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The Effectiveness Of Supplementary Computer-Assisted Instruction In Reading At The 4-6 Grade Level (Four-Six)

Lois Nentwich Ortmann

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THE EFFECTIVENESS OF SUPPLEMENTARY COMPUTER-ASSISTED
INSTRUCTION IN READING AT THE 4-6 GRADE LEVEL

A Dissertation
Presented to
the Faculty of the Graduate School
University of the Pacific

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

by
Lois Nentwich Ortmann
This dissertation, written and submitted by

Lois N. Artmann

is approved for recommendation to the Committee on Graduate Studies, University of the Pacific

Dean of the School or Department Chairman:

[Signature]

Dissertation Committee:

Heath W. Lowry, Chairman

[Signature]  John W. Schippers

[Signature]  Mary Bum

Bobby R. Hopkins

Dated October 26, 1983
THE EFFECTIVENESS OF SUPPLEMENTARY COMPUTER-ASSISTED INSTRUCTION IN READING AT THE 4-6 GRADE LEVEL

Abstract of Dissertation

The purpose of this study was to determine the effectiveness of supplementary computer-assisted instruction in raising the reading achievement of Chapter I pupils in grades 4, 5 and 6. There were 340 subjects in the sample, students in the Manteca Unified School District. Subjects were assigned to either the Experimental or Control Group based on their Reading Subtest scores on the Comprehensive Tests of Basic Skills.

The experiment was a non-randomized, pre-test/posttest design. Variables included each pupil's grade level, sex and ethnicity. The pre-test was the 1980 administration of the CTBS, Form S, and the posttest was the 1982 administration of the same test.

Analysis of variance and analysis of covariance were used to examine each pupil's raw score, percentile rank and reading grade placement. Scores on the Vocabulary and Comprehension Subtests were examined separately.

The results of the analyses showed that supplementary computer-assisted instruction in reading may be an effective method of raising reading achievement in some pupils. Data from this study indicate that neither sex nor ethnicity are reliable predictors of reading achievement. Pupils at different grade levels made comparable gains. There was a greater difference between the pre-test scores of high and low achieving Hispanics than between those of high and low achieving Anglos. After a year of supplementary CAI, the low achieving Hispanics made greater gains in reading than the low achieving Anglos who had received the same instruction.
CONTENTS

LIST OF TABLES .................................................. vii

Chapter

1. INTRODUCTION TO THE STUDY ................................. 1
   Statement of the Problem ................................. 3
   The Subproblems ........................................... 4
   The Hypotheses ............................................ 5
   Delimitations of the Study .............................. 6
   Limitations of the Study ................................ 7
   The Definitions of Terms and Abbreviations .......... 7
   Assumptions of the Study ................................ 9
   The Need for the Study ................................... 9
   Organization of the Study ............................... 11

2. REVIEW OF THE RELATED LITERATURE ....................... 12
   Introduction ............................................. 14
   PLATO ......................................................... 15
   The Stanford Project .................................... 16
   TICCIT ......................................................... 16
   Associationism ........................................... 18
   I. P. Pavlov ............................................... 19
   E. L. Thorndike ........................................... 21
   Connectionism and the Three Laws of Learning ....... 21
   Behaviorism ............................................... 23
<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edwin R. Guthrie</td>
<td>23</td>
</tr>
<tr>
<td>Edward C. Tolman</td>
<td>24</td>
</tr>
<tr>
<td>Clark L. Hull</td>
<td>25</td>
</tr>
<tr>
<td>Operant Conditioning</td>
<td>26</td>
</tr>
<tr>
<td>B. F. Skinner</td>
<td>27</td>
</tr>
<tr>
<td>The Cybernetic Model</td>
<td>29</td>
</tr>
<tr>
<td>The Process of Programming</td>
<td>30</td>
</tr>
<tr>
<td>The Development of a CAI Program</td>
<td>33</td>
</tr>
<tr>
<td>Research in the Teaching of Reading</td>
<td>36</td>
</tr>
<tr>
<td>Programmed Instruction in Reading</td>
<td>36</td>
</tr>
<tr>
<td>Programmed Instruction Today</td>
<td>40</td>
</tr>
<tr>
<td>Computer-Assisted Instruction in Reading</td>
<td>41</td>
</tr>
<tr>
<td>Social Aspects of CAI</td>
<td>47</td>
</tr>
<tr>
<td>Why CAI is Unique</td>
<td>48</td>
</tr>
<tr>
<td>Storage and Retrieval</td>
<td>49</td>
</tr>
<tr>
<td>Hardware</td>
<td>50</td>
</tr>
<tr>
<td>Software</td>
<td>51</td>
</tr>
<tr>
<td>Computer Language</td>
<td>52</td>
</tr>
<tr>
<td>Feedback</td>
<td>55</td>
</tr>
<tr>
<td>Extrinsic and Intrinsic Reinforcement</td>
<td>57</td>
</tr>
<tr>
<td>Reinforcement Schedules</td>
<td>59</td>
</tr>
<tr>
<td>Performance Styles</td>
<td>60</td>
</tr>
<tr>
<td>Modes of Instruction</td>
<td>61</td>
</tr>
<tr>
<td>Summary</td>
<td>65</td>
</tr>
<tr>
<td>3. PROCEDURES OF THE STUDY</td>
<td>68</td>
</tr>
<tr>
<td>The Sample</td>
<td>68</td>
</tr>
<tr>
<td>Chapter</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Data and Instrumentation</td>
<td>72</td>
</tr>
<tr>
<td>The CTBS</td>
<td>74</td>
</tr>
<tr>
<td>The Ginn 720 Reading Program</td>
<td>75</td>
</tr>
<tr>
<td>Reading, Grades 3-6</td>
<td>75</td>
</tr>
<tr>
<td>Reading for Comprehension</td>
<td>76</td>
</tr>
<tr>
<td>Experimental Treatment and Design</td>
<td>77</td>
</tr>
<tr>
<td>Statistical Analysis</td>
<td>83</td>
</tr>
<tr>
<td>Summary</td>
<td>85</td>
</tr>
<tr>
<td><strong>4. FINDINGS OF THE STUDY</strong></td>
<td></td>
</tr>
<tr>
<td>Total Group Achievement</td>
<td>87</td>
</tr>
<tr>
<td>Grade Level, Sex and Ethnicity</td>
<td>88</td>
</tr>
<tr>
<td>Grade Level Differences</td>
<td>95</td>
</tr>
<tr>
<td>Raw Scores, Grade 4</td>
<td>103</td>
</tr>
<tr>
<td>Raw Scores, Grade 6</td>
<td>104</td>
</tr>
<tr>
<td>Reading Grade Placement</td>
<td>106</td>
</tr>
<tr>
<td>Vocabulary Subtest Results</td>
<td>107</td>
</tr>
<tr>
<td>Comprehension Subtest Results</td>
<td>110</td>
</tr>
<tr>
<td>Summary of the Findings</td>
<td>115</td>
</tr>
<tr>
<td><strong>5. CONCLUSIONS AND RECOMMENDATIONS</strong></td>
<td></td>
</tr>
<tr>
<td>Total Group Achievement</td>
<td>122</td>
</tr>
<tr>
<td>Hypothesis 1</td>
<td>128</td>
</tr>
<tr>
<td>Sex and Ethnicity</td>
<td>129</td>
</tr>
<tr>
<td>Hypothesis 2</td>
<td>129</td>
</tr>
<tr>
<td>Hypothesis 3</td>
<td>130</td>
</tr>
<tr>
<td>Hypothesis 4</td>
<td>131</td>
</tr>
<tr>
<td>Grade Level Differences</td>
<td>132</td>
</tr>
<tr>
<td>Hypothesis 4</td>
<td>132</td>
</tr>
</tbody>
</table>
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## TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Summary of Background Factors for Grade Six, 1980-81</td>
<td>70</td>
</tr>
<tr>
<td>2. Analysis of Covariance of The Effects of Instruction on Total Reading Raw Scores of the Total Sample, Grades 4-6</td>
<td>90</td>
</tr>
<tr>
<td>3. Adjusted Mean Scores Earned by the Sample Population on the Total Reading Portion of the CTBS, 1982</td>
<td>90</td>
</tr>
<tr>
<td>4. Mean Total Reading Raw Scores for the Sample Population by Group and Year</td>
<td>92</td>
</tr>
<tr>
<td>5. Mean Reading Grade Placements for the Two Instructional Groups, 1981 and 1982</td>
<td>93</td>
</tr>
<tr>
<td>6. The Effects of Instruction, Grade Level, Sex and Ethnicity on the Total Reading Raw Scores of the Total Sample, with 1981 Scores as the Covariate</td>
<td>95</td>
</tr>
<tr>
<td>7. Mean Reading Grade Placement Gains by Ethnic Group, Year and Type of Instruction</td>
<td>98</td>
</tr>
<tr>
<td>8. The Effects of Interactions Between Variables on the Total Reading Raw Scores of the Total Sample, Grades 4-6</td>
<td>100</td>
</tr>
<tr>
<td>9. Adjusted Mean Raw Scores in Total Reading Earned by Anglos and Hispanics Receiving Two Types of Instruction</td>
<td>101</td>
</tr>
<tr>
<td>10. Mean Reading Grade Placements of the Sub-Groups for the Years 1981 and 1982</td>
<td>102</td>
</tr>
<tr>
<td>11. The Effects of Instruction on the Total Reading Raw Scores of Grade 4 Pupils</td>
<td>104</td>
</tr>
<tr>
<td>12. Mean Raw Scores for Grade 4 Pupils by Group and by Year, CTBS, Level 1</td>
<td>106</td>
</tr>
<tr>
<td>Table</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>-------------</td>
</tr>
<tr>
<td>13.</td>
<td>The Effects of Instruction on Total Reading Raw Scores of Grade 6 Pupils</td>
</tr>
<tr>
<td>14.</td>
<td>Mean Reading Grade Placement for Grades 4-6, 1980-1982</td>
</tr>
<tr>
<td>15.</td>
<td>Mean Reading Grade Placement Gains for Each Type of Instruction, Grades 4-6, 1981-1982</td>
</tr>
<tr>
<td>16.</td>
<td>A Comparison of the Unadjusted Mean Scores in Total Reading for Manteca Unified and the Publisher's Standardization Sample</td>
</tr>
<tr>
<td>17.</td>
<td>The Effects of Instruction, Sex, and Ethnicity on Vocabulary Subtest Raw Scores for Each Grade Level, 4-6</td>
</tr>
<tr>
<td>19.</td>
<td>Mean Gains on the Vocabulary Subtest for Grades 4-6, 1981-1982</td>
</tr>
<tr>
<td>20.</td>
<td>The Effects of Instruction, Sex and Ethnicity on Comprehension Subtest Raw Scores for Each Grade Level, 4-6</td>
</tr>
</tbody>
</table>
Chapter 1

INTRODUCTION TO THE STUDY

Historically, research in reading instruction has sought to discover the one "best" method of teaching children to read. Different generations of teachers and researchers have perceived different approaches to be superior and have conducted research to support these beliefs. It is interesting to note that in few studies was the dominant method in use at the time ever found to be the best.\(^1\) Research since the 1950's, however, climaxing with the definitive study by Chall, suggests that not one, but a combination of approaches, including basal, phonic, and structural elements, may in fact be the most effective way to teach reading.\(^2\)

The desire for accountability in education requires the reading teacher to use the most effective combination of teaching approaches. Work in the field of individual differences suggests that this combination may not be the same for every pupil.\(^3\) In fact, some current research lends

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\(^2\)Ibid., pp. 307-10.

credence to the belief that learning is the result of "the interaction of learner aptitudes and variables which are . . . part of textual materials and teaching behavior."\textsuperscript{4} That is to say, "the form of the content is a mediating variable in the learning process,"\textsuperscript{5} as well as the individual characteristics of the learner. One form of presenting reading content to remedial pupils which has not yet been fully examined is through the use of computer-assisted instruction as a supplement to regular classroom instruction.

According to a March, 1982 survey of 224 school sites in California, 146 are currently using microcomputers in their educational programs and an additional twelve sites anticipate acquisition of computers during the 1982-83 fiscal year. Of those responding to the survey, ten districts reported that they are using computers for instruction in the area of Reading.\textsuperscript{6}

Despite this somewhat limited current usage, computer-assisted instruction is a fitting field of inquiry for the reading researcher. It is through the computer that educators and technologists can work together to remedy what Lesser calls "the greatest source of inefficiency in


\textsuperscript{5}Ibid., p. 2.

\textsuperscript{6}William J. Wells, "CASBO 1982 Microcomputer Survey" (Sacramento: CASBO Sacramento Section, Data Processing, 1982). (Mimeographed.)
education," the failure to provide for individual differences.7

Statement of the Problem

California is committed to the idea that every child has a right to read. During the 1981-82 school year, $247,219,833 in federal funds came to California schools in grant awards made under Chapter I of the Elementary and Secondary Education Act.8 A primary purpose of the ESEA is to help school districts raise the achievement levels of poor readers. A significant portion of grant money is spent to provide computer-assisted instruction for these under-achieving readers at the elementary school level. A recent article in the American School Board Journal estimated that about 400,000 microcomputers are owned and used by schools in the United States right now.9

There are no extensive research studies to date which examine the use of computer-assisted instruction in reading as a supplement to a basal program with Chapter I students at the 4th to 6th grade level. Before more money


and effort are expended, it is necessary to answer the ques-
tion: Does computer-assisted instruction used as a regular
supplement to a basal program increase reading achievement
in Chapter I students, and does such instruction affect
pupils with various personal characteristics differentially?

The Subproblems

Research suggests that the effectiveness of any
teaching strategy should be studied in the light of the
individual characteristics of the learners. Such character-
istics as sex, grade level, academic ability and ethnicity
have all been found by some researchers to affect learning.
In view of these earlier studies, five subproblems seem
appropriate.

Subproblem one. The first subproblem is to deter-
mine whether there is a difference between the reading
achievement of students receiving a basal reading program
supplemented by computer-assisted instruction and the
achievement of pupils receiving the basal program alone.

Subproblem two. The second subproblem is to deter-
mine whether there is a difference between the reading
achievement gains of minority group students taught by a
basal reading approach and those taught by a basal approach
supplemented by computer-assisted instruction.

Subproblem three. The third subproblem is to deter-
mine whether there is a difference between the reading
achievement gains made by male and female students receiving basal instruction supplemented by computer-assisted instruction.

**Subproblem four.** The fourth subproblem is to determine whether there is a difference among the reading achievement gains made by 4th, 5th and 6th grade students who receive basal instruction supplemented by computer-assisted instruction.

**Subproblem five.** The fifth subproblem is to determine whether there is an interaction between a pupil's sex, grade level, ethnicity, type of reading instruction received and reading achievement. That is, are the two types of instruction equally effective or ineffective for all types of individuals? If there is no interaction between the treatment and the individual characteristics of the subjects, we can generalize the findings with much greater confidence. Generalization must be qualified, however, if interaction is found to be present.10

The Hypotheses

The following research hypotheses represent restatements of the subproblems identified earlier in this chapter. These hypotheses appear in the null form in Chapter 4.

---

1. Chapter I students in the 4th, 5th and 6th grades in a rural area demonstrate significantly greater gains in norm-referenced reading achievement after one year of supplementary computer-assisted instruction than students who do not receive the supplementary instruction.

2. Chapter I minority group pupils who receive supplementary CAI for one year will demonstrate significantly greater gains in norm-referenced reading achievement than minority group students who do not receive the computer-assisted instruction.

3. Chapter I male pupils receiving supplementary computer-assisted instruction in reading make significantly greater gains in norm-referenced reading achievement than female pupils receiving the same instruction.

4. Chapter I students in the 4th, 5th and 6th grades achieve differentially under a supplementary computer-assisted instruction program in reading.

5. Among Chapter I students, there is a significant relationship between a pupil's grade, sex, ethnicity, type of instruction and gains in reading achievement.

Delimitations of the Study

This study was limited to 4th, 5th and 6th grade English proficient pupils from a rural California school district of approximately 9,000 students. All students in the sample received basal reading instruction at an appropriate level in the Ginn 720 Reading Program. Pupils in the
Experimental Group received supplementary computer-assisted instruction on a regularly scheduled basis for one year. All students received computer-assisted instruction in the same Computer Center from the same instructor. Students worked on programs designed to remediate specific reading deficiencies, as determined by the teacher or the administration, as well as on programs designed to increase general reading abilities.

Limitations of the Study

The findings of this study may be generalized only to 4th, 5th and 6th grade populations in districts similar to the Manteca Unified School District. Other specific limitations are recognized. This study:

1. did not attempt to evaluate the effectiveness of the Ginn 720 Reading Program as a basal reading program.
2. did not attempt to evaluate the achievement of individual pupils.
3. was limited to pupils who have remained at the same school for the entire school year, 1981-82.
4. limited the Experimental Group to pupils using the programs Reading Grades 3-6 and Reading for Comprehension, published by the Computer Curriculum Corporation.

The Definitions of Terms and Abbreviations

The following definitions of terms and abbreviations were used throughout this study:
Basal reading program. A program concerned with the systematic development of reading skills and abilities including comprehension and word attack. In this study, the basal reading program was the Ginn 720 Reading Program.

CAI. Computer-assisted instruction.

Chapter I. A Chapter I student qualifies for compensatory instruction in a basic skill area under a provision of the Education Consolidation and Improvement Act of 1981 (ECIB).

Computer-assisted instruction. For this study, computer-assisted instruction referred to students interacting in a drill-and-practice format with on-line computers through the use of terminal screens and keyboards. The students used the programs Reading Grades 3-6 and Reading for Comprehension, published by Computer Curriculum Corporation.


Drill-and-practice. A mode of instruction designed to help the student acquire mastery of concepts already presented by the teacher. It is a repetitive and highly structured review in which correct responses are reinforced and errors are corrected immediately.

English proficient. Students who scored at Level 3, 4 or 5 on the Bilingual Syntax Measure, or native English speakers.

Interaction. Certain combinations of factors that
produce effects over and above those that would be expected from the factors considered separately and independently.\textsuperscript{11}

**Minority group pupil.** A pupil who is not Caucasian.

**Norm-referenced reading achievement.** Learning reflected by the total raw score on the CTBS, Reading subtest.

**On-line.** Receiving input and producing output.

**Program.** A planned sequence of instructions to a computer in order to produce a desired output.

**Assumptions of the Study**

A certain number of assumptions were made in the design of this study. These assumptions included the belief that:

1. maximizing pupil gains in reading achievement is a goal of the educational system of California.

2. CAI will continue to be used as a form of supplementary reading instruction in the elementary school.

3. pupils selected for this study are representative of the universe of rural California Chapter I elementary school pupils.

4. the CTBS is a valid and reliable tool for evaluating achievement in reading.

**The Need for the Study**

According to the Educational Policies Commission, \textsuperscript{11}Hopkins and Glass, op. cit., pp. 368-69.
No skill . . . is more fundamental than reading. It remains the chief means by which anyone can continue his education . . . after his school days have passed.  

Chapter I pupils in California elementary schools should be helped to develop to their greatest reading potential. Since, according to Chall, "no program can do all things for all children," a variety of approaches must be developed and tested. 

