show the positive effect of CAI and computer based instructional simulations and inquiry. Hartley compared the effectiveness of four methods of individualizing math instruction: CAI, cross-age tutors and peer tutoring, individual learning packets, and programmed instruction. Her results showed differences favoring CAI at the elementary school level of at least 0.5 standard deviations between those who received CAI and those who didn't. Hall concluded from his


7 Ibid., p. 679A

research that CAI reduces learning time 40-50% with equal or increased retention when compared with traditional instruction. Similarly, Vinsonhaler and Bass concluded from their research based on ten other studies consisting of thirty experimental situations in the areas of language arts and mathematics, that CAI plus traditional classroom techniques showed statistically significant advantage over one or the other.

Seymour Papert and his colleagues developed a computer language known as LOGO which emphasizes learning through simulation. His studies at MIT showed that LOGO encourages children to postulate theories, test results, and analyze and correct them if they're wrong. Howe, O'Shea and Plane then studied the effects of teaching mathematics through LOGO programming on student achievement. They concluded that a form of experimental mathematics based on computer programming can improve the mathematical understanding of less able children.

A four year longitudinal study was done by Marjorie Ragosta between 1977 and 1981. She looked at the effect of CAI on Title I children in mathematics, reading, and language arts at four schools in Los Angeles Unified School District.


The study found that in the area of mathematics computation the student scores from grades one through six improved somewhat over the three year period. The areas of concepts and application showed considerable less gain which the author attributed to the inability of several students to read, which was required in this part of the test.\textsuperscript{13}

**Definition of Attitude and Techniques for Evaluating Attitude**

The research done on the effects of CMI, CAI, and computer based instructional simulation and inquiry on student attitude toward mathematics is as limited as the research on CMI. While attitude connotes several different meanings, it is generally thought of as a combination of feeling toward and cognition of an object or subject matter.\textsuperscript{14} When defining attitude toward mathematics, anxiety is often included in the definition. Negative terms can also be found to be an integral part of the definition when discussing math attitudes. This is primarily because negative attitudes appear to be predominant over positive ones.\textsuperscript{15}

Because of the fact that attitude is considered part of the affective domain of learning theory rather than the cognitive domain, evaluating attitude can be very difficult. The most commonly used method is a self-report inventory from


which inferences about attitudes are made. This method assumes that the person knows what his attitude is toward the subject and is willing to let this attitude be known by others. Depending on the subject matter, this may not always be the case unless anonymity is ensured. Self-reports can be done by using a variety of different instruments such as interviews, surveys, questionnaires, or attitude rating scales. Although oral self-reports may be given, the more common practice is pencil and paper inventories. 

Several kinds of attitude scales or tests have been developed for self-reports. Perhaps one of the most widely used scale patterns is a Likert scale. The person is asked to respond to questions on a scale of 0 to 5 (for example) with each number increasing in intensity of agreement or disagreement (ranging from strongly disagree to strongly agree.) The midpoint is often a response such as undecided or no opinion toward the question asked. Likert scales are easier to develop and are more reliable than the Thurstone scale which requires judges to categorize attitude statements from which a few statements are chosen, evaluated, and scores distributed. Scales have also been developed which combine these various types (i.e. Likert and Thurstone.)


\[^{17}\text{Ibid., pp. 84-91.}\]
Many factors appear to uniquely effect attitudes toward mathematics. For example, Wilhelm and Brooks found correlations between parental attitude toward mathematics and the child's attitude toward math with some inversely affecting the other. Sex may also be a factor in a student's attitude toward math as well as grade level. Work volume and pupil conceptions of teachers and teacher's attitudes as well as environment may also have an effect on attitude toward mathematics as was found by Brassell, Petry and Brooks. Haladyna, Shaughnessy and Shaughnessy found that teacher quality and to some degree management-organization climate appear to affect attitudes toward mathematics in elementary grades and social psychological climate in secondary grades.

Because of the continuously researched factors which appear to affect attitudes toward mathematics, most recent studies have begun looking at attitudes toward mathematics as multidimensional rather than unidimensional. Michaels and Forsyth found this to be true while developing an attitude scale. The children tended to react negatively toward certain constructs or areas of math rather than to math in general. This implies that when measuring attitudes toward math the attitude scale used should include several dimensions rather than just a broad concept of "attitude." It also implies

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that these dimensions should be evaluated as separate entities, independent as much as possible from each other.  