Research to date has suggested that computer-assisted instruction may be an effective approach to instruction. According to Grimes, 

Computer-assisted instruction is a powerful extension of the teacher. It is a valuable learning resource that should be integrated into the regular flow of instruction rather than be considered a separate or unique program. 

There is, so far, a lack of research regarding the use of supplementary computer-assisted instruction with lower achieving elementary school pupils for the purpose of increasing achievement in reading. It was this lack of evidence concerning the efficacy of computer-assisted instruction in reading which provided the justification for this study. 

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Organization of the Study

In the introductory chapter the problem of, and the need for, this study have been explained. The subproblems and their related hypotheses have been presented. Terms and abbreviations used in the study have been defined. The delimitations, limitations and assumptions have been discussed. There are four additional chapters.

A review of the literature related to this study is presented in Chapter 2. This review includes an overview of the learning theories involved in the development of computer-assisted instruction, a description of the programming process, a discussion of computer-assisted instruction performance styles, and a review of research related to computer-assisted instruction in reading.

In Chapter 3, the procedures followed in conducting this study are described. This includes the sample description, administration and description of the testing instruments, the experimental treatment and design, and the statistical analyses employed.

Chapter 4 presents the results of the study. This includes the data generated by the statistical tests in regard to each of the five hypotheses. Results are presented in both narrative and tabular forms.

Chapter 5 contains an interpretation and discussion of the results reported in Chapter 4. It reports conclusions and makes recommendations for further study.
Chapter 2

REVIEW OF THE RELATED LITERATURE

One of the most popular exhibits at the 1982 World's Fair in Knoxville, Tennessee was located in the U.S. Pavilion. It was a display of interactive videodiscs connected to 23 Apple II computers with the capability of displaying graphically the meanings of 480 energy-related terms at the touch of the viewer's finger.¹

There is at this time a bill before Congress, the Technology Education Act of 1982, that if passed would provide at least one microcomputer for each of the 75,000 public elementary and secondary schools in the United States.²

According to L. R. Stewert, computers are now being successfully used to provide instruction in the areas of reading, history, mathematics, social studies, geography, science, environment, art, music, English, creative writing, special education, vocational education, physical education and health.³ In some districts, such as the Lyons Township,


in Illinois, computer literacy before graduation is a top priority of the system.⁴

But not all reactions to computers are positive ones. One problem preventing the more widespread use of computers in the schools is the paucity of teacher education programs which prepare graduates to use these new teaching tools.

According to Hausmann, university faculty gave a variety of reasons for not teaching their students to use computers in their own classrooms. These reasons included the beliefs that computer-assisted instruction is impersonal and, therefore, boring; that computer-assisted instruction encourages laziness in teachers; and that "extended exposure to a CAI terminal might cause regressive social behavior similar to that caused by too much exposure to television."⁵

What is this phenomenon called computer-assisted instruction, and where did it come from? How are materials for CAI developed and implemented? Does it appear to be an effective strategy for teaching reading? Why is computer-assisted instruction of such interest to educators? These are some of the topics dealt with in this chapter. More specifically, this review of the literature related to


computer-assisted instruction has attempted to show that:
(1) Computer-assisted instruction as a classroom strategy is based on the theory of Behaviorism. (2) Computer software for educational use is based on the cybernetic model of instruction. (3) Computer-assisted instruction appears to be an effective method for teaching reading to some students. The body of research in this area, however, is small. (4) The capabilities of computer-assisted instruction make it of great interest to educators concerned with the individualization of instruction.

Introduction

Sidney Pressey is credited with being the first person to design and use a teaching machine in a regular classroom.6

About this same time Norman Crowder, best known for his development of the scrambled book, was investigating the intrinsic or branching program.7 In a branching program, the route from the first frame to the last is determined by the responses of the student, rather than by the program design.

A third type of device, such as those designed by B. F. Skinner, utilized the constructed response.8 These

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7Ibid., p. 5. 8Ibid., p. 19.
machines presented frames to which a pupil responded in his own words. The program was linear, rather than branched, with a fixed order of steps.

Teaching machines were popular for only a short time during the 1950's and 1960's. Children using the devices grew bored because the machines were unable to individualize in any manner other than rate of presentation. The idea of using an automated device as an aid to instruction, however, has remained popular. Experiments during the 1960's utilized a new device, the computer, to present programs of instruction similar to those written by Pressey, Crowder and Skinner.

A computer is an electronic device capable of both input and output functions. The first large-scale computer, ENIAC, was built in 1946 by J. Presper Eckert and John W. Mauchly. Early machines were in fact capable only of computing, and the name stuck. Most modern computers are actually digital Boolean processors, which is to say they respond to discrete data on a binary basis.

**PLATO**

PLATO, Programmed Logic for Automatic Teaching Operation, was the first major computer-assisted instruction project in the United States. The project was designed by Donald Bitzer at the University of Illinois in 1960 for the

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purpose of adding interest to the somewhat dull materials available for individualized instruction at that time.10

The Stanford Project

In 1963, the Institute for Mathematical Studies in the Social Sciences began a research and development project in computer-assisted instruction at Stanford University, directed by Patrick Suppes and Richard C. Atkinson.11 As part of the project, the first computer-assisted instruction in reading began in 1966 at the Brentwood Elementary School in East Palo Alto, California.12 Fifty first-graders participated in a study designed to test the feasibility of teaching basic reading skills with a tutorial program via computer.

TICCIT

TICCIT, Time-shared Interactive Computer-Controlled Information Television is the joint project of C. Victor Bunderson, the University of Texas and the Mitre Corporation. Bunderson developed his new approach in 1970 while at Brigham Young University in Utah. The purpose of the TICCIT

10Ibid., pp. 19-20.


project is to implement computer-assisted instruction in American schools and to change the role of the teacher from one of instructor to one of tutor-advisor, diagnostician and problem-solver.¹³

The computer-assisted instruction movement got off to a slow start because of the original high costs of implementation and the lack of available programs.¹⁴ Recent developments, however, have reduced the cost per pupil contact hour, and scores of companies are now producing high quality educational software.¹⁵

With the sales of classroom computers increasing by 31% annually,¹⁶ it seems evident that computer-assisted instruction will continue as an important adjunct to traditional instruction for some time to come. It is important for today's teacher to be familiar with computer-assisted instruction as a valuable and available tool for classroom use. Toward that end, it is the purpose of this literature review to show that: (1) computer-assisted instruction and programmed instruction are based on the same psychological/theoretical principles; (2) the design of both computer software for educational use and programmed materials are

¹³Baker, op. cit., p. 22.


¹⁶Ibid., p. 66.
based soundly on the cybernetic principle of instruction; (3) both computer-assisted instruction and programmed instruction appear to be effective materials for teaching reading to some children; and (4) computer-assisted instruction is uniquely suited to individualize instruction for maximum gains because of its ability to store and retrieve information, to provide immediate feedback or knowledge of results, and to perform in a variety of styles.

Associationism

The doctrine of association has been the basis for explaining the thought process since the time of the early Greeks. Aristotle described these connections between ideas, called "Laws of Association," as being based on similarity, contrast and contiguity.

Because ideas are neither observable nor subject to scientific scrutiny, many psychologists rejected the Laws of Association as a way of explaining how learning occurs. These psychologists believed that learning occurred through the formation of an association between an energy change in the environment, to which an organism reacts (a stimulus)


19Bugelski, op. cit., p. 41.

20Blair, Jones, Simpson, loc. cit.
and a reflex (a response). These physical changes were observable, at least under laboratory conditions, and were hence more acceptable to the scientific community at the turn of the century.\textsuperscript{21,22} The new theory was known as "stimulus-response association"\textsuperscript{23} or "behaviorism."\textsuperscript{24}

I. P. Pavlov

The basis for the scientific study of the learning process was established in the early 1900's by I. P. Pavlov, in Russia, and by E. L. Thorndike, in the United States.\textsuperscript{25} Working as a physiologist studying the digestive systems of dogs, Pavlov made discoveries which profoundly affected the development of educational psychology to this day.

Classical conditioning. From his work with dogs, Pavlov knew that salivation at the sight of food was a natural, or unconditioned, response. Through experimentation and serendipity, he found that if an audible signal was sounded at the same time that the food was shown to the dog, and this was repeated several times, the dog would eventually begin to salivate at the sound of the signal alone.

\textsuperscript{21}Bugelski, op. cit., pp. 41-42.

\textsuperscript{22}Blair, Jones, Simpson, loc. cit.


\textsuperscript{24}Ibid., p. 327.

\textsuperscript{25}Bigge and Hunt, op. cit., pp. 107-8.
The salivation to the signal was a **conditioned response**, a form of learning.

Of the secondary principles of classical conditioning described by Pavlov, **extinction** is the most important. Pavlov found that if the unconditioned stimulus is omitted in a series of trials, the conditioned response begins to decrease and finally disappears. He described the unconditioned stimulus as a reinforcer or strengthener of the response, not a reward. The distinction is important. Pavlov also found that an extinguished response may occur again after a period of rest. He called this phenomenon **spontaneous recovery**.

Another important principle described by Pavlov is **generalization**. Pavlov found that once a response was conditioned, another stimulus similar to the conditioned stimulus would also elicit it. The importance of the principle of generalization for the classroom is apparent when one considers the task of reading textual material in a variety of typefaces.

Akin to generalization is the principle of **discrimination**, by which a subject is trained to respond to only one stimulus and not to similar ones. This principle is

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27Ibid. 28Ibid. 29Ibid.
also most evident in the classroom setting, for according to Bugelski:

In the concept of discrimination as a function of the extinction of undesirable generalized conditioning, we meet head on with some of the basic goals of education. The process of education might even be defined as the formation of finer and finer discriminations. 30

E. L. Thorndike

Thorndike regarded Pavlov's experiments in classical conditioning as a curiosity, with nothing to add to the body of knowledge about learning. What Pavlov's theories lacked, according to Thorndike, was an appreciation for the great power of reward. 31, 32

From his observations of small animals in problem boxes, Thorndike concluded that animal learning was the result of bonds between sense impressions and impulses to action. He believed these associations remained a part of an animal's behavior in the future as a result of the consequences which followed the action. Thorndike also believed that a large part of human learning was the result of similar associations. 33

Connectionism and the Three Laws of Learning

Thorndike's observations and experiments led him to

30 Bugelski, op. cit., p. 49. 31 Ibid., p. 56.
32 Bigge and Hunt, op. cit., p. 328.
postulate three Laws of Learning. The Law of Effect states that when a connection between a stimulus and a response is made, and is followed by a satisfying state or a reward, that connection is strengthened. If a connection is followed by an annoyance or a punishment, the bond is weakened.

The Law of Exercise states that connections are strengthened with use and weakened with disuse. Use implies the continuance of rewards.

Thorndike's third law was that of Readiness. The Law of Readiness proposes that the learner must have the mental, physical and emotional capacity to perform the desired response. He must also be motivated to respond.

Thorndike saw learning as blind, dumb and mechanical, totally dependent on reward. He gave no place to understanding, insight or even intelligence.

The only real difference between Thorndike's procedures and those of Pavlov were that Thorndike approached the problem in a typical American way: he arranged a situation in which learning could occur and then left it strictly up to the learner. Where Pavlov, in essence, forced his dogs to salivate, Thorndike left it up to the cats to pull the strings or not to pull. Although two different schools of thought developed around the views of Pavlov and Thorndike, both theorists can be described as objectivistic and believing in learning as the necessary result of environmental manipulation. Pavlov manipulated stimuli; Thorndike manipulated rewards.

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36Ibid., p. 68.
Pavlov's theories were first used in the United States by the founder of Behaviorism, John B. Watson. Watson believed that learning took place as a result of conditioning, and that the strength of a habit was determined not by reward, but by the frequency of its association with the stimulus. Although Watson was a controversial and much criticized figure during the 1920's for his advocacy of stern measures of child rearing, he did little to build on the classical conditioning theories he was said to espouse.

Edwin R. Guthrie

Edwin R. Guthrie's central proposition was that learning (an alteration in behavior based on experience) consists of conditioning responses (the contraction of muscles and the secretion of glands) to stimuli (the activation of sense organs) which he called "contiguous conditioning." Guthrie considered learning to be a one-trial affair; he had little use for the ideas of exercise, practice or frequency. According to Guthrie, we need to

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40Ibid.
practice an act we have already learned how to perform because the same stimuli are not likely to appear again in exactly the same form.

Rewards and punishments were also excluded from Guthrie's scheme. Since these occur after a response has been made, the learning has already taken place and cannot be affected by subsequent events.41

An aspect of Guthrie's theory especially relevant to the development of programmed instruction is that of specific rather than general instruction. According to Guthrie:

All learning tasks must be broken down into the movements that make up the act to reveal what response patterns are to be learned in what situations. Whatever the learning task is . . . each task consists of multiple subtasks—the specific units or movements—and these must be associated with specific stimuli. The teacher must know the units and must always refrain from the general attack. The first step in teaching is job analysis.42

Edward C. Tolman

Although a Behaviorist like Watson and Guthrie, Tolman was among the first to declare that the simple stimulus-response approach could explain only a portion of human behavior.43 Tolman, like Pavlov, believed that

42 Bugelski, op. cit., p. 107.
associations were formed between stimuli through a series of paired experiences. Like Pavlov and Guthrie, Tolman also saw no connection between reward or reinforcement and learning. Frequency of pairing was the most significant factor. Tolman felt, however, that intervening variables, such as motivation, skill, kind of learning situation and past experience, influenced learning for the human pupil.

Tolman's work lead to the description, in behavioral terms, of the observed distinction between learning and performance, which he referred to as "latent learning." Latent learning, in simplest terms, means that a person could acquire a great deal of knowledge without ever showing it, or using it. Tolman elaborated on this concept to include the idea of learning by being told or shown (the lecture method) rather than by doing, as advocated by Thorndike and Dewey (the discovery method).

Clark L. Hull

During the 1930's and 1940's Clark L. Hull was considered to be the outstanding learning theorist in the United States. According to Hull, the theories of Thorndike and Pavlov could be reconciled by demonstrating the Pavlovian principles of generalization, discrimination and spontaneous recovery in a Thorndikean setting. Hull

accepted Thorndike's Law of Effect, concluding that learning does take place in response to a reward.

Principles of reinforcement. Hull's ideas on human learning are expressed in his Principles of Reinforcement. The theory of Primary Reinforcement, or the Contiguity Hypothesis, states that there will be no learning unless a drive is reduced. This could be restated as establishing motivation for the learning. Secondly, the drive need only be diminished, not eliminated. Thirdly, learning will proceed in increments, the size of the steps depending on what has to be learned.

The theory of Secondary Reinforcement states that if a stimulus is present just before the reward that reduces the primary drive is presented, that stimulus will take on reinforcement characteristics. For the learner, "knowledge of results" was found to be a secondary reinforcer in many cases.

Operant Conditioning

Operant conditioning is a unique blend of associationism and behaviorism which postulates, among other things, that the reinforcing stimulus or reward is most


49 Bugelski, op. cit., p. 76.
effective when it occurs not simultaneously with or preceding the response, but following it. The reward reinforces the response, or operant, making it more likely to recur.

B. F. Skinner

B. F. Skinner developed his systematic views of learning during the 1930's, making him a contemporary of Hull. Unlike Hull, however, Skinner was interested in the practical aspects of the learning process rather than theory.

Skinner saw the difference between his ideas and Pavlov's as resulting from the innate differences between men and animals. Skinner's subjects acted on their environment, changing it in some way, which resulted in a reward. Pavlov's subjects, on the other hand, were acted upon by environmental stimuli. This new Law of Effect implied that:

Instead of saying that a man behaves because of the consequences which are to follow his behavior, we simply say that he behaves because of the consequences which have followed similar behavior in the past.50

According to Skinner, the key to successful teaching is to discover the contingencies of reinforcement which would precisely manipulate or control the behavior of the individual.51 He felt traditional teaching methods were inefficient for several reasons: (1) pupil behavior was


51Ibid., p. 112.
dominated by escape stimulation; (2) there was too great a
time lapse between a behavior and its reinforcement; (3)
there was no program of reinforcement which moves pupils
forward through a series of progressive approximations to
the final complex behavior; and (4) desired behavior was
reinforced too infrequently.  

Programmed instruction. According to Skinner,

We design and redesign our curricula in a des­
perate attempt to provide a liberal education while
steadfastly refusing to employ available engineering
techniques which would efficiently build the interests
and instill knowledge which are the goals of educa­
tion.  

In 1959, Skinner was talking about programmed in­
struction, a term he coined in 1954. In programmed in­
struction, or PI, subject matter is broken down into small
steps which are arranged in a logical sequence. Each step
builds on the one preceding it. A learner progresses
through the steps, or frames, at his own pace, being rein­
forced immediately after each response. The success of PI
was dependent on complete stimulus control, something
Skinner felt could be best accomplished through the use of
teaching machines.

52Bigge and Hunt, op. cit., p. 367.

53B. F. Skinner, Cumulative Record (New York: Apple­

54B. F. Skinner, "The Science of Learning and the
pp. 88-97.

55B. F. Skinner, "Teaching Machines," Science, 128
(1958), pp. 969-77.
The mechanical teaching machines available to Skinner enjoyed only limited popularity. These included the paper disk and slider machines which he designed himself. By 1956, Skinner was "already dreaming of a teaching machine that would combine the capacity of an electronic computer with the facility of a typewritten response." It took only a few years for Skinner's dream to come true, and for computer-assisted instruction (CAI) to become the latest step in the application of behavioral theory to education through the use of technology.

The Cybernetic Model

Behavioral learning theory, according to Skinner, contains all the elements necessary for successful teaching and learning. Transforming these elements into useful instructional materials is done by a process called programming.

The development of a programmed lesson is based on the cybernetic model of instruction. This is a three-part model made up of: (1) Input—the content of the lesson and information about the learner; (2) Operation sequence—the questions asked or activities presented and the specified mode of response; and (3) Feedback—the responses to questions determine what further questions will be asked and the direction the program will go. This type of feedback is

56Fry, op. cit., p. 20. 57Ibid., p. 21.
58Frederick J. McDonald, Educational Psychology (Wadsworth: n.p., 1965), p. 60.
often called the "knowledge of results," and it is crucial to the success of a programmed lesson.

The Process of Programming

Good programming results in a rationally constructed and empirically validated set of materials, systems or procedures. The process is made up of five distinct stages.

Choosing objectives. The first stage of programming consists of determining the objectives of the instruction. The programmer needs to know exactly what changes are required in the pupils in terms of knowledge, skills or attitudes. Goals should be narrowly defined. The programmer needs to have operationally specified objectives if adequate measuring techniques are to be included.

Specific or behavioral objectives have three distinguishing characteristics. First, they must describe an observable performance. This performance could be a written or oral statement, an application of a concept, an identification of a principle in a new situation, or an action which

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59Fry, op. cit., p. 157. 60Ibid.


reflects a change in attitude.

In the second place, a behavioral objective must specify the condition under which a student will demonstrate mastery. These conditions include the use of reference books, calculators, pencil and paper, or other aids. Also, the kind of questions which will be asked must be described.

Third, a specific objective must indicate the level of performance required to demonstrate mastery. This level might be expressed in terms of an allowable number of errors, a rate of speed or a minimum number of items to be completed.