Effect of Computers on Attitude Toward Mathematics

Few studies have actually tested the effects of CAI or CMI on student attitude toward mathematics. Hoffman and Waters studied the relationship between personality types and student performance. The results of their study revealed that those who have the ability to quietly concentrate, pay attention to details, memorize facts, and stay on task tend to learn better by computer and are less likely to drop out of the program. Gadzella concluded from her study that students exposed to CAI programs gained greater insight into study skills than those denied CAI if the study skills are written in an informative, entertaining, and enjoyable way.  

Howe, O'Shea and Plane did an extensive study of the effects of computer programming on student attitude toward mathematics. In this study, the researchers also looked at the effects computer programming had on student attitude.

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toward worksheets at the completion of the program. The results showed a prominent change in the willingness to talk about mathematics shown on a bipolar scale. The results of the effects on attitude toward worksheets showed a great lack of interest and motivation toward worksheets after going through the computer education program.²⁴

Menis, Snyder, and Ben-Kohav looked at the effects of computer education on low achieving students who disliked math. The results showed a tendency for those who used the computer as an aid in math to dislike math less after using it than those who did not use it.²⁵ Casner studied the affect of CAI on reducing anxiety levels in mathematics. The results of the study showed a significant difference in anxiety levels in males after CAI was implemented and found that these males were not only less anxious but also were less fearful and more likely to enjoy math. The same results were not found with females in the same condition, however.²⁶ O'Neil, Hedl, Richardson, and Judd found that certain curriculum models can reduce anxiety toward mathematics. Such models include game-like situations or relaxation techniques. This implies that non-threatening situations produce lower levels of anxiety in


²⁵ Menis, et al., "Improving Achievement by the Computer": 19-22.

students.  

Limitations in the Research

Generally, the limitations of the studies are based on the inability to generalize the studies to large populations or to various age groups, particularly the studies by Hoffman and Waters and by Gadzella. Both of these studies had limited samples of specific individuals, namely, Naval Technical Trainees and undergraduate psychology students, respectively. In addition, the number in the samples (155) were small. The studies done to test attitudes toward mathematics tended to focus on one particular age group of children or one specific geographic area. These, too, made generalization difficult. The limitation of Papert's study is the impracticality of his suggestion that every child be supplied a computer.

Becker's article enlightens the reader about the realities of using a computer in an educational setting. In his article he discusses the negative aspects of having computers in the classroom. The main emphasis of his article is that as the computers are presently being used, the performance gains may not be great enough to justify the financial investment. Furthermore, he emphasizes the unliklihood that computers will be used effectively by the teacher at the presently low ratio of computers to number of students using them. Lastly, Becker questions whether or not the resources

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should be used to develop more high level intellectual skills on computers rather than just for CAI or for practicing rote-learned rules.  

Other researchers reached similar conclusions in their studies. O'Dell concludes from his studies that the education field will not make significant use of computers until software is developed in a form useable to teachers. This, he states, is due to the number of different languages and media distribution systems. Craft concludes that while a great potential is there, materials won't be readily accessible for another ten years. Hicks and Hunka state that the currently used tools in CAI are diverse and almost incompatible due to the more than forty CAI languages and as many different computers used in CAI research. In addition, they state that it is difficult to compare research results or to exchange CAI programs and lessons. Hall concurs with this and states that CBE can't be evaluated per se, but rather single instances can be studied and evaluated.

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When studying attitude, several problems can arise concerning validity and reliability. For example, social desirability may influence a student to react according to peer pressure rather than true opinion. This, then, would produce and encourage dishonest answers. The inability to make decisions as well as age may be important factors to consider when looking at the attitude studies.  

**Suggestions for an Efficient Computer Education Program**

Taking these limitations into consideration, Becker points out the computer's potential particularly in diagnosing student error patterns and providing corrective tutorial instruction. He continues by developing some long range goals for computers. He proposes that computers be used as a higher level instrument which can enhance the current curriculum.  