Criterion measures. The second stage of programming for the purpose of producing educational materials is the selection of criterion measures for the chosen objectives. Criterion measures differ from achievement tests in important ways. According to Glaser:

Behaviorally defined objectives describe the specific tasks a student must be capable of performing in order to achieve a particular knowledge or competence level. ... Measures cast in terms of such criterion standards provide information as to the degree of competence obtained by a particular student which is independent of reference to the performance of others. ... In instances where a student's relative standing is the primary purpose of measurement, reference need not be made to criterion behavior. Educational achievement examinations, for example, are administered frequently for the purpose of ordering students in a class or school, rather than for assessing their attainment of specified curriculum objectives.64

Items to be used in criterion referenced measures must be valid, based on the opinion of subject-matter specialists. That is, they must actually test what they purport to test. The items must also be discriminatory. They must distinguish between students who have mastery of the material tested and those who do not. The procedure for evaluating a pupil's performance on the measure must be clearly specified.65

**Target population.** After selecting objectives and appropriate criterion measures, the programmer is ready to begin the third stage. This stage consists of making measurements of the target population in such areas as vocabulary, mathematical ability, reading ability and interests. It may be necessary to prepare alternate forms of the material if there is a wide spread in the ability levels of the pupils. At this stage the program designer also decides whether or not the materials will be self-pacing, linear or branching, and the size of the steps.

**Material design.** In the fourth stage the actual initial design of the materials is made. Since programmed instruction itself is not really a medium, appropriate types

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of presentation will need to be selected. Early programs were presented by machines with small windows through which the student could view the problem and the possible solutions, or, which had a blank space where the answer could be inserted. Depending on the objectives, today's programs can be in the form of tapes, recordings, films, videotapes or computer terminals such as teletypewriters or cathode ray tubes (CRTs).

Trial and revision. The fifth and final stage is that of repeated trial and revision, usually with one student at a time under close supervision. Insight gained from watching a student use the program leads to the inevitable rewriting and restructuring which will be needed to bring the program up to the set standard. It is the usual practice to increase the size of the test group after every major revision. Final test conditions should approximate the situation in which the program is designed to be used.66

The Development of a CAI Program

The development of a program for use in computer-assisted instruction is very similar to the process of programming described earlier. There are five steps in building a program, beginning with the selection of objectives.

Objectives. Behavioral objectives usually contain

a verb which defines exactly what a student is to do upon completion of the instructional sequence. The purpose of the interactive or CAI program, as with any teaching strategy, is for the learner to achieve a given set of these objectives. The goal of achievement is usually a percentage of all the students participating in the learning experience. For example, if the goal was for 80 percent of the material to be mastered by 90 percent of the pupils, the program would be said to have an 80/90 criterion for the measurement of its success.

Test items. After objectives have been selected, test items must be developed. There may be one or many items for each objective, depending on the type of program. A pool of many test items of various forms such as multiple choice and fill-ins is developed. The items are administered to a sample population and the results are examined carefully. This examination is known as item analysis. The item analysis allows poor items to be discarded and good items to be retained. A "good" item is valid, neither too difficult nor too easy and discriminates between pupils who score high and low on the test as a whole.67

Materials. Once the specific items have been selected, materials can be developed. One of the first

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steps in designing an educational material or device is the construction of a flow chart. The flow chart clarifies the logic of the instruction, and identifies the sequential possibilities. A set is chosen to be included from all available information. Next, the type of media is determined. For example, will there be an auditory component, or only a visual? Will films and video tapes be included, or only textual materials? Lastly, the type of coding to be used is selected. This includes the use or omission of certain forms of reinforcement, the size of the print in the text and the selection of accompanying films or pictures.

Model of organization. The fourth step in the development of a CAI program is the formulation of a model of organization. In the master teacher model, the interaction between the student and the system is patterned after the performance of an effective teacher. In the teaching process model, the actual teaching task is analyzed in terms of the requirements for learning. Each specific teaching function is identified as to the sequence in which it will be performed and the conditions of performance. The process model has been reported to be the most effective. 68

Methods of interaction. Selecting the methods of interaction between the student and the system comprises the

last step in the program design process. These selections should be based on good teaching practice, taking into consideration applicable theories of cognition, personality and attitude. According to Fry, "there is . . . no clear and distinct justification for preferring either constructed-response or multiple-choice response programs." His own research suggests that "the type of response very probably depends heavily upon the type of material taught."

Research in the Teaching of Reading

Since 1900 there have been literally thousands of studies designed to ascertain, once and for all, the best way to teach children to read. Agreement among scholars, however, has been limited to some slight degree of consensus on when to begin, how to begin, and what to emphasize at the onset of instruction.

Programmed Instruction in Reading

According to Fry,

If one were to search the literature to answer our question, "How effective is programmed instruction in the teaching of reading?," he would be hard put to find much serious research bearing directly on this question.

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Perhaps the most comprehensive attempt to provide an answer to Fry's question was made by Ruddell.\textsuperscript{73}

Ruddell. R. B. Ruddell compared twenty-four first grade classrooms using four different reading programs: a basic reading series alone, the basic series with a linguistic supplement, a programmed series alone, and the programmed series with the linguistic supplement. Students in the sample population represented a wide range of socio-economic levels. Ruddell's study revealed a superior standardized test performance by pupils in the programmed instruction groups in most areas after one year.

The study was extended through the second grade and similar tests showed the supplemented programmed group to be higher in achievement than the supplemented basal group. There was no difference between the performances of the basal alone and programmed instruction alone groups. This suggests that a combination of approaches may be a more successful approach to reading instruction than any single method.\textsuperscript{74}

\textsuperscript{73}R. B. Ruddell, "Reading Instruction in First Grade with Varying Emphasis on the Regularity of Grapheme-Phoneme Correspondences and the Relation of Language Structure to Meaning," \textit{Reading Teacher}, 19 (1966), pp. 653-60.

Sex. In 1964 McNeil investigated the effectiveness of programmed instruction and traditional instruction in teaching young boys to read. There were 172 boys and 60 girls in the sample, consisting of the entire kindergarten population of two public schools. There were seven teachers involved.

McNeil's findings indicated that programmed instruction may be more appropriate for teaching initial reading skills to boys than the usual classroom procedures. McNeil suggested that the reduction in peer group interaction also reduced aggressive behavior and failure to attend, thought to be common in young boys.75

Ability. Research relating to the interaction of teaching method and ability level in reading seems to have revealed divided opinion. Ellson76 observed that programmed instruction seems to be more effective with children of low ability, while Carr77 reported that achievement strides made through programmed instruction were independent of both


76 D. G. Ellson, "How Effective is Programmed Instruction in Teaching Reading?" N. B. Smith, ed. Current Issues in Reading, Newark, Delaware: International Reading Assoc., 1969.

intelligence and aptitude.

Disadvantaged. In working with the disadvantaged, Ausubel,78 Cheney79 and Reissman80 found programmed instruction in reading a useful tool. On the other hand, Howards81 reported no superiority in achievement gains made by pupils using programmed materials when compared to students using traditional approaches. One explanation for such contradictory results may be the fact that all studies do not consider or control for each significant variable which may be present in any interaction.

Hammill and Mattleman82 compared the reading achievement of second and third grade inner-city children using programmed instruction alone, programmed instruction with a basal reader, and basal readers alone. The children were matched on pretest reading scores. Although no significant differences were found in the achievement scores of the


three groups at either grade level, the authors provide an interesting discussion of why they believe this is so.

According to Hammill and Mattleman, there will always be difficulty in comparing traditional and innovative programs. Teachers are a product of their professional preparation, their background and their perception of the teacher's role. As Chall affirmed, "teachers tend to bring to new methods the same procedures they have used previously in other methods or that were in use when they received their training in teaching children to read."\(^{83}\) Hence, one may conclude research not taking into account the variable of the teacher may produce less than reliable results.

Programmed Instruction Today

A summary of the research in the field of programmed instruction clearly indicates that it is an effective tool for some teachers and some learners. Many of today's successful innovations are in fact offshoots of research in PI, including the development of behavioral objectives, formative evaluation and criterion-referenced testing.

PSI. The personalized system of instruction (PSI) developed by Keller\(^{84}\) is another current use of programmed instruction theory. In PSI, a course of study is divided

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into a number of units with specific objectives. The learner works through each unit individually, at his/her own pace. Upon completion of a unit, mastery is demonstrated to a teacher or proctor on a criterion-referenced measure. The Ginn 720 Reading Series is an example of effective utilization of the principles of PSI.85

**Computer-Assisted Instruction in Reading**

The early research in computer-assisted instruction in reading was mainly for the purpose of further development of CAI in general and of evaluating methods and materials in particular. Computer-assisted instruction in reading began in 1964, financed by a United States Office of Education grant.86 After initial tryouts at Stanford, the system was used in a number of schools in the adjacent districts. Data was collected pertaining to many aspects of CAI in reading, including possible gains, effect on social behavior, teaching strategies with terminals, installation, time constraints and software.

**The Stanford Project.** The most comprehensive evaluative research on the Stanford project was conducted by


Atkinson and Hansen. Atkinson and Hansen. Their work describes the CAI program in initial reading, lesson preparation and curriculum materials presentation.

After one year, the difference between the slowest and the fastest student was over 4,000 problems, but the researchers found no difference between the progress made by boys and girls using the same CAI materials. This is in contrast to the common finding that in beginning reading girls progress more rapidly than boys. It has been suggested that female teachers reinforce the responses and behavior of young girls more than that of young boys in beginning reading classes, thereby contributing to this difference in achievement. The CAI program reinforces boys and girls equally, eliminating a possible source of trouble.

The experimental group, receiving CAI in reading, performed better on all but one posttest. The control group performed better on the comprehension subtest of the California Achievement Test. The control group in the reading investigation received CAI in mathematics to control for the Hawthorne effect. Atkinson's conclusion is that the Stanford system of computer-assisted instruction results in better performance than does traditional classroom


instruction.

Other studies. A study by George H. Litman\(^89\) compared the reading achievement of 4th, 5th and 6th grade pupils using CAI. Litman found that students made statistically and practically significant gains in reading achievement as measured by the Iowa Test of Basic Skills. The researcher reported no significant differences because of sex. He concluded that the program was successful with pupils considered previously to be hopeless.

Virginia Stacy\(^90\) compared the reading achievement scores of elementary school pupils using traditional and individualized reading programs. She found no significant difference by sex, but a notable difference between the two types of programs at the 3rd and 4th grade levels.

Catherine Anelli\(^91\) investigated the nature of the relationship between time spent on CAI, reading improvement, performance and attitudes. She found no support for the hypothesis that CAI improves the performance of disadvantaged


\(^90\)Virginia Stacy, "A Comparison of Reading Achievement Scores of an Independent Reading Program and a Traditional Reading Program" (Unpublished doctoral dissertation, Brigham Young University, 1975).

students. Neither time on-line nor frequency of instruction appeared to affect reading achievement of the 121 subjects as measured by the Stanford Achievement Test.

Ervin Huddleston\textsuperscript{92} compared the effectiveness of four different programs in reading as they relate to achievement at the middle school level. The 320 subjects were rated for achievement on the Nelson Reading Skills Test, Form 4. The four programs in the experiment were the Science Research Associates (SRA) Reading Lab IIIa, EDL Controlled Reading Materials, Follett Publishing Company Venture I Reading Incentive Program and Houghton-Mifflin Company Serendipity.

Huddleston concluded that none of the materials was most effective for all students. Student intelligence is directly related to the effectiveness of materials in the areas of word meaning and comprehension. Controlled Reading was most effective for the high ability group, whereas Serendipity was most effective for the low ability group. Prior level of success in reading was related to the successful use of materials in the areas of word meaning, reading comprehension and reading rate.

Joanne Burley\textsuperscript{93} compared four methods of reading

\textsuperscript{92}Ervin Leroy Huddleston, "A Comparative Study of the Effectiveness of Four Reading Programs as They Relate to the Reading Achievement of Selected Middle School Students" (Unpublished doctoral dissertation, Texas Technical University, 1980).

\textsuperscript{93}Joanne Elaine Burley, "A Comparative Study: Four Methods of Reading Practice and Their Effect on Achievement
practice and their effect on achievement and attitude. There were three programmed and one self-selected reading instruction approach in the study of 10th and 11th grade pupils. Each group studied using one of the approaches for fifteen minutes a day in addition to their regular reading instruction. After the posttest, The Stanford Diagnostic Reading Test, Level III, Burley concluded that at this level, self-selected reading was the most effective form of practice.

The effect of locus of control on achievement has been examined in a number of recent studies. Joan Rodriguez investigated the relationship between three student traits and three modes of presentation. She utilized an inserted mathemagenic device and learning from prose. Examining the interaction of the variables at the .05 level, Rodriguez found four main effects: locus of control, pretest, reading comprehension and mathemagenic device. This suggests that for some children, locus of control is a significant factor in reading instruction.

Another study attempting to clarify this same issue was done by Bennie Webster. Using a sample of 300 college and Attitude" (Unpublished doctoral dissertation, University of Pittsburgh, 1979).

94Joan Hughes Rodriguez, "The Relationship of Three Student Traits, Three Modes of Presentation, and an Inserted Mathemagenic Device to Learning from Prose" (Unpublished doctoral dissertation, New Mexico State University, 1980).

95Bennie Marie Webster, "An Investigation of Locus of Control and Reading Achievement Levels of Selected
freshmen, Webster compared performance on the Nelson-Denny Reading Test with scores on a scale designed to measure internal versus external control. Webster concluded that at the college level there was no significant relationship, regardless of sex, between locus of control and reading.

These seemingly contradictory reports emphasize the fact that no single method of teaching reading and no single variable can be universally applied in research. Methods which are effective with one age group are less effective with others; variables which greatly influence performance in one group do not affect another group at all. Even the standardized tests used to evaluate achievement can result in erroneous conclusions.96

Ethnicity. The question of an ethnicity by reading method interaction remains unanswered at this time. Studies in this area have produced inconclusive results.

Arnold and Westphal97 studied 307 Black, Latino, Asian and Anglo 2nd, 4th and 6th graders. Experimental groups consisting of good, average and poor readers were


tested on the Stanford Diagnostic Reading Tests and the Wide Range Achievement Test (WRAT). Analysis of variance was computed for the main effects of ethnicity, reading level and interaction. The researchers' conclusions were that ethnic groups read alike, that is, there is no evidence of an ethnic group related difference in reading skills.

Fletcher and Atkinson report psychological differences from students of variant cultural backgrounds which may enter into the interaction. Evaluating the Stanford program in 1969, the investigators found greater mean gains for all pupils using CAI when compared to a control group in the area of initial reading. Their results indicated that CAI in reading was a useful tool for working with minority group pupils. "We believe that for many aspects of the cognitive domain, computers, with their absolute imperturbability and objectivity, represent the best means of reaching these children." 98

Social Aspects of CAI

Not all the benefits of the computer revolution are to be found in the reading or mathematics laboratory. Crandall observed the behavior of students who were involved in a CAI program. He found reduced rates of truancy, tardiness and vandalism, as well as an increase in student

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participation in before and after school activities, including the use of terminals.\textsuperscript{99}

On the other hand, we are advised to proceed slowly into the world of technology. McDonald and Kropp have expressed the fear that too much exposure to computers will, in the long run, reshape man's cognitive structure. The mind of man, say the authors, is limitless in its range of responses. The computer, by virtue of its mechanical structure, is limited to a specific range of responses. Too much exposure to the limits of the computer may stifle creativity, and may affect in a negative way the distribution of human skills and mental abilities. The computer, according to McDonald and Kropp, will eventually eliminate both ends of the normal curve.\textsuperscript{100}

\textbf{Why CAI is Unique}

If one were to read only this far, one might fairly ask, "is there any real difference between PI and CAI?" For, as shown in the first three sections of this review, both PI and CAI (1) appear to be based on the same psychological/theoretical model, (2) utilize lessons constructed


according to the cybernetic principle of instruction, and (3) appear to be effective methods of teaching reading to some children.

There are differences, however. CAI although an outgrowth of PI, is much more flexible. It provides the educator with a way of individualizing instruction to an extent never before thought possible. According to Markle:

> Without a computer the degree of individualization is limited, for there are real limitations on the capacity of students to follow complex directions and on the capacity of instructors to monitor complex systems involving frequent assessment of where the student is and where he should go next. 101

Such extensive individualization of instruction is made possible by CAI's ability to (1) store and retrieve information, (2) provide immediate feedback, and (3) perform in a variety of styles.

**Storage and Retrieval**

An enormous amount of information from many sources can be stored easily in a computer's memory. This includes information about individual learners such as name, sex and placement in the program as well as information input by the teacher regarding the number of questions to be answered in each session and the amount of time allotted to each question. Input devices and memory are part of the computer's

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Hardware

The electronic equipment which makes up the CAI system is known as the "hardware." The types of hardware one owns determines the types of programs which can be run. Some systems have both visual and auditory components while others have only one. The "brain" of the computer system is the central processing unit or CPU. Input to the CPU from any of its terminals results in the opening or closing of electric circuits. These changes in the circuitry result in output from the CPU to the initiating communication device, or to another receiver or printer.

The CPU is connected to magnetic tapes which are used for high-speed input and output, and is also connected to magnetic discs for the long-term storage of courses of study and student records. The size of the disc storage determines how much of a work load the system can handle at any given time. The storage capacity is described in terms of "k," and is sometimes called the "memory" of the computer.102

The circuitry of the computer is such that it can rapidly retrieve information stored in the memory and present it on a terminal for review. It can also utilize the

information, according to the directions of the program, to plan the subsequent lessons of an individual learner. Just how the memory can be used is part of the software design.

Software

The term "hardware" is roughly synonymous with "equipment." The term "software" includes almost everything else which makes up the computer system. According to Hicks and Hunka, there are several categories of software.

One category is the "teaching logic" representing, for one or more different subjects, the approach which a lesson-writer takes in helping a student to learn. Another category of software includes the "system" or "resident" programs, which are data and sets of rules and instructions which the computer uses in carrying out various specific operations that are common to, or may be used by, any lesson-writer or programmer. . . . These and other computer programs in the software actually "exist" in the minds of the lesson-writers or programmers, on sheets of paper where they are fully documented, on punched cards or punched paper tape to be read into the computer, and in one of the storage devices or memories of the computer itself.103

The retrieval and computational powers of the system can be used to make an immediate evaluation of student performance, a thing desired, but lacking, in education up to this point. According to Bushnell and Allen:

In standard classroom teaching it is impossible to use in any sensitive way the achievement records of the students in the class. Partly because of the requirements of group teaching, we have very little experience in such matters. A gifted tutor will remember and use many facts about the past performance of his pupil, but scientific studies of how

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this should be done are as yet in their infancy. Practical decisions about the amount of review work needed, the time needed for the introduction of new concepts, and so forth, which vary widely from student to student, must ultimately be much influenced by the student's past performance.104

Computer Language

Information to be input to the computer system for either immediate evaluation or for storage must be in a language which the computer can understand. Computer languages are artificial languages, each one made up of a precise set of characters as well as rules for combining these characters into "words," and rules governing the arrangement of these "words" into meaningful groups. The lack of any easy to learn and use language was one of the main reasons for the slow emergence of computer-assisted instruction in the educational marketplace.