Dershimer points out the advantages of initially implementing CBE in elementary schools and the higher success rate if tutorial applications are avoided. Potts emphasizes the support of faculty as a contributory factor in success of CBE programs and Craft acknowledges the need to prepare graduates of teacher

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education programs in the use of computers as instructional tools.  

Hall summarizes his article with some instructional guidelines which should be included in computer education programs. Some of these guidelines are; frequent feedback to learners, individual pacing and progression, clarity of presentation, motivational factors, variability in class activities, enthusiasm, task oriented or achievement oriented instruction, and an opportunity for students to learn criterion material.  

Hoffman and Waters suggest the need to find new ways of improving CBE for all types of people perhaps by providing mini-lectures for clarification, more student interaction, frequent question-discussion sessions and pop quizzes to encourage competition.  

Craft points out that when evaluating the study, careful attention should be paid to the possibility of the Hawthorne Effect occurring particularly when the computer education program is being used for the first time.  

James Wiebe also looked at factors which may produce a more efficient computer education program. He maintained that students retain more, achieve higher scores on tests and are able to transfer more to new situations if they understand what they are doing. Based on several studies, he suggests  

\[\text{\textsuperscript{37}}\text{Craft, "Education Research":26-27.}\]

\[\text{\textsuperscript{38}}\text{Hall, "Computer Based Education," pp. 353-367.}\]

\[\text{\textsuperscript{39}}\text{Hoffman and Waters, "Effect of Student Personality on Success,":21-22.}\]

\[\text{\textsuperscript{40}}\text{Craft, "Education Research":26-27.}\]
seven characteristics which can be found in an efficient computer education program. The program should: Stress mathematical relationships, principles, and meanings; ask the child to think of specific concrete experiences that relate to the concept being developed; ask the child to actually do the manipulations pictured on the screen; use graphic representations of concrete models on the screen to help clarify symbolic manipulations or abstract discussions; allow the child to discover teaching sequences; develop and sharpen abilities to problem solve; and, lastly, be adapted or adjusted to the correct level of the student.41

Wiebe also specified particular areas in mathematics in which the computer should be used: place value and understanding of the meaning of multi-digit numerals; problem solving; meaning of fractional numerals and operations on fractions; and decimal and percentage numerals and operations on decimals and percentage, time and money, areas and volume, metric units, and geometry concepts.42

42 Ibid.
METHODOLOGY

This study was designed to look at the potential effect of Computer Assisted Instruction on student achievement and attitude in the area of mathematics. The computer used in the study was an Apple IIe which was furnished by Apple Computer, Inc. through the Kids Can't wait Program. The software was provided by the school.

Sampling

Apple Valley School District is comprised of three schools, all at the elementary level. The target population for this study consists of approximately 700 children in grades one through six who attend one of these schools, Yucca Loma School. The study included one-fourth of all third, fourth, and fifth grade students in the school. Therefore, the sample included approximately 100 students. Due to the fact that transiency is high in this district, attrition must be taken into consideration. Thus, only those children who started the program at the beginning of the study were included in the final evaluation.

Research Design and Procedures

Yucca Loma School received one computer in December, 1983. The purpose of this study was to test the potential effect of computer (CAI) education on a small group of students in grades three, four, and five. The study specifically looked at the potential effect of CAI on academic achievement and attitude toward mathematics.
There were two parts to the evaluation, one analyzing the results testing Hypothesis I and one analyzing the results testing Hypothesis II. Hypothesis I, which looked at the effect of computers on academic achievement, was tested by looking and comparing the pre-post scores on a standardized test, the Iowa Test of Basic Skills (ITBS). Hypothesis II, which looked at the effect of computers on student attitude toward mathematics, was tested by looking and comparing the results from two questionnaires, one to the students individually and one to the teacher.

The ITBS was analyzed in the following way: A pretest was given in January of 1984 consisting of two sections of the ITBS, namely, M-2 Mathematics Problem Solving and M-3 Mathematics Computation. From these test results, the lowest 35th percentile from each grade level tested was selected as the experimental and Control Group I. Three students from each grade level were randomly selected from those students scoring in the lowest 35th percentile. The remaining students who scored in the 35th percentile made up Control Group I. The ITBS was then readministered in May of 1984 and a score which reflected each child's achievement was determined. These scores were then compared within each grade level and a standard deviation was found within each group.

The questionnaires to show the effect of computer education on student attitude was given to both students and teachers in the sample at the beginning and end of the study. Student responses were scored in each response area and totals
were compared from beginning to end. Teacher questionnaires were scored in the same way. Copies of the questionnaires can be found in the Appendix.

Each classroom consisted of one experimental group and two control groups. Each experimental group consisted of three students. Each of these students used the computer for CAI for a period of twenty minutes, three times per week from February 5 through May 11. Computer programs used by the students varied weekly so as not to cause familiarity or boredom with a particular program. A list of all programs used in the study can be found in the Appendix.

Control Group I consisted of those students who also scored at the 35th percentile and below. These students received the exact math lessons as the three students in the experimental group. The only difference between the two groups was the computer-assisted instruction. Control Group II consisted of the students remaining at each grade level. The results of these students were used to control for natural maturation at the various grade levels.

Limitations

Previous research in the area of computer education has shown that the Hawthorne Effect is often a cause for improved scores. This needs to be considered when drawing final conclusions about the study. In conjunction with the Hawthorne Effect, students may also become too familiar with computers as computers are now found in so many homes. While none of the students in the experimental group or Control
Group I have computers at home, a few children in Control Group II did have computers at home. This somewhat limits the results of the study.

Another major limitation is of course the lessons given by the individual teachers. As teachers are individuals, methods of teaching the different concepts tested in this study may vary. This limitation was slightly controlled by Control Group I who were receiving the exact lesson. Similarly, students are different and understand concepts at different rates and by different methods. This must also be considered.

Sample size must also be discussed as a limitation as well as the length of the study. Due to limited materials, namely, only one computer, sample size had to be limited. This limited sample makes generalization even to other schools in the area quite difficult. The fact that the study only ran for approximately three months might be very important in determining the true effects of CAI on achievement and attitude especially since attitude often takes a long period of time to change.

Two final limitations exist because of uniqueness of Yucca Loma School. The computer program being used in this study may not be similar to programs used in other schools. Lastly, the transiency rate and therefore attrition rate, may be unique to this geographic area and may have an effect on both the sample size and the final results.
FINDINGS

At the conclusion of the study, the ITBS and the questionnaires were readministered to all of the students who were also pretested. The final sample was comprised of exactly 80 students with the following breakdown in grade levels: Grade Three= 29; Grade Four= 25; Grade Five= 26.

Analytic Techniques

There were three steps used in analyzing the data. First, the tests were scored and each student was given a score which reflected the percent correct on the test. This was done for both the pre and post ITBS test. A percent was also assigned to each student which reflected the amount of change or percent increase from the pretest to the posttest. A mean was then found within each group (Experimental, Control Group I, Control Group II) which reflected the mean of the percentage that that particular group had changed. Lastly, a standard deviation was found for each group.

The questionnaires were scored in a similar way. Each item on the questionnaire was assigned a value, 10 points were assigned to answers which reflected a positive feeling toward mathematics, 5 points were assigned to the response "Sometimes" and 0 points were assigned to responses in which a child chose an answer other than a positive answer toward mathematics. Again a mean was found for each group and a standard deviation was calculated.
At the completion of the calculations of the Experimental Group and Control Group I, a t score was found to analyze whether the change was significant.

**Description of Findings**

Since there were two hypotheses tested, each hypothesis will be reviewed and analyzed separately.

**Hypothesis I:** The introduction of computers into the existing curriculum will have no significant effect on the academic achievement of children in two areas of mathematics, namely, basic concepts and applied concepts.