Machine language. At the lowest level is machine language, the only language the computer can understand. All machine language is composed of combinations of the numerals 1 and 0, called binary bits. These bits cause the electric circuits in the hardware to open and close, allowing changes in the computer's core or memory. Programming by translating instructions into bits was a tedious chore. In addition, machine languages are specific to a computer or

a class of computers. Therefore, the bits which instruct one are meaningless to another.

Compiler language. Because writing a program in machine language was so time consuming and subject to error, it was necessary to develop a language which would make this phase of programming easier and more precise. The result was the invention of compiler language in the mid-1950's. Compiler, or machine oriented language, accepts symbolic representations of programming instructions and generates the corresponding binary bits. The output of a compiler is called an "object code." The compiler is stored within each core and is unique to each type of unit.

Procedure oriented language. The third level of computer language was developed in 1957 and is machine independent. Procedure oriented language describes how the process of solving a problem is to be carried out. Procedure oriented language has two distinct advantages over machine oriented language:

1. The programmer is no longer required to memorize each machine instruction that is to be executed, and determine the order of execution. The programmer may describe in one statement an involved process which would require many machine language instructions.

2. The procedure languages are almost machine independent. A program written for one computer can be executed on another machine with a few minor changes.

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105 Luskin, op. cit., p. 35.  106 Ibid.  107 Ibid.
Some of the best known procedure oriented languages are FORTRAN (formula translation), for problems which can be expressed in algebraic notation, COBOL (common business oriented language), ALGOL (algorithmic language) and BASIC (beginners' all-purpose symbolic instruction code). In order to run a program in any of these languages, the computer must have stored the appropriate compiler.

**Problem oriented language.** Problem oriented languages were developed in the 1960's for two reasons. First, there were many specific areas in which the procedure oriented languages such as FORTRAN and COBOL were unsuitable. Second, in order to write in a procedure oriented language, a writer must have an understanding of machine language, or of how a problem is to be solved. Many would-be program writers, especially in the field of education, did not have this knowledge.

A problem oriented language allows a subject matter expert to write a lesson almost exactly as it is to appear to the user. A "translator," a processing unit similar in function to a compiler, translates the problem oriented language or "source code" into one of the procedure oriented languages for which the unit contains a compiler. By 1968 there were 65 different languages used in support of computer-assisted instruction,\(^{108}\) including the problem

\(^{108}\)Ibid., p. 37.
oriented ones such as COURSEWRITER, PLANIT (programming language for interactive instruction), MENTOR, ELIZA and CAILAN (computer aided instruction language). By 1969 there were 120. All of these languages, designed to input data to the computer, are collectively known as "source codes."

**Feedback**

All programmed instruction is based on the rationale that immediate reinforcement facilitates learning. Reinforcement may be in the form of verbal praise either orally presented or printed in a text. Reinforcement may also be in the form of knowledge of the results of one's own actions.

Unfortunately, no human teacher can call on every child in the class simultaneously, allow every child to answer every question or even reward every child who answers correctly. CAI, on the other hand, can provide for every pupil at the same time. CAI can reward every correct response. Mistakes are immediately brought to the attention of those who made them but to no one else. For the shy child, afraid of ridicule, this is especially important.

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110Luskin, op. cit., p. 36.

Every child gets to answer every question necessary to lead him to mastery of the objective.

A description of the CAI reading project at Stanford gives a good picture of how this reinforcement is accomplished:

In the reading program correct responses are rewarded by such verbal messages as "good," "you're doing fine," "right," etc. Since studies have shown that reinforcement tends to lose its effectiveness when it is continuous and repetitious, verbal rewards in the reading program are given on an intermittent basis. Immediate feedback is provided through reward messages, through the presentation of the next problem and also through "wrong answer" messages.\textsuperscript{112}

In response to the criticism that praise from a machine is too dehumanized to really appeal to children, and to serve as a reinforcement or reward for them, Wilson and Atkinson reply that:

The elimination of the social intercourse aspect of learning through CAI is one of its great strengths. The computer is an eternally patient teacher. The machine never becomes angry or threatening. Those of us who have spent some years teaching in the classroom are well aware of the fact that after repeated student errors it is difficult, if not impossible, to restrain certain voice or facial cues which indicate our displeasure. The messages coming from the machine, however, are completely free of any such threat or anger. The "wrong answer" messages recorded in the quiet of the recording studio can be a continuously neutral "No, this is the right word. Touch it."\textsuperscript{113}


\textsuperscript{113} Ibid., p. 4.
Extrinsic and Intrinsic Reinforcement

Social approval and knowledge of results are adequate reinforcers for many children.\textsuperscript{114} For others, however, more tangible rewards, such as trinkets or edibles, are necessary "until the skill itself acquires \ldots reinforcement properties."\textsuperscript{115} Tangible rewards are a form of extrinsic reinforcement, that is, they are a form of reinforcement which originates outside of the learner.

Another form of extrinsic reinforcement is the use of interesting texts in the design of the learning situation. According to Silberman, this may reinforce the behavior of "obtaining meaning from printed material," but may not be related to the reinforcement of "correct phonemic responses" in a given reading lesson.\textsuperscript{116} In other words, the use of interesting material will make the pupil more inclined to read the assignment than the use of uninteresting material will.

Events can also serve as extrinsic reinforcers. Premack reports that "of any two responses, the one that occurs more often, when both are available, can reinforce


\textsuperscript{115}Ibid.

the one that occurs less often."

The work of Moore has suggested that control over the physical environment can act as a reinforcer. In a responsive environment, the natural curiosity of the learner is rewarded by stimuli which are "novel, unfamiliar, complex, surprising, incongruous, assymetrical, etc." Moore's work suggests that a learner's curiosity may be selectively maintained in "an instructional environment which provides for appropriate variation and change in both the stimulus characteristics of the subject materials confronting the student and also the responses required of him by these materials."

Intrinsic reinforcement comes from within the learner himself. Often called motivation, it is the goal for which all teachers should strive. A self-motivated person goes on learning whether or not he is in school or the teacher is by his side.

According to Bigge and Hunt, Intrinsic motivation is that tendency to activity which arises when the resolution of tension is to be found in mastering the learning task itself; the material learned provides its own reward. If a job

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117 Ibid., p. 797. 118 Ibid., p. 798.
119 Ibid., p. 798. 120 Ibid., p. 799.
is done because doing it is somehow satisfying, if the job carries its own reward, if it is done for its own sake, then we say that motivation is intrinsic.

According to the Behaviorist point of view, all motivation "arises either directly from one's organic drives or basic emotions or from a tendency to respond that has been established by prior conditioning of the drives and emotions."\textsuperscript{123} CAI, however, appears to have achieved an effective blending of both intrinsic and extrinsic motivation for learning in its materials, despite its Behaviorist foundation. In this area Crandall reports:

Most children who come from a poverty background see themselves as externally controlled and don't understand that there is a relationship between their own efforts and achievements. Computer assisted learning teaches these children internal control to establish a cause and effect relationship with their own actions and to savor success.\textsuperscript{124}

Reinforcement Schedules

Research at this point cannot tell us too much about the effect of reinforcement on children with different personality types, who may be either impulsive or reflective learners.\textsuperscript{125} We do know, however, that different rates or schedules of reinforcement have varying effects on


\textsuperscript{125}Bushnell and Allen, op. cit., p. 22.
When reinforcement is given at fixed intervals, for example, the rate of response increases as the time for reinforcement approaches. In the CAI drill and practice lesson, a fixed number of seconds is allowed for each question. If the pupil answers within the time limit, he is reinforced for either a correct or incorrect response as the case may be. If he doesn't select an answer within the time allowed, he is credited with a time out. A time out counts in his total score as a wrong answer, and the question is presented again later in the session, or in the next session. According to Computer Curriculum Corporation, too many time outs indicate that a student may be working at too advanced a level, having trouble with a particular concept, or lacking interest. When the item reappears, the answer choices will have been rearranged by the program. "This process enables students to learn from a mistake and to experience success by answering the item correctly."

Performance Styles

The flexibility of CAI which permits it to perform

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126 McDonald, op. cit., p. 324. 127 Ibid.


in a variety of styles is best illustrated by a description of several modes of instruction. It should be remembered, however, that in each mode five important criteria of good teaching are implemented. These five, according to Bigge and Hunt,\textsuperscript{130} are: (1) a constant interchange between the program and the pupil; (2) insistence that a point be understood before the pupil moves on; (3) presentation of material for which the pupil is ready; (4) assistance to the pupil when necessary to help him discover the correct answer; and (5) reinforcement of every correct response. Skinner states that "... the effect upon each student is surprisingly like that of a private tutor."\textsuperscript{131}

Modes of Instruction

There have been dozens of labels used over the years to classify the various patterns of interaction between the learner and the computer. Grubb\textsuperscript{132} lists eleven strategies: drill, practice, problem review, diagnosis and prescription, tutorial, fact finding, computation, logical problem solving, gaming, simulation and exploration. Stolurow\textsuperscript{133} lists five: imitation, remediation, inducement, capitalization and

\textsuperscript{130}Bigge and Hunt, op. cit., p. 372.


\textsuperscript{133}Ibid.
compensation. Hansen reviewed adaptive instructional models and recommended the implementation of the following: (1) drill and practice to increase student speed and proficiency; (2) concept acquisition, developed by varying the sequence and the kinds of examples; (3) complex tutorial to provide the student with problem-solving strategies; (4) algorithmic regression including a detailed plan of prescriptive instruction, incentives and outcome evaluation; and (5) dynamic programming, a master instructional model incorporating many strategies in order to maximize student progress and proficiency.

Although several of these strategies for learning are similar, several are quite distinct. Some are within the range of a basic computer system and some require highly sophisticated equipment and extensive programming. Within each similar mode there are variables which differ from system to system, and from program to program. Some modes are more appropriate for use with certain students than with others.

Although there have been more than twenty suggested modes of interaction, most software suppliers and curriculum writers do not deal with more than five or six. These have proved to be versatile enough to fit most situations, and to be different enough to maintain the interest of the student. The five most often used modes are inquiry, problem solving,

\[134\text{Ibid.}\]
tutorial, drill and practice, and simulation. In the inquiry or retrieval mode, the student can obtain a presentation of facts, concepts or other information from the computer system upon request. Of course, a student may only request data which has been stored previously within the system. In a basic system, a student types a code onto a keyboard. After "sending" the message to the processing unit, the student waits for the system to secure and display the information requested, or to answer a question. Output of information may be in any one of several forms such as video display, teletypewriter or high speed printer. More advanced systems allow questions to be stated in normal English sentences rather than in code.

Problem-solving mode. In the problem-solving mode the student uses the computer system to solve a problem according to the user's instructions. These instructions make up the "program" of the computer. This mode is more difficult to use than the inquiry mode because the student must feed both the program and the data into the system in a language that the computer can understand. Normal English syntax cannot ordinarily be used. In this case, the

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135Luskin, op. cit., p. 37.

computer system is actually functioning as a sophisticated calculator, useful in solving mathematical problems.\textsuperscript{137}

\textbf{Tutorial mode.} The tutorial mode is in fact the teaching technique which we call the "Socratic dialogue." In this method, a question is posed and the pupil responds. The answer is interpreted by the teacher, which in this case is the computer program. Then another question is asked, designed to lead the student closer and closer to understanding the underlying concept involved in the questions. A branching or intrinsic program format is necessary in order to use the tutorial mode. Branching refers to the fact that the computer selects from a set of options based on the pupil's response to the previously asked question.\textsuperscript{138}

\textbf{Drill and Practice.} At the elementary school level there are probably more drill and practice programs used than any other kind. One author has described this form of CAI as "electronic flashcards," in the sense that it frees the teacher from repetitive and highly structured review activities needed by some, but not all, of the students.

Drill and practice materials are structured by the author and are designed to produce specific effects. Problems are stored in the computer and are presented to the student according to a set of rules. These rules include (1) how long a student has to respond to a problem before it

\textsuperscript{137}Ibid. \textsuperscript{138}Ibid.
is counted as a wrong answer ("time out"), (2) how many problems will be presented in a strand, and (3) how often a pupil is reevaluated and moved up or down in a program. Drill is usually controlled by the program, whereas practice is often structured by the student himself. 139

**Simulation.** In the simulation mode the student experiences a simulated real-life situation such as driving an automobile, conducting a chemistry experiment or prescribing medication for a "patient." Obviously, the savings in time, expense and risk are great. The student is in control of the input to a simulation program. The output informs the student of the result of his decisions, as would occur naturally in such a situation. The quality of the program is dependent upon the designer of the model and the writer of the CAI program. At this time, simulation is used to instruct pilots in emergency procedures and to give medical students practice in diagnosing illness and prescribing medication. 140

**Summary**

From this review of the literature in the field of programmed and computer-assisted instruction in reading, several generalizations seem pertinent. (1) Computer-assisted instruction as a classroom strategy is based on the

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139 Ibid. 140 Ibid.
theory of Behaviorism. Behaviorism was made popular in the United States by B. F. Skinner, who, in the 1950's and 1960's developed Programmed Instruction as the practical application of that theory to educational practice. Both PI and CAI materials follow the stimulus-response pattern, with reinforcement coming after the response.

(2) Both programming for PI and the writing of software packages for CAI are based on the input-operations-feedback, or cybernetic, model of instruction. The input stage consists of concepts, facts, principles and hypotheses as well as information from past experiences. The teacher/programmer uses the input to construct the educational plan or program. The operation sequence is composed of the manifestation of the plan or program, the learning activities, readings and questions, and a test to determine the effect of the plan or program on the student's behavior. The feedback stage consists of using the results of the test as part of the input, leading to new, more effective plans.

(3) Although the body of the research is small, both PI and CAI appear to be effective methods for teaching reading to some students. Further research is needed to investigate the effectiveness of CAI when it is used as a supplementary strategy along with a good, basal or developmental program. More work is also indicated in the area of using CAI to develop reading skills in minority group and limited English speaking children.

(4) The capabilities of CAI to store and retrieve
information, to provide immediate feedback and to perform in a variety of styles will help the teacher to individualize instruction to a degree never possible before. Other computer capabilities include absolute patience, accuracy, memory and the ability to evaluate objectively, continuously and instantaneously.\textsuperscript{141} It also seems evident from the readings undertaken as part of this review that we are indeed entering a "brave new world" of education.

Within the next decade teachers and computers will become educational partners. Their students will receive both classroom instruction and computer-assisted instruction. Today this partnership \ldots is uncommon. Only a few powerful computer systems are dedicated to instruction, and computer-assisted instruction is found only in a few schools. But a large number of teachers of the future must learn to use and to manage computer-assisted instruction as a new educational resource so that they can find, from day to day, the combination of classroom and computer-assisted instruction that best serves the needs of each student.\textsuperscript{142}

\begin{flushright}
\textsuperscript{141}Hicks and Hunka, op. cit., pp. 24-25.
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\begin{flushright}
\textsuperscript{142}Ibid., p. 20.
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Chapter 3

PROCEDURES OF THE STUDY

In this chapter the procedures employed in conducting this study are presented. These procedures have been divided into four main sections for discussion purposes: (1) The Sample, (2) Data and Instrumentation, (3) Experimental Treatment and Design, and (4) Statistical Analysis.

The Sample

Sequoia Elementary School is located in the Manteca Unified School District, approximately fifteen miles south of Stockton, California. Manteca is a rural district with an average daily attendance in grades K-12 of 9,132.¹ The sample for this investigation was made up of a composite of students who attended Sequoia Elementary School between April, 1980 and April, 1982. There were a total of 340 pupils, grades 4 through 6, in the sample.

The composite sample was selected by listing all the students in grades 2, 3 and 4 who were in attendance at Sequoia in April, 1980, all the students in grades 3, 4 and 5 who were in attendance in April, 1981, and all the

students in grades 4, 5 and 6 who were in attendance in April, 1982. Each individual was listed only once, even if he or she appeared on more than one end-of-the-year list.

The purpose of the composite was to enable the researcher to study changes in the average yearly gains made by groups of students over a period of time. The years covered by the composite include one full year in which students received no computer-assisted instruction, one year in which they received some computer-assisted instruction and one year in which they received a full year of computer-assisted instruction.

The 1979-80 California Assessment Program (CAP) survey reported that about 24% of Manteca pupils belong to ethnic minorities, including about 19% who are Hispanic.\(^2\) The 1980-81 survey reported about 2.8% of the district's 6th graders to be either limited or non-English speaking.\(^3\) About 13.1% of the 6th grade families in the district receive Aid to Families with Dependent Children.\(^4\) The mobility of Manteca's 6th graders, the percentage enrolled in the school of testing for the first time at the 6th grade level, was 23%.\(^5\) Figures for Sequoia Elementary closely parallel those of the district for the same years.

\(^2\)Ibid.


\(^4\)Ibid.  \(^5\)Ibid., p. 5.
Table 1
Summary of Background Factors for Grade Six, 1980-81

<table>
<thead>
<tr>
<th>CAP Factor</th>
<th>Sequoia Elem.</th>
<th>Manteca Unified</th>
<th>California</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minority</td>
<td>24.00</td>
<td>24.20</td>
<td>42.14</td>
</tr>
<tr>
<td>Hispanic</td>
<td>22.80</td>
<td>18.90</td>
<td>14.90</td>
</tr>
<tr>
<td>LES/NES</td>
<td>1.10</td>
<td>2.80</td>
<td>6.00</td>
</tr>
<tr>
<td>AFDC</td>
<td>11.50</td>
<td>13.10</td>
<td>a</td>
</tr>
<tr>
<td>Mobility</td>
<td>21.00</td>
<td>23.00</td>
<td>30.00</td>
</tr>
</tbody>
</table>

AFDC statistics for specific grade levels are unavailable. During 1981, 575,146 families in California received Aid to Families with Dependent Children.

Sources:
- Telephone interview, California State Department of Education, Office of Compensatory Education.
Relative strengths and weaknesses indicate the relationship between scores earned in a specific skill area and the total score earned on the subtest. The 1981 California Assessment Program survey for Grade 3 listed these relative weaknesses in Reading for the Manteca district: word identification; phonics; consonants; structural analysis; analysis of prefixes, suffixes and roots; recognizing word meaning. Relative strengths were reported to be: comprehension of sequence; drawing conclusions about details; study locational skills; table of contents. The CAP survey reported the relative strengths of Sequoia's 3rd graders to be: analysis of contractions and compound words; comprehension of pronoun references; drawing conclusions about details. Weaknesses relative to the total reading score included: phonics; vowels; using context; details from a single sentence; drawing conclusions about characters.

Sample participants who were in attendance in April, 1981 were administered The Comprehensive Tests of Basic Skills, Expanded Edition, Form S, 1973. Those whose total Reading subtest percentile ranks were between 1 and 40 comprised the Experimental Group. The district identified these students as Chapter I pupils, eligible to receive

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7Ibid., School Report for Sequoia Elementary, p. 3.
computer-assisted instruction as a supplement to their regular reading instruction. Those students whose percentile ranks were between 41 and 99 on the 1981 CTBS were designated as the Control Group. Legal constraints of the Education Consolidation and Improvement Act require that no lower achieving pupils be excluded from the supplementary instruction, and also that non-Chapter I pupils be excluded from special instruction whose financial base was provided by an ECIA grant. These selection procedures resulted in a total Experimental Group of 118 pupils and a Control Group of 232 students.

The obvious differences in the achievement of the two groups was addressed through the use of statistical procedures explained later in this chapter. The treatment, which was designed for lower achieving and remedial pupils, was included as part of the regular compensatory education program at Sequoia School. It was assumed, under those circumstances, that the selection of the Experimental Group from the population of students qualifying for compensatory education would not affect the external validity of this study nor its generalizability.

Data and Instrumentation

The data collected for this study were both primary and secondary in nature. Primary data included the subtest and total raw scores earned by each member of the sample on the 1980, 1981, and 1982 administrations of the CTBS, Form
S, 1973, in both reading and mathematics. Percentile ranks and grade placement scores for all members of the sample population were also collected. There were no scores for the 1980 administration of the CTBS for pupils who completed the fourth grade in 1982 because the CTBS was not given to second graders in 1980 in the Manteca district. Missing scores were so noted.

Primary personal data included the sex, grade and ethnic group membership of each member of the sample. Sex and grade level designations were obtained from the CTBS score reports. Ethnic group designations were supplied by the district. All but three of the minority group pupils included in the total sample were of Hispanic background. It was decided to use the term "Hispanic" to describe these pupils in Hypothesis Two rather than the term "minority group pupil." This decision was made in an effort to be as accurate as possible in the description of the sample.

Secondary data included published studies, manuals and texts and unpublished dissertations and theses. A computer search of the ERIC data banks using the descriptors "Reading," "Computer-assisted instruction," and "Elementary Education" was conducted. Dissertation Abstracts International was hand searched under the category heading, "Reading," for the years 1973 to the present. Relevant citations from these sources were included in Chapter 2, the information collected during an extensive library search at the University of the Pacific. Photo copies of pertinent
surveys and reports were obtained from the California State Department of Education. Score reports for the **CTBS** for the years 1980-82, for the Sequoia Elementary School were obtained from the principal of Sequoia School.

The **CTBS**

Within-grade reliabilities (K-R) for the reading subtests ranged from .89 to .94. Community type, school type, enrollment, geographic region and other demographic data were considered in the selection of the 130,000 pupil normative sample. Item point-biserial comparison was used to identify culturally biased items. There was some bias, but not enough to cause rejection of the test. There was a lack of predictive and concurrent validity statistics in the Buros review which was not considered detrimental for the purposes of this study.\(^8\)

The **CTBS** was administered by regular classroom teachers in April of each year, in grades three through six. The tests were machine scored by the publisher. Score reports sent to the school contained the pupil's raw score on each subtest, total raw score, grade placement according to standards established by the publisher, and percentile rank in regard to all California students who took the same test. The reading subtests were Vocabulary and Comprehension. Only total raw scores were collected for the math

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The Ginn 720 Reading Program

According to Ginn and Company, the Ginn 720 Reading Program

... is a comprehensive general, basic reading instructional program. It is designed to take non-reading school-entering children through 13 levels of structured, sequenced instruction, bringing them to an acceptable level of general reading competence.9

It is also important to note that Reading 720 is "a complete program in that no other materials are needed to teach children to read."10

The Reading 720 program has been organized into seven strands. The Core Skill Strands are Decoding, Vocabulary and Comprehension. The Application/Enrichment Strands are Study Skills, Literature and Language Creativity.

Reading, Grades 3-6

Reading, Grades 3-6 is published by Computer Curriculum Corporation, Palo Alto, California. It is a software program designed to provide the remedial reader with individual drill and practice in five basic skill areas. It also provides supplementary remedial exercises in basic sentence patterns.

10Ibid.
This program is also organized into strands, a graduated sequence of items within a skill area. The five basic strands in Reading, Grades 3-6 are: Word Attack, Vocabulary, Literal Comprehension, Interpretive Comprehension and Work-Study Skills. A normal lesson is composed of mixed drill, a combination of items from different strands. Individual sessions vary in the proportions of questions which are drawn from each strand, and in the levels of difficulty they represent.

Movement within a strand is independent of movement in other strands, and is based on the number of correct responses made in that strand. When a student misses an item, the item reappears later in the drill. The answer choices are rearranged by the program to insure careful rereading of the item.

Reading for Comprehension

Reading for Comprehension, from Computer Curriculum Corporation, is very similar to the program, Reading, Grades 3-6. The comprehension program provides individualized drill and practice in the same five basic skill areas covered by the basic program. An additional element is the Paragraph strand, which requires students to integrate the specific skills as they read and answer questions.

Reading for Comprehension lessons are composed of mixed drill, and movement within strands is handled similarly to movement in Reading, Grades 3-6. There are slight
differences between the two programs in the subskills covered in each of the five basic areas. Reading for Comprehension, unlike Reading, Grades 3-6, is not designed specifically for the remedial student.

Experimental Treatment and Design

All students at Sequoia School were assigned to teachers by the principal on a quasi-random basis, which included students of different ability levels in each room. Each teacher taught two or three reading groups per day, including average, above average and poor readers.

All teachers at the school used the Ginn 720 Reading Program as a basal text. Levels specified for different grades included suggestions for slow, average and fast learners. At the 4th grade level, slow learners worked at Level 7 or 8, average learners worked at Level 9 or 10 and fast learners worked at Level 11. At the 5th grade level, slow learners used Level 8, 9 or 10, average learners used Level 11 and fast learners used Level 12. Slow learners in the 6th grade worked on Level 9, 10 or 11, average learners on Level 12 and fast learners at Level 13.

Computer-assisted instruction in a drill and practice format, such as that provided by the software packages Reading, Grades 3-6 and Reading for Comprehension, was designed to supplement the classroom teaching of reading. As such, computer-assisted instruction was operated as a "pull-out" program for Chapter I students at Sequoia School.
Pupils in the Experimental Group left their classrooms for computer-assisted instruction two or three times each week, depending on scheduling. It should be noted here that the publisher, Computer Curriculum Corporation, recommended that their programs be used on a daily basis. Optimal use was prohibited by the large number of Chapter I students and the limited number of terminals.

During their ten minutes "on-line," students could answer from ten to thirty or more items, depending on how fast they read and responded. The publisher suggests an average of 35 reading items can be answered in a ten minute session.\(^\text{11}\) A maximum of sixty seconds was allowed for each item before the pupil was given the correct answer. The program then advanced to the next item automatically. A failure to respond within the time limit was recorded as a "time-out" by the computer rather than as an incorrect response. After the first month of instruction, too many time-outs may indicate trouble with some part of the coursework or a lack of interest.

The treatment period extended from late April, 1981 until April, 1982. Variations in school programs and attendance produced minor variations in the number of actual sessions attended by each pupil. The number of available

sessions ranged from 72-108 for the year.

The Computer Center instructor was a salaried, non-certificated employee of the Manteca Unified School District. She was trained by the district, with the cooperation of the Stockton Unified School District, which operates a similar program. It should be noted that the software packages provided all instruction for the students using them and made decisions involving placement, movement and mastery. The role of the Computer Center instructor was largely supervisorial, rather than instructional, involving the maintenance of discipline, care of equipment and the distribution of reports on progress generated by the computer program itself upon request.

Computer-assisted instruction in a drill and practice format requires the active participation of the learner. The student is engaged in the silent reading of items or in reacting to what is read. Progress is determined by the learner's own response rate and the number of items in each strand required by that learner before demonstrating mastery of the concept being drilled.

For the courseware Reading, Grades 3-6 and Reading for Comprehension, students were enrolled at a level one-half year below their grade level score on the CTBS. Pupils whose grade level score was below 2.5, the beginning level of Reading, Grades 3-6, were placed at the 2.5 level. During the first ten sessions, the courseware automatically adjusted the placement of students to conform to their
performance on the program items. This Initial Placement Motion occurred in half-year steps and included grade levels 2.5-6.9 for the program Reading, Grades 3-6, and 3.0-6.9 for Reading for Comprehension.

Experimental Group students were enrolled in their courses by the Computer Center instructor. To enroll a student, the instructor typed the student's full name, teacher's name, identification number, course code and enrollment level on a terminal keyboard. The information was then input to the central processing unit. The central processing unit automatically added the time and date to each entry, and stored the information in its memory.

After being enrolled, the student began each session by typing his or her identification number and first name on a terminal keyboard. The computer responded by displaying "Hi," followed by the pupil's first name. The computer located the student's history and placed him or her at the appropriate level within each strand of the course.

Items appeared on the screen in a mixed drill format. That is, items from different strands were presented in a random fashion to the student at the required level of difficulty. Students had sixty seconds to respond to an item by typing an answer on the keyboard. As the student typed, his or her response appeared on the screen. Answers had to be properly spelled and capitalized in order to be counted correct.

After reading an item silently and selecting the
preferred response, the pupil pushed the GO key on the keyboard. A correct response was rewarded with an asterisk on the screen, and occasionally by printed words of praise. An incorrect response was followed by the symbol //// and the words, "Try again," on the screen.

To correct an error before pushing GO, a pupil pushed the ERASE key. To capitalize a letter, a student held down the SHIFT key and typed the letter. These procedures were explained and practiced by students during their first weeks on the terminals.

The majority of items in both Reading, Grades 3-6 and Reading for Comprehension were multiple choice. A few required the pupil to supply a specific word found in the text, but not listed as a possible answer. Pupils answered the multiple choice items either by typing the number of the correct answer or by typing the correct word from a group of choices.

This study utilized a non-randomized control group pretest-posttest design. This design, according to Leedy, is useful in those situations in which random selection and assignment are not possible. In such a case, the researcher is advised to employ analysis of covariance in analysis of the data, in order to compensate for the initial differences between the experimental and control groups.

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"Analysis of covariance reduces the effects of initial group differences statistically by making compensating adjustments of final means on the dependent variable."\(^{13}\)

In this investigation, the pretest served both as a selection procedure and as a method of obtaining a baseline for gain scores. Posttest scores were utilized to test the hypotheses regarding achievement in reading. The pretest also was used as the covariate in the statistical analysis of the data.

The design chosen provided maximum internal and external validity within the limitations set by the use of intact groups. Campbell and Stanley suggest the quasi-experimental design is successful in the internal control of history, maturation, testing, instrumentation, selection and mortality.\(^{14}\) In terms of external validity, the major concern in such a design is with pretest effects. This was not considered problematic since testing with the CTBS is done on a yearly basis as part of the Chapter I selection and implementation process. As such, the pretesting would be considered part of the implementation of the treatment, and any possible effects would not limit the generalization of the findings of this study.

\(^{13}\)Ibid.

Statistical Analysis

Before conducting the statistical analyses required in this investigation, the hypotheses presented in Chapter 1 were restated in the null form. The restated hypotheses were:

H₁. There is no difference in the reading achievement gains of Chapter I students in the 4th, 5th and 6th grades who received one year of supplementary computer-assisted instruction and those who did not receive computer-assisted instruction.

H₂. There is no difference in the reading achievement gains of Hispanic students who received one year of supplementary computer-assisted instruction and those who did not receive computer-assisted instruction.

H₃. There is no difference between the reading achievement gains of male and female students who have received one year of supplementary computer-assisted instruction.

H₄. There is no difference in the reading achievement gains of 4th, 5th and 6th grade pupils who have received one year of supplementary computer-assisted instruction.

H₅. There is no relationship between Chapter I pupils' sex, grade level, ethnicity, type of instruction and their reading achievement gains.
Two-tailed tests were employed in all cases, with the level of significance for rejecting the null hypothesis set at .05. That is to say, the probability of the investigator arriving at an erroneous conclusion that a relationship exists between the dependent and independent variables when, in fact, no such relationship exists, is 5%. It should be noted that statistical significance does not in every case imply practical significance.

The data collected for this investigation were analyzed using the analysis of variance procedure, and a combination of regression and analysis of variance which helps to statistically control variables which cannot be controlled experimentally. Analysis of covariance involves the use of a pretest, known as the covariate, which represents the variable to be controlled and a posttest, known as the criterion or dependent variable. In this study, the CTBS 1981 scores in reading served as the covariate. The 1982 scores were the criterion measure. The pretest scores were used to control for the fact that the Experimental Group had lower scores on the CTBS than the Control Group to begin with.

The more closely the pretest and posttest are correlated, the more satisfactory the analysis. It is appropriate, when possible, to use the same instrument for both the pre- and posttest, since the relevance is then 100%. Another way of explaining this, according to Roscoe, is:

To the extent that performance on the posttest
can be predicted from performance on the pre-
test, this performance cannot be attributed to
the experimental activities. The analysis of
covariance consists essentially of determining
that a proportion of the variance of the cri-
terian existed prior to the experiment and
this proportion is eliminated from the final
analysis. It should be immediately apparent
that two substantial benefits accrue from
such a procedure: (1) any variable that in-
fluences the variation of the criterion var-
iable may be controlled, and (2) the error
variance in the analysis is substantially
reduced.\footnote{John T. Roscoe, \textit{Fundamental Research Statistics}
for the Behavioral Sciences, 2nd ed. (New York: Holt,
Rinehart and Winston, 1975), p. 352.}

Each of the five hypotheses in the investigation was
tested using the Statistical Package for the Social Sciences
(SPSS) program, "Analysis of Variance" (ANOVA).\footnote{Norman H. Nie and others, \textit{Statistical Package for
pp. 408-12.} Analysis
of each null hypothesis utilized the 1981 CTBS total raw
score for the Reading subtest as the covariate and the 1982
CTBS total raw score for the Reading subtest as the depen-
dent variable. Independent variables in each of the five
analyses were specific to the hypothesis being tested.
These independent variables included sex, grade level,
etnicity and type of instruction received.

\textbf{Summary}

For this quasi-experiment, a sample of 340 4th, 5th
and 6th graders was chosen in a non-random manner and
divided into Experimental and Control Groups based on
pre-test scores. The pretest and posttest were the Comprehensive Tests of Basic Skills: Reading, Expanded Edition, Form S, 1973, administered in 1981 and 1982, respectively.

The experimental treatment lasted for one school year and consisted of daily computer-assisted instruction in the programs Reading, 3-6 or Reading for Comprehension, software published by the Computer Curriculum Corporation, Palo Alto, California. The number of treatment sessions ranged from 72-108.

Analysis of variance and covariance were used to analyze the data collected in this study. In each covariate analysis, the pretest served as the covariate and the posttest served as the dependent variable. Independent variables included sex, grade level, ethnicity and type of instruction.

In the next chapter, the results of the analysis have been presented in both narrative and tabular forms. A brief interpretation of each analysis follows each set of data.
Chapter 4

FINDINGS OF THE STUDY

In this chapter the findings of the investigation are presented. The research hypotheses are stated in the null form, and the results of the analyses are reported. The chapter is organized into five main sections: (a) total group achievement, (b) grade level, sex and ethnicity, (c) grade level differences, (d) vocabulary subtest results and (e) comprehension subtest results.

Analysis of variance and analysis of covariance procedures were utilized in this study to examine the influence of several variables on the reading achievement of Chapter I pupils in a rural school district. Variables included sex, grade level, ethnicity and type of instruction received. Raw scores, gains, reading grade placements and percentile ranks were examined.

The purpose of the analyses was to determine if supplementary computer-assisted instruction in reading, as employed by the Manteca Unified School District, was an effective method of raising the reading achievement of Chapter I pupils in grades 4 to 6. Chapter I pupils are those students who score at or below the fortieth percentile on a standardized test of basic skills. In this study, the standardized test was the CTBS, Form S, Level 2 for Grades 5 and 6, and Form S, Level 1 for Grade 4.
In Chapter 1 of this study, five hypotheses relating to reading achievement were presented. These hypotheses, restated in the null form, are:

\( H_1 \). There is no difference in the reading achievement gains of Chapter I students in the 4th, 5th and 6th grades who have received one year of supplementary computer-assisted instruction and similar students who have not received the supplementary instruction.

\( H_2 \). There is no difference in the reading achievement gains of Hispanic pupils who received one year of supplementary computer-assisted instruction and the gains of Hispanic students who did not receive the supplementary instruction.

\( H_3 \). There is no difference between the reading achievement gains of male and female students who have received one year of supplementary computer-assisted instruction.

\( H_4 \). There is no difference in the reading achievement gains made by 4th, 5th and 6th grade students who have received one year of supplementary computer-assisted instruction.

\( H_5 \). There is no relationship between Chapter I pupils' grade, sex, ethnicity, type of instruction and their gains in reading achievement.

**Total Group Achievement**

The first hypothesis was concerned solely with
differences between the Experimental and Control Groups on the Total Reading portion of the CTBS. This hypothesis was examined by the application of analysis of covariance techniques. The analysis utilized the 1981 Total Reading raw scores on the CTBS Reading Subtest as the covariate. Type of instruction was the independent variable and the 1982 raw scores for Total Reading served as the criterion.

Of the 340 students included in the original sample, CTBS Total Reading raw scores for both 1981 and 1982 were available for 208 students, or 61.4 percent of the total original population. The losses of subjects from both the Experimental and Control Groups were not considered detrimental to the validity of the study for three reasons. First: the analysis of covariance procedures used to examine the data are somewhat forgiving of unequal group pretest means. Second: in the district from which the sample was selected, high pupil mobility is a constant factor to be considered in the selection and evaluation of a reading program. Third: analysis of variance of gains was used to further investigate the findings. In this test, a value of p less than .05 indicates statistical significance. Data in Table 2 show that according to ANOVA there was a statistically significant difference in the performance of the Experimental and Control Groups on this test.

The Adjusted mean Total Reading scores for the Experimental and Control Groups were also compared. Table 3 data indicate that the Control Group, receiving
### Table 2

**Analysis of Covariance of The Effects of Instruction on Total Reading Raw Scores of the Total Sample, Grades 4-6**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>33664.59</td>
<td>1</td>
<td>33664.59</td>
<td>370.20</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>33664.59</td>
<td>1</td>
<td>33664.59</td>
<td>370.20</td>
<td>0.00</td>
</tr>
<tr>
<td>Main Effects</td>
<td>1700.17</td>
<td>1</td>
<td>1700.17</td>
<td>18.69</td>
<td>0.00</td>
</tr>
<tr>
<td>Instruction</td>
<td>1700.17</td>
<td>1</td>
<td>1700.17</td>
<td>18.69</td>
<td>0.00</td>
</tr>
<tr>
<td>Explained</td>
<td>35364.76</td>
<td>2</td>
<td>17682.38</td>
<td>194.45</td>
<td>0.00</td>
</tr>
<tr>
<td>Residual</td>
<td>18641.65</td>
<td>205</td>
<td></td>
<td>90.93</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>54006.41</td>
<td>207</td>
<td>260.90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 3

**Adjusted Mean Scores Earned by the Sample Population on the Total Reading Portion of the CTBS, 1982**

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Adjusted Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>146</td>
<td>59.43</td>
</tr>
<tr>
<td>Experimental</td>
<td>74</td>
<td>55.95</td>
</tr>
</tbody>
</table>
traditional instruction, had a higher mean score on the Total Reading portion of the CTBS than the Experimental Group. But these findings do not adequately account for pre-treatment differences in group means.

These findings alone, however, should not be considered indicative of the worth of the experimental treatment. The Control Group was made up of average and above-average pupils and the Experimental Group of below average, Chapter I pupils. It was not expected that one year of supplementary instruction would raise the achievement scores of the lower achieving group to equal those of the higher achievers.

An analysis of variance of the Total Reading raw scores for all grades was made, with a breakdown by type of instruction. The analysis revealed that in 1981, after receiving traditional instruction in reading, the Control Group had a mean Total Reading raw score of 65.8. At the same time, the Experimental Group, also receiving traditional instruction, had a mean Total Reading raw score of 36.7.