**Table 1**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>PRETEST $X_1$</th>
<th>POSTTEST $X_2$</th>
<th>CHANGE $X_1 - X_2$</th>
<th>CHANGE $\sigma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPERIMENTAL n= 9</td>
<td>30.2</td>
<td>51.1</td>
<td>20.9</td>
<td>14.57</td>
</tr>
<tr>
<td>CONTROL GROUP I n= 17</td>
<td>32.7</td>
<td>53.1</td>
<td>20.9</td>
<td>17.25</td>
</tr>
<tr>
<td>CONTROL GROUP II n= 54</td>
<td>60.8</td>
<td>73.1</td>
<td>12.3</td>
<td>11.46</td>
</tr>
</tbody>
</table>

$\overline{x}$ = Mean  
$\sigma$ = Standard Deviation  
$t$ = .074  
$24$ = Degrees of Freedom  
Not significant at Level .05
As was shown in Table 1, there was no significant change in mathematics achievement from the beginning of the study to the end between the Experimental Group and Control Group I. While there was a slight improvement in the Experimental Group, the percent increase was not significant at the .05 level according to the t test. Thus, the null hypothesis was supported for Hypothesis I.

Hypothesis II: The introduction of computers into the existing curriculum will have no significant effect on the students' attitude toward two areas of mathematics, namely, basic concepts and applied concepts.

### Table 2

**Mean Percentage of Attitude Questionnaire Scores, Percent Change, and Standard Deviation of Change**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>PRETEST $\bar{X}_1$ (%)</th>
<th>POSTTEST $\bar{X}_2$ (%)</th>
<th>CHANGE $\bar{X}_1 % - \bar{X}_2 %$</th>
<th>CHANGE $\sigma$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPERIMENTAL</td>
<td>6.78</td>
<td>6.78</td>
<td>0</td>
<td>1.38</td>
</tr>
<tr>
<td>n= 9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTROL GROUP I</td>
<td>5.24</td>
<td>5.38</td>
<td>.14</td>
<td>2.41</td>
</tr>
<tr>
<td>n= 17</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTROL GROUP II</td>
<td>6.10</td>
<td>5.57</td>
<td>-.53</td>
<td>1.56</td>
</tr>
<tr>
<td>n= 54</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\bar{X}$ = Mean  
$\sigma$ = Standard Deviation  
$t$ = -.235  
$24$ = Degrees of Freedom  
Not significant at Level .05
As was shown in table 2, there was no significant change in mathematics attitude from the beginning of the study to the end between the Experimental Group and the Control Group I. The change between the two groups was not significant at the .05 level according to the t test. Thus, the null hypothesis was supported for Hypothesis II.

**Other Findings**

When grade levels are looked at individually in academic achievement (see tables 3, 4, and 5) it would appear that the use of computers was successful at improving test scores in Grade Three. However, if this were true, the opposite would have to be said about Grade Four with no significant improvement in Grade Five. It must be kept in mind when looking at individual grade levels that the number in the Experimental and Control Group I was small within the grade levels and one score could skew the results drastically one way or the other.

**TABLE 3**

**MEAN PERCENTAGE OF ITBS SCORES AND PERCENT CHANGE BY GRADE LEVEL—GRADE THREE**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>PRETEST $\bar{x}_1$ %</th>
<th>POSTTEST $\bar{x}_2$ %</th>
<th>CHANGE $\bar{x}_2 - \bar{x}_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPERIMENTAL</td>
<td>18</td>
<td>48</td>
<td>30</td>
</tr>
<tr>
<td>n= 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTROL GROUP I</td>
<td>29.6</td>
<td>43.6</td>
<td>14</td>
</tr>
<tr>
<td>n= 5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTROL GROUP II</td>
<td>61</td>
<td>74</td>
<td>13</td>
</tr>
<tr>
<td>n=21</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 4

**MEAN PERCENTAGE OF ITBS SCORES AND PERCENT CHANGE BY GRADE LEVEL—GRADE FOUR**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>PRETEST $\bar{x}_1$</th>
<th>POSTTEST $\bar{x}_2$</th>
<th>CHANGE $\bar{x}_2 - \bar{x}_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPERIMENTAL</td>
<td>29</td>
<td>54.3</td>
<td>25.3</td>
</tr>
<tr>
<td>$n=3$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTROL GROUP I</td>
<td>29</td>
<td>68.3</td>
<td>39.3</td>
</tr>
<tr>
<td>$n=6$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTROL GROUP II</td>
<td>54</td>
<td>72.2</td>
<td>18.2</td>
</tr>
<tr>
<td>$n=16$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 5