The following year computer-assisted instruction as a supplementary form of instruction in reading for Chapter I pupils was introduced. In 1982, after a year of the same traditional instruction, the Control Group had a mean Total Reading raw score of 67.4. The Experimental Group had a mean Total Reading raw score of 40.1. Both groups made gains in mean Total Reading raw score. The results of this analysis are shown in Table 4.
Table 4
Mean Total Reading Raw Scores for the Sample Population by Group and Year

<table>
<thead>
<tr>
<th>Group</th>
<th>1981</th>
<th>1982</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>65.8</td>
<td>67.4</td>
</tr>
<tr>
<td>Experimental</td>
<td>36.7</td>
<td>40.1</td>
</tr>
</tbody>
</table>

Analysis of variance procedures were used to compare the Reading Grade Placement (RGP) gains of the Control and Experimental Groups between 1980 and 1981. During this year, both groups were receiving the same traditional instruction in reading. There was a significant difference in the grade placement gains made by the two groups. The Control Group had a mean gain of 1.35 years in Reading Grade Placement, while the Experimental Group had a mean gain of .78 years. ANOVA procedures indicated that the difference in gains between the groups was significant, with p=.007.

The following year, Reading Grade Placement gains were again compared. Between 1981 and 1982 there was not a significant difference in the grade placement gains made by the two groups. The mean gain for the Control Group was 1.14 years, and the mean gain for the Experimental Group was .89 years. ANOVA procedures revealed no significant difference between the means, with p=.114. This is a significant finding because in this case, no significant difference is significant. This means that the Experimental
Group, made up of Chapter I pupils diagnosed as in need of special help in reading, have progressed about as well as the non-Chapter I Control Group in Reading Grade Placement gains after one year of computer-assisted instruction.

In both 1981 and 1982 there was a significant difference in the Reading Grade Placement scores by instructional group. That is, even though Chapter I pupils were now gaining at about the same rate as the non-Chapter I pupils, they remained, as a group, significantly behind their peers in RGP. This is shown in Table 5.

Table 5
Mean Reading Grade Placements for the Two Instructional Groups, 1981 and 1982

<table>
<thead>
<tr>
<th>Instructional Group</th>
<th>1981 RGP Mean</th>
<th>1982 RGP Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional (Control Group)</td>
<td>6.20</td>
<td>7.2</td>
</tr>
<tr>
<td>CAI (Experimental Group)</td>
<td>3.29</td>
<td>4.10</td>
</tr>
</tbody>
</table>

ANOVA was used to examine the percentile ranks of students in the sample. Because the two instructional groups were selected based on their percentile scores, there was, of course, a significant difference in the percentile scores by instructional group. Chapter I pupils are, by definition, those pupils who qualify for special services because of earning a score at or below the 40th percentile.
on a standardized test. In 1980, the mean Reading Percentile (RP) for the Control Group was 64, and the mean for the Experimental Group was 21.

In 1981, the RP scores were much like those of 1980. No significant difference was found except by instructional group. The Control Group had a 1981 RP mean of 68 and the Experimental Group had a mean of 24.

In 1982, after a year of supplementary CAI, the means were still significantly different. The 1982 mean RP for the Control Group was 66, and the mean for the Experimental Group was 25. Although the means are still significantly different, it appears as if the Experimental Group may have made some progress toward narrowing the gap between the groups.

Further analysis of the data was made to determine, as far as possible, the specific nature of the difference between the two instructional groups. Variables of sex, ethnicity, grade level and Ginn 720 Reading Program placement level were used in the subsequent analyses.

A Pearson correlation analysis of the independent variables revealed that the correlation of the Ginn level to the 1982 Total Reading raw score on the CTBS ranged from .77 to .87. An analysis of covariance procedure was then utilized with the Ginn placement levels as the criterion, type of instruction as the independent variable and Total Reading raw score on the 1981 CTBS as the covariate. This analysis indicated that the Ginn level was not significantly
influenced by the type of instruction, with the probability (p) being equal to 0.25. The Ginn level was dropped from further analyses at this point.

Grade Level, Sex and Ethnicity

In order to test Hypotheses 2 and 3 concerning the influence of ethnicity and sex on reading achievement scores, the data were again analyzed using both the analysis of variance and analysis of covariance procedures. This time, grade level, sex and ethnicity were added as independent variables, or predictors. The 1981 Total Reading raw scores on the CTBS were used as the covariate. The 1982 raw scores were used as the criterion or dependent variable. The results of this analysis appear in Table 6.

Table 6

The Effects of Instruction, Grade Level, Sex and Ethnicity on the Total Reading Raw Scores of the Total Sample, with 1981 Scores as the Covariate

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Effects</td>
<td>9491.74</td>
<td>5</td>
<td>1898.34</td>
<td>36.19</td>
<td>0.00</td>
</tr>
<tr>
<td>Instruction</td>
<td>160.58</td>
<td>1</td>
<td>160.58</td>
<td>3.06</td>
<td>0.08</td>
</tr>
<tr>
<td>Grade Level</td>
<td>7466.06</td>
<td>2</td>
<td>3733.03</td>
<td>71.17</td>
<td>0.00</td>
</tr>
<tr>
<td>Sex</td>
<td>3.93</td>
<td>1</td>
<td>3.93</td>
<td>0.07</td>
<td>0.78</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>8.18</td>
<td>1</td>
<td>8.18</td>
<td>0.15</td>
<td>0.69</td>
</tr>
</tbody>
</table>

These data indicate that sex and ethnicity may not be good predictors of reading raw scores. Grade level and instructional group may be good predictors.
Analysis of variance procedures were used to examine the Reading Grade Placement (RGP) gains of the sample population in regard to the variables being examined by this paper's five hypotheses. Analyses were made for the years 1980-1981, when traditional instruction alone was used for all students and for 1981-1982, when the Experimental Group received supplementary computer-assisted instruction.

Between 1980 and 1981, there was a significant difference in the Reading Grade Placement gains made by the Chapter I (Experimental Group) pupils and the other pupils in the sample. There was also a significant difference between the gains made at different grade levels. There was no significant difference between the gains made by members of different ethnic groups nor by members of the two sexes. There were also no significant interactions between the variables.

Between 1981 and 1982 there was no significant difference between the Reading Grade Placement gains made by the two groups, by different grade levels, by different ethnic groups, or by members of the two sexes. That is, after one year of supplementary CAI, pupils in the Experimental Group were making as good gains in Reading Grade Placement as pupils in the Control Group, according to the CTBS. The factors of grade level, sex and ethnicity do not appear to be significant factors in predicting grade placement gains.

Breakdown procedures were used in conjunction with
ANOVA to examine more closely the effects of the two types of instruction on the gains made by the two ethnic groups. As reported, there was a significant difference in the RGP gains made by the two instructional groups during the school year 1980-1981, with $p=.007$. During that year, the mean RGP gain for Anglos in the Control Group was 1.27 years and for Anglos in the Experimental Group, .91 years. In the Hispanic sample, the mean RGP gains for 1980-1981 in the Control Group was 1.63 years. For the Hispanics in the Experimental Group, the mean gain for the year was .42 years.

During the school year 1981-1982, the mean gains in RGP were examined for the same four groups. For Anglos in the Control Group, the 1981-1982 gain was 1.10 years. For Anglos in the Experimental Group, receiving CAI, the gain for the same period was .93 years. For Hispanics in the Control Group, the 1981-1982 gain in RGP was 1.26 years. For Hispanics in the Experimental Group, the gain was .78 years. A visual examination of the scores shows that while Anglos receiving CAI increased their mean gain from .91 to .93, Hispanics increased their mean gain from .42 to .78. It appears as if the Hispanic pupils made more gains in RGP after a year of CAI than their Anglo peers. These data are illustrated in Table 7.

Hypothesis 5, the interaction hypothesis concerning the variables of grade, sex, ethnicity and instruction was
### Table 7
Mean Reading Grade Placement Gains by Ethnic Group, Year and Type of Instruction

<table>
<thead>
<tr>
<th>Group</th>
<th>1980-81</th>
<th>1981-82</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hispanic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional Instruction</td>
<td>1.63</td>
<td>1.26</td>
<td>-.37</td>
</tr>
<tr>
<td>CAI</td>
<td>.42</td>
<td>.78</td>
<td>+.36</td>
</tr>
<tr>
<td>Anglo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional Instruction</td>
<td>1.20</td>
<td>1.10</td>
<td>-.17</td>
</tr>
<tr>
<td>CAI</td>
<td>.91</td>
<td>.93</td>
<td>+.02</td>
</tr>
</tbody>
</table>
examined separately using analysis of covariance. The 1982 raw scores for Total Reading on the CTBS were the criteria, the 1981 scores for the same test were the covariate, and the independent variables were grade level, sex, ethnicity and type of instruction. Out of a total sample of 340, 208 cases were included in this analysis. The results suggested that no significant interaction exists among the variables other than a two-way interaction between ethnicity and instruction, with \( p = .00 \), which will be discussed later in this chapter. There was, therefore, support for the hypothesis, as stated in Chapter 1. There does appear to be a relationship between a pupil's sex, grade level, ethnicity, type of instruction and total reading achievement as measured by the CTBS. In this case, it was necessary to reject the null hypothesis. The results of this analysis are shown in Table 8.

In order to further examine the relationship between ethnicity and type of instruction in this study, these two variables were combined. In this manner a four-celled bivariate table was generated, as shown in Table 9. There were 220 cases included in this analysis which suggested that regardless of grade level, the difference between methods for Hispanics exceeded that for Anglos.

This finding must not be construed to indicate that Hispanics should receive only traditional instruction. What it appears to indicate is a greater difference between the high and low achieving Hispanics than between high and low
Table 8
The Effects of Interactions Between Variables on the Total Reading Raw Scores of the Total Sample, Grades 4-6

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-Way Interactions</td>
<td>708.66</td>
<td>9</td>
<td>78.74</td>
<td>1.50</td>
<td>0.15</td>
</tr>
<tr>
<td>Instruction</td>
<td>45.90</td>
<td>2</td>
<td>22.95</td>
<td>0.43</td>
<td>0.64</td>
</tr>
<tr>
<td>Grade Level</td>
<td>33.13</td>
<td>2</td>
<td>16.56</td>
<td>0.31</td>
<td>0.73</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>504.49</td>
<td>1</td>
<td>504.49</td>
<td>9.61</td>
<td>0.00</td>
</tr>
<tr>
<td>Sex</td>
<td>21.81</td>
<td>1</td>
<td>21.81</td>
<td>0.41</td>
<td>0.52</td>
</tr>
<tr>
<td>3-Way Interactions</td>
<td>275.35</td>
<td>7</td>
<td>39.33</td>
<td>0.75</td>
<td>0.63</td>
</tr>
<tr>
<td>Instruction</td>
<td>91.37</td>
<td>2</td>
<td>45.69</td>
<td>0.87</td>
<td>0.42</td>
</tr>
<tr>
<td>Grade Level</td>
<td>27.46</td>
<td>2</td>
<td>13.73</td>
<td>0.26</td>
<td>0.77</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>15.10</td>
<td>1</td>
<td>15.10</td>
<td>0.28</td>
<td>0.59</td>
</tr>
<tr>
<td>Sex</td>
<td>138.18</td>
<td>2</td>
<td>69.09</td>
<td>1.31</td>
<td>0.27</td>
</tr>
<tr>
<td>4-Way Interactions</td>
<td>267.57</td>
<td>2</td>
<td>133.78</td>
<td>2.55</td>
<td>0.08</td>
</tr>
</tbody>
</table>
achieving Anglos.

Table 9
Adjusted Mean Raw Scores in Total Reading Earned by Anglos and Hispanics Receiving Two Types of Instruction

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Traditional</th>
<th>CAI</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anglo</td>
<td>61.04</td>
<td>52.59</td>
<td>8.45</td>
</tr>
<tr>
<td>Hispanic</td>
<td>64.22</td>
<td>48.62</td>
<td>15.60</td>
</tr>
</tbody>
</table>

When examined together with the data provided in Table 8, this analysis seems to indicate that even though there is a much greater gap between the reading achievement of high and low achieving Hispanics, low achievers who receive CAI are able to make greater gains than their Anglo peers who are also low achievers and who receive the same instruction.

In 1981 and 1982, no significant difference was found in the mean Reading Grade Placement scores of the two sexes. The same was true for the two ethnic groups examined in the study. A significant difference was found between the mean RGP scores of the three different grade levels and the two instructional groups. That is, for the year in which all students received traditional reading instruction and for the year of the experimental treatment, pupils of both sexes and both ethnic groups performed alike on the
As predicted, students differed by grade level and by instructional group. For both years, pupils in Grade 6 had a higher mean RGP than pupils in Grades 4 or 5. Students in Grade 5 had a higher mean RGP than pupils in Grade 4. For both years, also, the Control Group had a significantly higher mean RGP than the Experimental Group. These data are presented in tabular form in Table 10.

Table 10
Mean Reading Grade Placements of the Sub-Groups for the Years 1981 and 1982

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean RGP 1981</th>
<th>Mean RGP 1982</th>
<th>Significant Difference in Sub-Group Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>5.17</td>
<td>6.21</td>
<td>no</td>
</tr>
<tr>
<td>Female</td>
<td>5.10</td>
<td>6.19</td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anglo</td>
<td>5.24</td>
<td>6.30</td>
<td>no</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4.82</td>
<td>5.89</td>
<td></td>
</tr>
<tr>
<td>Instruction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional Instruction</td>
<td>6.20</td>
<td>7.20</td>
<td>yes</td>
</tr>
<tr>
<td>CAI</td>
<td>3.29</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>Grade Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 4</td>
<td>3.99</td>
<td>5.11</td>
<td>yes</td>
</tr>
<tr>
<td>Grade 5</td>
<td>5.31</td>
<td>6.31</td>
<td></td>
</tr>
<tr>
<td>Grade 6</td>
<td>6.05</td>
<td>7.15</td>
<td></td>
</tr>
</tbody>
</table>

The percentile ranks of students were also examined
using ANOVA. In 1980, there was no significant difference in the Reading Percentile Ranks (RPs) of students by sex, ethnicity or grade level. That is, boys and girls and pupils in both ethnic groups performed comparably on the reading subtest of the CTBS. The grade level percentiles represent a normal curve. That is, at each grade level, most pupils scored around the 50th percentile. A few students scored very low and a few scored very high.

In 1981, the Reading Percentile scores were much like those earned in 1980. No significant differences were found between groups examined by sex, ethnicity or grade level.

In 1982, after a year of supplementary instruction, ANOVA also revealed no significant differences by sex, ethnicity or grade level. This indicates that these three variables may not be good predictors of reading achievement regardless of the type of instruction provided.

**Grade Level Differences**

The next step in the examination of the data was to examine the pupils' achievement at each grade level. Three separate analyses were made. These analyses were: (1) Raw Scores, Grade 4, (2) Raw Scores, Grade 6, and (3) Reading Grade Placement. Raw scores for Grade 5 could not be examined and compared because pupils in Grade 5 took the CTBS, Level 1 in 1981 and the CTBS, Level 2 in 1982. Raw scores on two different forms of a test cannot be compared.
The results of these analyses are reported below.

**Raw Scores, Grade 4**

There were 112 pupils at the 4th grade level in the original sample. Of these, sixty-six cases contained sufficient data to allow inclusion in this part of the study. A significant difference between the achievement of students receiving the supplementary computer-assisted instruction and those not receiving supplementary instruction was revealed. Table 11 illustrates the results of this analysis.

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>14488.01</td>
<td>1</td>
<td>14488.01</td>
<td>303.74</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td>14488.01</td>
<td>1</td>
<td>14488.01</td>
<td>303.74</td>
<td>0.00</td>
</tr>
<tr>
<td>Main Effects</td>
<td>376.81</td>
<td>1</td>
<td>376.81</td>
<td>7.90</td>
<td>0.00</td>
</tr>
<tr>
<td>Instruction</td>
<td>376.81</td>
<td>1</td>
<td>376.81</td>
<td>7.90</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Table 12 data show that instruction was a significant factor at the 4th grade level. It is interesting to note, however, that the difference in achievement is in favor of the Control Group, which did not receive the supplementary instruction, rather than the Experimental Group which did receive it.

Again, it is important to note that the Experimental
and Control Groups were not matched. Each group contained a variety of boys and girls, Hispanics and Anglos, at grade levels ranging from 4 through 6. The groups were divided for experimental purposes on the basis of percentile rank on the 1981 CTBS. At no time should it be inferred that the instructional method alone was responsible for pupils' achievement in reading. According to Dechant, correlates of reading achievement, in addition to adequate instruction, include physical maturity, experiential background including socioeconomic and cultural factors, intellectual development, attention span, and interest.¹

When the unadjusted means are examined, a different picture of the 4th grade pupils' achievement is presented. In 1981, after a year of traditional instruction, 4th grade pupils in the Control Group earned the following mean scores on the 1981 CTBS, Level 1: Vocabulary-29.6; Comprehension-32.2; Total Reading-61.8. The Experimental Group earned somewhat lower scores for the same year, as might have been expected. Their scores were: Vocabulary-15.2; Comprehension-16.9; Total Reading-32.1.

In 1982, after the Experimental Group had completed one year of supplementary computer-assisted instruction, the pupils were again tested on the CTBS, Level 1. The 1982 means for the Control Group are higher than for the previous

year: Vocabulary-33.4; Comprehension-36.9; Total Reading-70.4. The means for the Experimental Group were also higher: Vocabulary-22.0; Comprehension-19.2; Total Reading-41.2. During the year in which the Experimental Group received the CAI, they made a Total Reading gain of 9.1 points, as compared with a gain of 8.6 points made by the Control Group. Table 12 data illustrate these findings.

Table 12

Mean Raw Scores for Grade 4 Pupils by Group and by Year, CTBS, Level 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Test</th>
<th>Control</th>
<th>Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981</td>
<td>Vocabulary</td>
<td>29.6</td>
<td>15.2</td>
</tr>
<tr>
<td></td>
<td>Comprehension</td>
<td>32.2</td>
<td>16.9</td>
</tr>
<tr>
<td></td>
<td>Total Reading</td>
<td>61.8</td>
<td>32.1</td>
</tr>
<tr>
<td>1982</td>
<td>Vocabulary</td>
<td>33.4</td>
<td>22.0</td>
</tr>
<tr>
<td></td>
<td>Comprehension</td>
<td>36.9</td>
<td>19.2</td>
</tr>
<tr>
<td></td>
<td>Total Reading</td>
<td>70.4</td>
<td>41.2</td>
</tr>
</tbody>
</table>

Raw Scores, Grade 6

Achievement in reading at the 6th grade level was then examined. There were 113 students in the original sample. Of these, 73 had enough data to allow inclusion in the final analysis. At the 6th grade level, no significant difference in reading achievement was found between the Experimental and Control Groups. Table 13 illustrates
this finding.