**MEAN PERCENTAGE OF ITBS SCORES AND PERCENT CHANGE BY GRADE LEVEL—GRADE FIVE**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>PRETEST $\bar{x}_1$</th>
<th>POSTTEST $\bar{x}_2$</th>
<th>CHANGE $\bar{x}_2 - \bar{x}_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPERIMENTAL</td>
<td>44.3</td>
<td>51.7</td>
<td>7.4</td>
</tr>
<tr>
<td>$n=3$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTROL GROUP I</td>
<td>39</td>
<td>45.7</td>
<td>6.7</td>
</tr>
<tr>
<td>$n=6$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CONTROL GROUP II</td>
<td>66.7</td>
<td>73.6</td>
<td>6.9</td>
</tr>
<tr>
<td>$n=17$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A final comparison was made between boys and girls in the study (see table 6.) Again, no significant improvement can be found between the boys in the Control Group I and the boys in the Experimental Group. However, from the table it appears that the girls receiving CAI did significantly better than the girls in the Control Group I. Again, these results may be misleading due to sample size but it does appear as though the computer was able to help the girls slightly improve their test scores. This might be a topic for future study in the area of computer education.

**TABLE 6**

**MEAN PERCENTAGE OF ITBS SCORES AND PERCENT CHANGE BY SEX—BOYS VERSUS GIRLS**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>PRETEST $X_1$</th>
<th>POSTTEST $X_2$</th>
<th>CHANGE $X_2 - X_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EXP.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOYS $n=5$</td>
<td>33.8</td>
<td>51.2</td>
<td>17.4</td>
</tr>
<tr>
<td>GIRLS $n=4$</td>
<td>25.75</td>
<td>51</td>
<td>25.25</td>
</tr>
<tr>
<td><strong>C-I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOYS $n=10$</td>
<td>30.9</td>
<td>52.7</td>
<td>21.8</td>
</tr>
<tr>
<td>GIRLS $n=7$</td>
<td>35.3</td>
<td>53.5</td>
<td>18.2</td>
</tr>
<tr>
<td><strong>C-II</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BOYS $n=25$</td>
<td>57.2</td>
<td>71.8</td>
<td>14.6</td>
</tr>
<tr>
<td>GIRLS $n=29$</td>
<td>61.2</td>
<td>74.2</td>
<td>13</td>
</tr>
</tbody>
</table>
It is interesting to note that the students who scored at the 35th percentile and below, regardless of whether or not they received CAI, improved their test scores significantly more than those in Control Group II who were the average and above average students. This lends thought to the notion that perhaps the improvement which did occur in the Experimental Group and Control Group I was due in part to a natural maturation or development of the lower achieving students. That is to say, perhaps these lower academic students had finally come to an understanding of the material and were just slower than their average peers. This would somewhat account for the individual grade level scores decreasing with age thereby in a sense closing the gap between peers with Grade Five showing little difference. This suggests another topic to be researched in the future.

Further findings can be found in the attitude questionnaires. When analyzing the individual questions asked, it was revealed that most students enjoyed math and learning math facts. Reading was enjoyed equally as much as math but math was liked better than spelling. Approximately fifty percent liked fractions and more than fifty percent enjoyed geometry. Few children enjoyed story problems and most found math boring sometimes. Most liked playing games to learn math concepts and only ten students stated that computers were solely for playing games. (A frequency distribution can be found in the Appendix.)

Though the number of teachers involved in the study
was only three, an analysis of the results of their questionnaires must be done and compared to the student attitude questionnaire. (Frequency distribution can be found in the Appendix.) All three teachers involved in the study found manipulatives to be effective in teaching math even though only two of the three used them. Story problems were seen as frustrating to students by all of the teachers which may have some correlation with how the students felt about story problems. Geometry was perceived as somewhat enjoyable for the students which agrees with student opinion. None of the teachers found reading to be more enjoyable than math and in fact the teachers tended to feel that the students enjoyed math more than reading. The students, however, found the two subjects to be equally enjoyable. Both teachers and students found math to be more enjoyable than spelling. All three teachers changed their opinions of the basic facts to state they were stimulating which concurs with student opinion.