Table 13
The Effects of Instruction on Total Reading
Raw Scores of Grade 6 Pupils

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>19490.70</td>
<td>1</td>
<td>19490.70</td>
<td>459.14</td>
<td>0.00</td>
</tr>
<tr>
<td>Total 1981</td>
<td>19490.70</td>
<td>1</td>
<td>19490.70</td>
<td>459.14</td>
<td>0.00</td>
</tr>
<tr>
<td>Main Effects</td>
<td>31.72</td>
<td>1</td>
<td>31.72</td>
<td>0.74</td>
<td>0.39</td>
</tr>
<tr>
<td>Instruction</td>
<td>31.72</td>
<td>1</td>
<td>31.72</td>
<td>0.74</td>
<td>0.39</td>
</tr>
</tbody>
</table>

Reading Grade Placement

The mean Total Reading grade placement scores were also examined. These scores were computed by grade level, by type of instruction, and by year. Because the CTBS is not given to 2nd or 3rd grade students in the district, no 1980 scores are available for the 4th grade group.

In 1981, the 4th grade pupils in the Control Group had a mean grade placement of 4.9 on the CTBS, Level 1. In 1982, the mean grade placement for this group was 6.0. For the same years, the Experimental Group's means were 2.7 and 3.2, respectively.

At the 5th grade level, scores are available for all years. In 1980, the Control Group had a mean grade placement of 4.5. In 1981, the mean grade placement for the group was 6.1, and in 1982, it was 7.0.

Grade 6 pupils in the Control Group performed well every year that data were collected. The mean reading grade
placements for the years 1980-1982 were 6.2, 7.3 and 8.6 respectively. The Experimental Group at this grade level earned scores of 3.2, 3.8 and 4.7 for the same years. These data are illustrated in Table 14.

Table 14

Mean Reading Grade Placement for Grades 4-6, 1980-1982

<table>
<thead>
<tr>
<th>Group and Grade</th>
<th>1980</th>
<th>1981</th>
<th>1982</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 4</td>
<td>N/A</td>
<td>4.9</td>
<td>6.0</td>
</tr>
<tr>
<td>Grade 5</td>
<td>4.5</td>
<td>6.1</td>
<td>7.0</td>
</tr>
<tr>
<td>Grade 6</td>
<td>6.2</td>
<td>7.3</td>
<td>8.6</td>
</tr>
<tr>
<td>Experimental</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 4</td>
<td>N/A</td>
<td>2.7</td>
<td>3.2</td>
</tr>
<tr>
<td>Grade 5</td>
<td>2.3</td>
<td>3.3</td>
<td>4.2</td>
</tr>
<tr>
<td>Grade 6</td>
<td>3.2</td>
<td>3.8</td>
<td>4.7</td>
</tr>
</tbody>
</table>

There was no significant difference between the RGP gains made by the Experimental and Control Groups between 1981 and 1982. The mean gains for the year can be examined at each grade level using Breakdown. For the total Control Group, the mean gain in RGP for the year was 1.14 years. For Grade 4, the mean gain was 1.14, for Grade 5 it was 1.11 and for Grade 6 it was 1.17.
In the Experimental Group, for the year 1981-1982, the mean gain in RGP was .89 years. Broken down by grade, this included a gain of .81 for the 4th grade, .84 for the 5th grade and .99 for the 6th grade. This means that at the 6th grade level, the Chapter I pupils who received one year of supplementary CAI made almost one full year of growth for one year of instruction. This is better than could be expected for low-achieving pupils. These data are displayed in Table 15.

Table 15
Mean Reading Grade Placement Gains for Each Type of Instruction, Grades 4-6, 1981-1982

<table>
<thead>
<tr>
<th>Group and Grade</th>
<th>Mean Gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Instruction</td>
<td></td>
</tr>
<tr>
<td>Grade 4</td>
<td>1.14</td>
</tr>
<tr>
<td>Grade 5</td>
<td>1.11</td>
</tr>
<tr>
<td>Grade 6</td>
<td>1.17</td>
</tr>
<tr>
<td>CAI</td>
<td></td>
</tr>
<tr>
<td>Grade 4</td>
<td>.81</td>
</tr>
<tr>
<td>Grade 5</td>
<td>.84</td>
</tr>
<tr>
<td>Grade 6</td>
<td>.99</td>
</tr>
</tbody>
</table>

The results of these analyses do not support the hypothesis, stated in Chapter 1, that there was differential achievement among 4th, 5th and 6th grade students who had
received one year of computer-assisted instruction in reading. All Experimental Group pupils made gains comparable to those made by the Control Group pupils after one year of CAI.

The adjusted means for the Sequoia pupils who took the Level 2 test compared with the means of the standardization sample used by the test publisher. It is interesting to note that the means for the groups in this study were higher than the means of the standardization sample at all grade levels. Data in Table 16 illustrates this finding.

Table 16

A Comparison of the Unadjusted Mean Scores in Total Reading for Manteca Unified and the Publisher's Standardization Sample

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>M.U.S.D.</th>
<th>Standardization Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 5</td>
<td>54.80</td>
<td>51.70</td>
</tr>
<tr>
<td>Grade 6</td>
<td>59.79</td>
<td>57.90</td>
</tr>
</tbody>
</table>

Vocabulary Subtest Results

A statistically significant difference in Total Reading achievement was found between the Experimental and Control Groups in the first set of analyses. Although not

part of the original experimental design, the investigator decided to examine Vocabulary and Comprehension subscores separately in an effort to gain a greater understanding of the exact nature of the revealed differences.

The Pearson correlation (r) between the Vocabulary subtests in 1981 and 1982 was found to be .87. It was surmised, on the basis of this correlation, that differences in the tests would not be a factor in the results obtained from a comparison of test scores for these two years.

Because grade level had already been shown to be a significant factor in the prediction of Raw Scores, data for 4th, 5th and 6th grade students were examined separately. Analysis of variance and covariance procedures were used to examine the 1982 Vocabulary subtest scores on the CTBS in relation to a pupil's sex, ethnicity and the type of instruction received. The 1981 Vocabulary subtest scores were used as the covariate.

This analysis revealed no significant difference in Vocabulary subtest scores for 4th or 5th graders by type of instruction. Sex and ethnicity were also shown to be non-significant when considered alone at these levels. At the 6th grade level, however, a significant difference in Vocabulary achievement was found between the Experimental and Control Groups, and between the two ethnic groups represented in the study. The interaction between instruction and ethnicity was also found to be statistically significant for the 6th grade level, and between sex and ethnicity at
the 4th grade level. The results of this analysis are shown in Table 17, page 113.

The interaction between instruction and ethnicity at the 6th grade level is consistent with the findings previously described in the Grade Level, Sex and Ethnicity section. The interaction between sex and ethnicity at the 4th grade level is statistically significant at the .05 level. This finding does not, however, imply practical significance.

Further examination of the adjusted mean scores for the Vocabulary subtest for 6th graders revealed that the difference in means was in favor of the Control, rather than the Experimental Group. The difference in performance between the ethnic groups was in favor of the non-minority group. The difference in these means was so slight, however, that no further consideration was given to them, other than to note their existence in this report. The results of this examination are shown in Table 18, page 114.

The unadjusted Vocabulary Subtest raw score means for grades 4 and 6 were then examined. The gains in Vocabulary made during the 1981-1982 school year were computed for both the Experimental and Control Groups. The computations show that after one year of CAI, the Experimental Group at Grade 4 gained 6.8 points while the traditionally instructed group gained 3.8 points. For the 6th graders, raw score means were very close. The Control Group gained 3.7 points and the Experimental Group gained 3.6 points. Table 19,
Table 17

The Effects of Instruction, Sex, and Ethnicity on Vocabulary Subtest Raw Scores for Each Grade Level, 4-6

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grade 4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Effects</td>
<td>62.71</td>
<td>3</td>
<td>20.90</td>
<td>1.32</td>
<td>0.27</td>
</tr>
<tr>
<td>Instruction</td>
<td>35.70</td>
<td>1</td>
<td>35.70</td>
<td>2.25</td>
<td>0.13</td>
</tr>
<tr>
<td>Sex</td>
<td>20.72</td>
<td>1</td>
<td>20.72</td>
<td>1.31</td>
<td>0.25</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>3.56</td>
<td>1</td>
<td>3.56</td>
<td>0.22</td>
<td>0.63</td>
</tr>
<tr>
<td>2-Way Interactions</td>
<td>90.13</td>
<td>3</td>
<td>30.04</td>
<td>1.90</td>
<td>0.14</td>
</tr>
<tr>
<td>Instruction Sex</td>
<td>17.69</td>
<td>1</td>
<td>17.69</td>
<td>1.11</td>
<td>0.29</td>
</tr>
<tr>
<td>Instruction Ethnicity</td>
<td>0.00</td>
<td>1</td>
<td>0.00</td>
<td>0.00</td>
<td>0.99</td>
</tr>
<tr>
<td>Sex Ethnicity</td>
<td>63.73</td>
<td>1</td>
<td>63.73</td>
<td>4.03</td>
<td>0.04</td>
</tr>
<tr>
<td><strong>Grade 5</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Effects</td>
<td>52.99</td>
<td>3</td>
<td>17.66</td>
<td>1.03</td>
<td>0.38</td>
</tr>
<tr>
<td>Instruction</td>
<td>11.28</td>
<td>1</td>
<td>11.28</td>
<td>0.65</td>
<td>0.41</td>
</tr>
<tr>
<td>Sex</td>
<td>12.02</td>
<td>1</td>
<td>12.02</td>
<td>0.70</td>
<td>0.40</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>22.09</td>
<td>1</td>
<td>22.09</td>
<td>1.29</td>
<td>0.26</td>
</tr>
<tr>
<td>2-Way Interactions</td>
<td>113.45</td>
<td>3</td>
<td>37.81</td>
<td>2.21</td>
<td>0.09</td>
</tr>
<tr>
<td>Instruction Sex</td>
<td>37.91</td>
<td>1</td>
<td>37.91</td>
<td>2.21</td>
<td>0.14</td>
</tr>
<tr>
<td>Instruction Ethnicity</td>
<td>38.66</td>
<td>1</td>
<td>38.66</td>
<td>2.25</td>
<td>0.13</td>
</tr>
<tr>
<td>Sex Ethnicity</td>
<td>14.67</td>
<td>1</td>
<td>14.67</td>
<td>0.85</td>
<td>0.35</td>
</tr>
<tr>
<td><strong>Grade 6</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Effects</td>
<td>306.31</td>
<td>3</td>
<td>102.10</td>
<td>7.33</td>
<td>0.00</td>
</tr>
<tr>
<td>Instruction</td>
<td>189.59</td>
<td>1</td>
<td>189.59</td>
<td>13.62</td>
<td>0.00</td>
</tr>
<tr>
<td>Sex</td>
<td>26.50</td>
<td>1</td>
<td>26.50</td>
<td>1.90</td>
<td>0.17</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>104.25</td>
<td>1</td>
<td>104.25</td>
<td>7.49</td>
<td>0.00</td>
</tr>
<tr>
<td>2-Way Interactions</td>
<td>78.25</td>
<td>3</td>
<td>26.08</td>
<td>1.87</td>
<td>0.14</td>
</tr>
<tr>
<td>Instruction Sex</td>
<td>2.41</td>
<td>1</td>
<td>2.41</td>
<td>0.17</td>
<td>0.67</td>
</tr>
<tr>
<td>Instruction Ethnicity</td>
<td>75.91</td>
<td>1</td>
<td>75.91</td>
<td>5.45</td>
<td>0.02</td>
</tr>
<tr>
<td>Sex Ethnicity</td>
<td>5.21</td>
<td>1</td>
<td>5.21</td>
<td>0.37</td>
<td>0.54</td>
</tr>
</tbody>
</table>
Table 18
Adjusted Mean Scores on the Vocabulary Subtest Earned by Different Groups of 6th Grade Pupils in 1982

<table>
<thead>
<tr>
<th>Instruction</th>
<th>N</th>
<th>Adjusted Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>45</td>
<td>30.84</td>
</tr>
<tr>
<td>CAI</td>
<td>28</td>
<td>24.68</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>N</th>
<th>Adjusted Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anglo</td>
<td>56</td>
<td>29.18</td>
</tr>
<tr>
<td>Hispanic</td>
<td>17</td>
<td>26.18</td>
</tr>
</tbody>
</table>

Table 19
Mean Gains on the Vocabulary Subtest for Grades 4-6, 1981-1982

<table>
<thead>
<tr>
<th>Grade</th>
<th>Control</th>
<th>Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>+3.8</td>
<td>+6.8</td>
</tr>
<tr>
<td>6</td>
<td>+3.7</td>
<td>+3.6</td>
</tr>
</tbody>
</table>
ANOVA was used to examine the Vocabulary Subtest scores for each year. In 1981, Sex was not a significant variable, but Grade Level, Ethnicity and Instructional Group were significant. That is, while boys and girls in the sample performed comparably on the Vocabulary subtest, pupils in the different grades, Hispanics and Anglos and Chapter I and non-Chapter I pupils performed quite differently.

In 1982, sex was also non-significant as a variable effecting Vocabulary Subtest raw scores. Grade Level was significant, as was Instructional Group. This year, Ethnicity was a significant variable. This finding coincides with findings reported in the Grade Level, Sex and Ethnicity section which posit that greater gains were made by low-achieving Hispanics after a year of CAI than by low-achieving Anglos who received the same type of supplementary instruction.

**Comprehension Subtest Results**

The correlation between the 1981 and 1982 Comprehension subtests was found to be .75. This correlation suggests that differences in scores earned on the two instruments may not be caused by differences in the tests.

Because grade level had already been shown to be a significant factor, the Comprehension subtest scores for
each grade level were examined separately. Analysis of variance and covariance procedures were employed to compare the 1982 Comprehension subtest scores in relation to each pupil's sex, ethnicity and type of instruction received. The 1981 Comprehension scores served as the covariate.

In the area of Comprehension, no significant difference was found between the Experimental and Control Groups at the 6th grade level. Sex and ethnicity were also shown to be non-significant when considered alone. At the 4th and 5th grade levels, instruction was a statistically significant variable. Two-way interactions between the variables of sex, ethnicity and type of instruction were also examined. No significant differences were revealed. Data in Table 20, page 117, summarize the results of the analysis of Comprehension scores.

These findings suggest that, in the area of Comprehension, the most significant differences occur at the 4th and 5th grade levels between the Chapter I and non-Chapter I pupils.

During the 1981-1982 school year, the 4th graders in the Control Group received traditional instruction and gained 4.7 points in Comprehension. The Experimental Group, which received supplementary CAI, gained only 2.3 points in Comprehension. Sixth graders in the Control Group gained 3.9 points, while those in the Experimental Group gained 4.8 points. When the gains in Comprehension for both the grades are computed, they are very close. The Control Group gained
Table 20
The Effects of Instruction, Sex and Ethnicity on Comprehension Subtest Raw Scores for each Grade Level, 4-6

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Grade 4</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Effects</td>
<td>469.95</td>
<td>3</td>
<td>156.65</td>
<td>7.43</td>
<td>0.00</td>
</tr>
<tr>
<td>Instruction</td>
<td>457.45</td>
<td>1</td>
<td>457.45</td>
<td>21.71</td>
<td>0.00</td>
</tr>
<tr>
<td>Sex</td>
<td>0.99</td>
<td>1</td>
<td>0.99</td>
<td>0.04</td>
<td>0.82</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>21.36</td>
<td>1</td>
<td>21.36</td>
<td>1.01</td>
<td>0.31</td>
</tr>
<tr>
<td>2-Way Interactions</td>
<td>50.80</td>
<td>3</td>
<td>16.93</td>
<td>0.80</td>
<td>0.49</td>
</tr>
<tr>
<td>Instruction Sex</td>
<td>50.01</td>
<td>1</td>
<td>50.01</td>
<td>2.37</td>
<td>0.12</td>
</tr>
<tr>
<td>Instruction Ethnicity</td>
<td>3.43</td>
<td>1</td>
<td>3.43</td>
<td>0.16</td>
<td>0.68</td>
</tr>
<tr>
<td>Sex Ethnicity</td>
<td>0.04</td>
<td>1</td>
<td>0.04</td>
<td>0.00</td>
<td>0.96</td>
</tr>
<tr>
<td><strong>Grade 5</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Effects</td>
<td>216.54</td>
<td>3</td>
<td>72.18</td>
<td>2.13</td>
<td>0.10</td>
</tr>
<tr>
<td>Instruction</td>
<td>206.99</td>
<td>1</td>
<td>206.99</td>
<td>6.12</td>
<td>0.01</td>
</tr>
<tr>
<td>Sex</td>
<td>7.14</td>
<td>1</td>
<td>7.14</td>
<td>0.21</td>
<td>0.64</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>38.79</td>
<td>1</td>
<td>38.79</td>
<td>1.14</td>
<td>0.28</td>
</tr>
<tr>
<td>2-Way Interactions</td>
<td>78.10</td>
<td>3</td>
<td>26.03</td>
<td>0.77</td>
<td>0.51</td>
</tr>
<tr>
<td>Instruction Sex</td>
<td>39.48</td>
<td>1</td>
<td>39.48</td>
<td>1.16</td>
<td>0.28</td>
</tr>
<tr>
<td>Instruction Ethnicity</td>
<td>27.41</td>
<td>1</td>
<td>27.41</td>
<td>0.81</td>
<td>0.37</td>
</tr>
<tr>
<td>Sex Ethnicity</td>
<td>0.02</td>
<td>1</td>
<td>0.02</td>
<td>0.00</td>
<td>0.98</td>
</tr>
<tr>
<td><strong>Grade 6</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Effects</td>
<td>47.07</td>
<td>3</td>
<td>15.69</td>
<td>0.82</td>
<td>0.48</td>
</tr>
<tr>
<td>Instruction</td>
<td>23.65</td>
<td>1</td>
<td>23.65</td>
<td>1.25</td>
<td>0.26</td>
</tr>
<tr>
<td>Sex</td>
<td>1.37</td>
<td>1</td>
<td>1.37</td>
<td>0.07</td>
<td>0.78</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>11.56</td>
<td>1</td>
<td>11.56</td>
<td>0.61</td>
<td>0.43</td>
</tr>
<tr>
<td>2-Way Interactions</td>
<td>23.06</td>
<td>3</td>
<td>7.68</td>
<td>0.40</td>
<td>0.74</td>
</tr>
<tr>
<td>Instruction Sex</td>
<td>16.18</td>
<td>1</td>
<td>16.18</td>
<td>0.85</td>
<td>0.35</td>
</tr>
<tr>
<td>Instruction Ethnicity</td>
<td>5.14</td>
<td>1</td>
<td>5.14</td>
<td>0.27</td>
<td>0.60</td>
</tr>
<tr>
<td>Sex Ethnicity</td>
<td>1.86</td>
<td>1</td>
<td>1.86</td>
<td>0.09</td>
<td>0.75</td>
</tr>
</tbody>
</table>
8.6 points in Comprehension while the Experimental Group gained 7.1 points. Table 21 data illustrate these findings.

Table 21
Mean Gains on the Comprehension Subtest for Grades 4 and 6, 1981-1982, With Totals

<table>
<thead>
<tr>
<th>Grade</th>
<th>Control</th>
<th>Experimental</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>+4.7</td>
<td>+2.3</td>
</tr>
<tr>
<td>6</td>
<td>+3.9</td>
<td>+4.8</td>
</tr>
<tr>
<td>Total</td>
<td>+8.6</td>
<td>+7.1</td>
</tr>
</tbody>
</table>

Grade 5 Comprehension subtest gains cannot be computed because these pupils took the CTBS, Level 1 in 1981 and the CTBS, Level 2 in 1982.