A direct dichotomy existed between the two teachers who felt computers are an effective way to teach math and the one who strongly objected. The objection by the one individual teacher was to the idea that the computers teach math. This teacher felt that computers should only be used to reinforce math skills, not teach them.

This was restated by the same teacher on the second page of the questionnaire which ranked the potential uses of the computer in the classroom. The three most common uses were
remediation, evaluating student progress, and simulating real events. Two of the teachers felt that the other uses were valid though not as important while the third teacher stated that the computer should never be used for teaching new concepts or problem solving. Perhaps the term "teaching" should have been more clearly defined.

When looking at the comparisons between student attitude and teacher opinion, several specific areas correlate. Perhaps the attitudes of students are somewhat affected by the enthusiasm and attitudes of their teachers. This is an idea which needs further research.
DISCUSSION AND CONCLUSIONS

This study looked at the effect of computer assisted instruction on lower achieving students in grades three, four, and five. The study found that over a short period of time, computer assisted instruction did not significantly aid the students in a classroom situation to achieve higher scores on standardized tests nor did the students appear to change their attitude after use of the computer in mathematics.

Limitations

The study had limitations in addition to those previously mentioned. The CAI was not administered in a lab situation as was found in the review of the literature. Rather, the students in the Experimental Group received the treatment in a regular classroom. This may have had some effect on the student scores. In addition, only lower academic students were examined in this study. The possibility exists that average and above average students might improve test scores at a higher rate than their peers and/or improve attitude toward mathematics. Further research needs to be gathered and tested in those areas with more participants in the Experimental Group.

Due to the limited size of the Experimental Group, little recognition of individual personality types could be taken into consideration. As previous research showed, some students do better in CAI than others simply because they learn by a
different method. A larger scale study where more students with varying learning styles can be tested and those test scores analyzed, might produce very different results.

Lastly, the amount of software available for this study as well as the quality of the software, was limited. There is a vast amount of software available on the market but the amount of funding available for this particular school was minimal. This may have limited the potential growth of the students in math achievement in the Experimental Group.

**Implications**

The study has several implications for education. Although the effect of CAI on achievement was not significant, the problem may not be that the students did not learn from the computer but that they did not transfer that knowledge to the standardized tests. This has at least one major implication. Perhaps what is being tested on standardized tests is not the accumulation of knowledge attained by students but how well students are able to take standardized tests. This would then greatly limit the use of computer education programs for improving test scores unless the software programs used are in the form of standardized tests. The software programs with which the students interacted in this particular study were not in the form of standardized tests.

There appears to be an impetus in education and particularly in individual school districts to purchase computers and software without much thought being given to the quality and effectiveness of them. Perhaps one computer in a class-
room does not have the effectiveness that a computer lab situation does which would imply that money might be better spent in ways other than a computer and software when only one can be purchased. If a computer and software are purchased, the software should be carefully analyzed and evaluated in terms of effectiveness, content, and ease with which students can understand the directions and apply the information to their existing knowledge. The teacher should have a purpose and rationale for use of the computer in the classroom for justification to parents and school.

If indeed computers are the future trend in education then teacher education programs need to provide future teachers appropriate training. These teacher trainees need to be made aware of the potential effectiveness of computer education programs and what they as teachers can do to best utilize the computer in the classroom. They need to be cognizant of the scheduling difficulties which occur with only one computer and thirty children and some practical classroom management techniques for properly diagnosing students and prescribing software beneficial to learning. In addition, they need to be taught back-up systems for improvising when the computer shuts down. Lastly, they need to be taught methods for evaluating the current software on the market. Perhaps beyond that the teacher trainees might also be taught how to write their own programs so that more effective programs could be used for individual student needs in individual classrooms. Additional programs might also be developed which have a higher correlation with the standardized test being used.
since standardized testing appears to be the most common method for evaluating student growth.

Student attitudes toward mathematics may be a direct reflection of the teacher's enthusiasm or lack of enthusiasm for the subject or concept being taught. If this statement is indeed valid, it would imply that teachers can affect attitudes more than a computer since a computer cannot express emotions either positive or negative. If computers are proposed to be used to significantly change attitudes toward math in the positive direction, potential software must be carefully studied and evaluated for that specific purpose. In addition, teachers must be enthusiastic about the potential of computer education, and thereby direct their attitudes toward computers in the positive direction.

The computer did have some effect on academic achievement in some of the students which cannot be overlooked. Some children may be able to learn or retain knowledge better than others based on individual learning styles. The computer in this particular learning situation could only be seen as a visual learning device and not as an aural learning device. Therefore, those students who do not learn as well by visual techniques would not have improved as significantly as those who do learn easily by visual techniques. Thus, the computer needs to be considered as one of a wealth of tools which may be used to help some students attain higher test scores and develop more positive attitudes toward mathematics.
APPENDIX
DIRECTIONS FOR QUESTIONNAIRES

STUDENT QUESTIONNAIRES

1. Administer one to each child in your class. The questionnaires are numbered according to your class list. Please pass them out according to your class list. This is done so as not to identify the individual child, but to validate the questionnaires. Only those children who answer the questionnaires initially will receive questionnaires for the final evaluation.

2. Please read each item to the children and allow ample time for each child to complete the item. Instruct them to either put a check or an "X" in the blank.

3. Encourage the children to answer questions 13 and 14 as honestly as possible. Please aid them if they need help with spelling.

TEACHER QUESTIONNAIRES

1. Please answer questions as honestly as possible as your responses will be a part of the final evaluation process for the project.

2. Answer question 11 assuming that you had the use of a computer for the students in your classroom even if you don't.

3. Any comments about the project or questionnaires are encouraged and welcomed.

Thank you for your time, both personal and classroom time, spent on answering the questionnaires, collecting the questionnaires, and returning them to me.
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</table>

**GRADE YOU TEACH**

1. The students find math groups stimulating.

2. I use manipulatives such as blocks, games, beans, counters, etc. to teach math.

3. I think manipulatives (see above) are ineffective in teaching most children.

4. The children find basic math facts (+, -, x, ÷) fun and stimulating.

5. The children get easily frustrated with story problems.

6. Geometry is fun for the students.

7. The students enjoy reading more than math.

8. The students enjoy math more than spelling/language.

9. I think computers are an effective way to teach math.

10. I am happy with the way my math program is at present.

A = Strongly Agree  a = Agree  ? = No Opinion  d = Disagree  D = Strongly Disagree

(Top score represents pretest and bottom score represents posttest.)
11. If I had my choice about use of a computer to teach math I would choose: (Please Number in Order of Preference 1-7)

___ Remediation of students
___ Teaching new concepts
___ Teaching steps of problem solving
___ Simulating real events
___ Teaching programming to the students
___ Record Keeping
___ Evaluating Student Progress

12. Comments:

If you would like a copy of the results from this research either on your students only or in general, please tear off the bottom portion of this sheet and return it with the questionnaires.

___ Yes, I would like a copy of the results of my students only
___ Yes, I would like a copy of the general results.

Name ____________________
I AM A  BOY   GIRL

1. I enjoy doing Math at school.
2. I like reading better than math.
3. I think learning multiplication tables is fun.
4. I like spelling better than math.
5. I dislike doing fractions.
6. Geometry is a lot of fun.
7. I think learning addition and subtraction is fun.
8. I enjoy doing story problems.
9. Math is boring for me.
10. I like playing games to learn things in math.
11. Computers are for playing games.
12. I use a computer at school.

13. The best thing about math is: ___________________________

14. The thing I don't like about math is: ___________________________
1. Alien Addition, Minus Mission, Meteor Multiplication and Demolition Division By Developmental Learning Materials (DLM). Drills the basic facts in mathematics and scores the students according to number correct in a certain amount of time.

2. Bumble Games By The Learning Co. Teaches children how to place numbers on a graph by plotting to reveal pictures.

3. Fractions Sequence By Milliken. Introduces the concept of fractions and then advances each child through various uses of fractions at his own pace.

4. Gulp!! And Arrow Graphics Edufun By Milliken. Drills basic math facts and times the student on them. Also teaches direction and following directions in Graphics.

5. Piece of Cake by Counterpoint. Drills various skills in math including problem solving, basic facts and speed in basic facts.
BIBLIOGRAPHY