ANOVA was used to examine the Comprehension Subtest raw scores of the sample in 1981 and 1982. In 1981, Sex and Ethnicity were not significant variables in the prediction of Comprehension raw scores. Grade Level and Instructional Group were significant. That is, both boys and girls and Hispanics and Anglos performed comparably on the Comprehension Subtest portion of the CTBS in 1981. Pupils in different grades and in the two groups, Control and Experimental, did not perform comparably.

In 1982, Sex, Grade Level and Ethnicity were all non-significant variables. Instructional Group remained statistically significant. This seems to indicate that
Chapter I, low-achieving pupils tend to remain low-achieving, regardless of their sex, ethnicity or grade level, at least in the area of Comprehension.

Summary of the Findings

Five research hypotheses were posited by this study and restated in the null form. Four of the null hypotheses were supported by the data.

As suggested in Hypothesis 1, Chapter I students in grades 4 to 6 did not differ in their reading achievement gains according to the type of instruction they received. Analysis of variance of the Reading Grade Placement scores of all pupils in the study revealed no significant difference in RGP gains between the Experimental and Control Groups. Raw Scores, Reading Grade Placements and Percentile Ranks for the Control Group were higher than the scores earned by the Experimental Group, as was expected.

As suggested in Hypothesis 2, Ethnicity was not found to be a significant variable in the prediction of reading achievement. A greater difference was revealed between the Reading Grade Placements and the Reading Percentiles of high and low achieving Hispanics than between the scores of high and low achieving Anglos. Low achieving Hispanics who received one year of CAI made greater gains than low achieving Anglos who received the same instruction. Hispanics in the high achieving group also outperformed the high achieving Anglos. No significant
difference in the reading achievement gains as measured by the CTBS was found between Hispanic and Anglo pupils. Hypothesis 2 was supported.

Hypothesis 3 suggested that there was no difference in the performance of boys and girls in the study. This was supported by the data. Sex was a consistently non-significant variable in the prediction of reading achievement as measured by the CTBS. Raw Scores, Reading Grade Placements and Reading Percentile Ranks were all comparable for boys and girls in both the Experimental and Control Groups. Hypothesis 3 was supported by the data.

The data supported Hypothesis 4. There was no significant difference in the gains made by 4th, 5th and 6th graders. There was a significant difference in the Reading Grade Placements, but not in the Percentile Ranks or in the gains made after a year of instruction. As expected, 6th graders had higher Grade Placements than 4th or 5th graders. Fifth graders had higher Grade Placements than 4th graders. All grades had percentile Ranks indicative of a normal curve.

Hypothesis 5 posited that there was no significant interaction among the variables. Analysis of the Raw Scores of the total sample revealed no significant three- or four-way interactions. One significant two-way interaction was revealed between ethnicity and instruction. Further examination of the data indicated that low-achieving Hispanics in the Experimental Group, receiving one year of
supplementary CAI, made greater gains than their low-achieving Anglo peers. On the basis of this interaction, Hypothesis 5 was rejected.

In Chapter 5, an interpretation of the findings reported in this chapter is presented. The investigator also offers recommendations for further study based on the findings of this investigation.
Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

This investigation dealt with an examination of the effectiveness of supplementary computer-assisted instruction in reading for Chapter I students in grades 4 to 6.

The sample used in this investigation was composed of 340 4th, 5th and 6th grade students from the Sequoia Elementary School, located in the Manteca Unified School District. A portion of the sample, the Experimental Group, was made up of Chapter I students. The Control Group was made up of average and above-average students. There was a mix of boys and girls, Hispanics and Anglos in the sample.

Classroom reading instruction for both groups utilized the Ginn 720 Reading Program, with students being divided into ability groups. Students in this study were placed on Ginn levels 7 through 13. According to the publisher, students ranging in ability from slow-learning 4th grade level to fast-learning 6th grade level would cover material from the end of Level 7 through Level 13. The group of students involved in this study may then be considered to be within the normal range for their grades in the area of reading.

The Experimental Group received supplementary instruction in reading. This supplementary instruction, as described in Chapter 3, consisted of daily ten minute
sessions in the Computer Center using the Computer Curriculum Corporation programs, Reading, 3-6 and Reading for Comprehension.

This study employed a non-randomized control group pretest-posttest design. The pretest was the CTBS, Level 1 or 2, given in 1981. The posttest was the same test given in 1982. Other data collected and analyzed included each pupil's grade level, sex, ethnicity, CTBS reading raw scores, reading grade placement, reading percentile rank and Ginn 720 Level.

The selection bias inherent in this type of experiment resulted in two essentially different groups or subjects. Chapter I students, with performances below the 40th percentile on a standardized test of reading achievement, made up the Experimental Group. The Control Group was made up of students who scored above the 40th percentile, and included above-average as well as average pupils. For a number of reasons, Experimental Group students may have been less motivated to perform in an academic setting, had less favorable attitudes toward school related tasks, had lower aptitudes for academic work, and had less enriched home backgrounds. A treatment for this group of students may be considered effective even though the group means remain below average, and below those of the Control Group.

Reading achievement, as measured by a standardized test, is affected by many factors. These factors must be considered whenever an evaluation of such achievement is
made. Several factors pertinent to this study are discussed below.

**Type of test.** The CTBS is a normative-referenced test. That is, students taking the CTBS are compared in their performance with a sample group of students whose scores on the test are known. A well-normed test attempts to include in the sample population students who are representative of the types of students who will be taking the test. This type of test is quite different in form and in use from a criterion-referenced test. A criterion-referenced test reflects the progress of the individual pupil in relation to his/her starting point and the material covered by the program being tested. There is no attempt to compare the student with others. What is measured is the pupil's progress toward mastery of the given material.

Progress reported by the software programs Reading, 3-6 and Reading for Comprehension is criterion-referenced progress. Obviously, scores on these two kinds of tests cannot be successfully compared.

**Generalizability.** When taking a standardized test such as the CTBS, a student must generalize from one situation to another. Even a pupil who does well on publisher-provided progress tests may have trouble answering similar questions presented in a different manner on the CTBS. There is a trend in workbooks today to simulate the format used on the CTBS. The pupils are trained to answer
questions asked in a certain format. The questions asked in Reading, 3-6 and Reading for Comprehension were not in the same format as the questions on the CTBS.

**Teaching vs. reinforcing.** There are two ways of presenting and reinforcing a lesson using computer-assisted instruction. In the first, the teacher presents the concept and uses CAI in a drill and practice format to practice and reinforce it. In the second, the CAI program teaches the concept and the teacher uses worksheets, class discussion or other means to expand and reinforce it. According to George Mason, both sequences are effective if they are completed.¹ It is necessary for the classroom teacher to design his/her curriculum to provide reinforcement and expansion of the concepts taught to the students via CAI. If the teacher is doing the actual teaching, then s/he must be sure that the time spent in the Computer Center is spent reinforcing those same concepts. The investigator found no evidence of this complete cycle of instruction in the school where data were collected for this investigation. Gains were made by the Experimental Group in spite of this lack.

**Individualization of instruction.** According to George Mason,² you need the same variety in computer

1George Mason, Professor of Reading Education, University of Georgia, in an address (Reading Clinics and the Use of the Computer: They'll Do More Than You May Have Thought") at the symposium, Computers and Reading/Learning Difficulties, February 6, 1983, Oakland, California.

2Ibid.
programs as you do in books, for pupils to choose from. For this study, only two programs were available for pupil use. The programs were run as supplied, with no modifications for individual differences. This, according to Gerald M. Senf, editor-in-chief of the Journal of Learning Disabilities, may be an ineffective method of employing computers in the classroom.  

Without individualized programs, the reasons for errors made by the pupils may never be really found out. For example, a pupil may be marked "wrong" by the computer for a syntax error, a spelling error, a typing error, or because the sentence which asked the question was too complex for him/her to understand. In programs equipped with a "time out" function, as were the programs in this study, a too slow response time would also result in a wrong answer. A pupil may train him/herself to guess or to answer impulsively, rather than to reflect and carefully consider the choices when faced with a "time out" situation. Such a habit may be hard to break and may lead to poor test performance in other situations.

Another aspect of the Reading, 3-6 and Reading for Comprehension programs pertinent to the understanding of this study was the fact that both programs were non-auditory.

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3Gerald M. Senf, in his keynote address at the symposium, Computers and Reading/Learning Difficulties, February 5, 1983, Oakland, California.
All instructional information was presented in printed form on the monitor. This type of instruction may have been somewhat ineffective with strongly auditory learners.

**Timing.** The two programs employed in this study used a fixed sixty second "time out." That is, after a question was posed to the pupil, the pupil had sixty seconds to answer it before the computer registered a "time out," provided the answer, and went on to the next question. The number of TOs (time outs) in each session were recorded on the pupil's individual report. TOs counted the same as wrong answers in calculating the pupil's percentage score for the session. Such a function in a program serves the purpose of moving the pupil through the material in a pre-determined amount of time. When a large number of pupils are scheduled to use the computer center, timing is an important managerial task.

The disadvantages of a timed program are serious enough to warrant discussion here. As mentioned in the previous section, pupils in a timed program often become habitual guessers, rarely taking the time to think through an answer and consider all the possible choices. Often, a pupil in a timed program may fail to understand a question, but the sixty seconds allotted is often not long enough for the pupil to signal a teacher or aide for assistance. By the time the teacher gets to the student, the question is gone from the monitor. The pupil may or may not remember
just what it was s/he didn't understand. A valuable opportunity to instruct is lost. The teacher may not find out what it was the student didn't understand until late in the term, when it may be hard to "unteach" a false assumption made by the pupil, based on the parts of the question which were understood. Both the habit of guessing and the false assumptions may be transferred by the pupil to the standardized testing situation.

It is the opinion of this investigator that new educational methods and materials must be thoroughly scrutinized and tested before inclusion in the educational program. Such was the aim of this study. The sample used, the methodology employed and the statistical tests conducted have been described. This final chapter presents and discusses the conclusions reached as a result of the analyses.

The chapter is organized into six main sections. In each of the first five, conclusions and interpretations are presented relative to the data presented in Chapter 4. These five sections are: (a) total group achievement, (b) sex and ethnicity, (c) grade level differences, (d) vocabulary subtest results, and (e) comprehension subtest results. The final section presents recommendations for further study based on the conclusions and interpretations.

**Total Group Achievement**

This investigation examined a total of five hypotheses. The first of these hypotheses pertained to
the performance of the total sample on the CTBS, including raw scores, reading grade placements, and percentile ranks.

Hypothesis 1

Hypothesis 1, which was concerned with the differences between the Experimental and Control Groups, was supported, in the null form, by the data. There was no significant difference in the reading gains of Chapter I students in the 4th, 5th and 6th grades who had received one year of supplementary computer-assisted instruction and the gains of similar students who did not receive the supplementary CAI. That is, the low-achievers were making comparable gains in reading grade placement as the average and above-average readers. In the year before CAI, there was a significant difference in the RGP gains made by the two groups. At that time, the low-achievers were making significantly smaller gains than the average and above-average readers. It is therefore reasonable to conclude that the supplementary instruction provided for the low-achievers may have been effective in raising their gains in Reading Grade Placement.

Sex and Ethnicity

Two hypotheses relative to the effects of sex and ethnicity on a pupil's reading achievement were examined in this study. These hypotheses were presented in the null form in Chapter 4. These two hypotheses were supported by
Hypothesis 2

Hypothesis 2 examined gains made by Hispanic pupils who received either of the two types of instruction. Hypothesis 2 predicted that there would be no significant difference in the gains of the two groups. The original analysis of variance experiment found ethnicity to be non-significant, with $p = .69$, for the Total Reading raw scores of all the pupils in the sample, grades 4 through 6. A two-way interaction between instruction and ethnicity was found to exist between these scores for the total sample with $p = .002$. This suggests that there may be a relationship between a pupil's ethnic group membership, type of instruction and reading achievement.

In the examination of Reading Grade Placement Gains, there was no significant difference between the performance of Hispanics and Anglos on either the 1981 or the 1982 CTBS. There was a substantial difference in the performance of Hispanics in the Control and Experimental Groups. These findings do not suggest that the variable Ethnicity was an effective predictor of achievement in reading. They do indicate that there was a greater difference in the performance of high and low-achieving Hispanics than between high and low-achieving Anglos.

Although they started with the lowest scores of any group in the sample, large gains were made by the Hispanic pupils in the Experimental Group. It appears that these
pupils were able to make almost twice the gain after a year of CAI as they made the preceding year in traditional instructional groups.

Hypothesis 3

Hypothesis 3 suggested that the reading achievement gains made by male and female pupils who had received one year of supplementary computer-assisted instruction in reading would be comparable. The hypothesis was supported by the data. The analysis of variance for Total Reading raw scores for all pupils indicated that sex was non-significant, with $p = .78$. Similar results were obtained when Reading Grade Placement and Percentile Rank scores were examined. Two-way interactions between sex and other variables such as instruction, grade level and ethnicity were also not significant, as were three-way interactions. It was concluded that sex is not a contributing factor to the performance of pupils on the CTBS.

While sex may be a significant factor in beginning reading instruction, all subjects in this study were reading at a level of 2.5 or above, the level required to use the programs Reading, 3-6 and Reading for Comprehension. The fact that the sample population could already read was confirmed by the Ginn 720 Placement Test results, which placed the lowest achieving child on Level 7. Beginning readers in the Ginn program start on Level 1.
Grade Level Differences

The most significant factor in the relationship of the criterion scores of the Experimental and Control Groups was grade level. That is, the grade a pupil was in when the test was taken was a better predictor of performance on the CTBS than sex, type of instruction or ethnicity. During each year that data were collected, 6th graders had higher mean scores in Total Reading raw score, Reading Grade Placement and Percentile Rank than 4th or 5th graders. Fifth grade pupils had higher means than 4th graders.

Hypothesis 4

Grade level analyses were made in order to examine Hypothesis 4 which, in the null form, suggested that there is no difference between the gains of 4th, 5th and 6th grade pupils who have received one year of supplementary computer-assisted instruction. This hypothesis was supported by the data.

At each grade level Total Reading raw scores, Reading Grade Placements and Percentile Ranks were examined. At the 4th grade level, Instruction was a significant variable, with \( p = .007 \). The Control Group had higher mean scores in each area, but the gains made by the two groups were not significantly different.

At the 6th grade level comparable gains were also made by both groups. Between 1981 and 1982, the Control
Group pupils gained 6.4 in mean Total Reading raw score. The Experimental Group gained 8.4 points. There was no statistically significant difference in the gains.

Gain scores for the 5th grade pupils could not be examined. In 1981, the 5th graders took the CTBS, Level 2. Raw score gains cannot be computed when two different tests are taken. An analysis of Reading Grade Placement scores for the 5th grade pupils showed no significant difference between the gains of the two groups.

**Hypothesis 5**

Hypothesis 5 was the interaction hypothesis. It suggested, in the null form, that no relationship exists between a pupil's grade, sex, ethnicity, type of instruction and reading achievement gains. An analysis of variance including 208 cases from the original sample revealed that grade level was the most effective predictor of achievement on the CTBS. A statistically significant interaction between ethnicity and instruction was also revealed. The difference in gains made by Hispanic pupils in the Experimental and Control Groups was greater than the difference in gains made by Anglos in the two groups. Hypothesis 5 was not supported by the data, and was rejected.

**Vocabulary Subtest**

The Vocabulary Subtest scores of the CTBS were examined separately for each grade level. Analysis of covariance revealed no significant difference between the
scores of the Experimental and Control Groups at the 4th grade level. There was no significant difference in performance between males and females nor between ethnic groups at these levels. Supplementary CAI did not appear to lead to significant gains in Vocabulary for the lower achieving group as a whole, nor for other specific groups examined in this study, when covariate analysis was used.

An analysis of the gain scores, however, shows that a substantial improvement in Vocabulary Subtest scores was made by the Experimental Group. The greatest gains were made by the 4th graders, who gained 6.8 points between 1981 and 1982. Fourth graders in the Control Group gained only 3.8 points during the same time. Next best gains were made by the 6th graders, who gained 3.6 points, almost equaling the gains made by their peers in the Control Group, who gained 3.7 points. While these gains are not statistically significant, they appear to indicate that supplementary CAI did lead to gains in the area of Vocabulary for students who received it.

When examining Vocabulary Subtest gains, it is necessary to remember that the Vocabulary lessons presented by the computer programs may not have correlated well with the vocabulary questions on the criterion measure. This lack of correlation refers to both test format and test content.

A pupil cannot be expected to do well when tested on material that s/he has not been taught. The first step
in selecting a program should be to compare the content of the lessons with the content of the criterion measure. Since in this funded program the criterion was to be the standardized test, the content of Reading, 3-6 and Reading for Comprehension should have been compared to what was covered on the CTBS. The author is, of course, not advocating "teaching the test." However, if pupils will be tested on contractions, compound words and synonyms, then the pupil had better be taught about contractions, compound words and synonyms. If the pupil has not been taught about what is to be tested, then the test may be invalid for the purpose of evaluating the program.

The format of the CTBS and the format of the teaching program were dissimilar enough to cause pupils difficulty in generalizing from one task to the other. On the CTBS, pupils are required to fill in the appropriate "bubble" corresponding to the answer they have chosen. In the programs, Reading, 3-6 and Reading for Comprehension, the pupils are required to choose either the number or the correct word and type it, spelled correctly and capitalized when necessary. Such a system requires much greater care on the part of the pupil than simply recognizing and marking the chosen answer. The possibility of making a mistake in typing the answer, or of being marked wrong by the computer for a similar reason suggests an area of concern for teachers considering the use of CAI with lower-achieving pupils.
In the programs Reading, 3-6 and Reading for Comprehension, an incorrect response, whether due to a misspelling, lack of capitalization, typo or an actual wrong choice, is indicated by the symbol ////. The monitor screen then displays the words "THE ANSWER IS" followed by the correct response. Such a program does little to teach the student through his/her errors. The student may not even realize why the answer given was incorrect. A better method would be designing or choosing a program which used a pupil's mistakes as a basis for reteaching. Also, programs may be designed to "forgive" errors in spelling, capitalization or other concommitant errors when the answer indicates that the pupil has understood the concept and did, in fact, know the correct answer.

Comprehension Subtest

Scores on the CTBS Comprehension Subtest were examined separately by grade level using analysis of covariance. No significant difference between the Experimental and Control Group scores was revealed at the 6th grade level. There was also no significant difference between the performance of males and females nor between Hispanics and Anglos at this grade level.

At the 4th grade level, Type of Instruction appeared to be a significant variable, with $p < .01$. The differences were shown to be in favor of the Control Group. That is, the Control Group at the 4th grade level had a significantly
higher mean score on the Comprehension Subtest than the Experimental Group.

Analysis of variance was then used to compare the Comprehension Subtest gains of the 4th graders after one year of CAI. Although they did not make as great a gain in Comprehension as in Vocabulary, the Experimental Group did make some gains. The greatest gain was made by the 6th grade group, which gained 4.8 points over the 1981 mean. The next best gain was made by the 4th graders, who gained 2.3 points.

These findings suggest that comprehension skills may be more effectively taught in a group situation, by more traditional means, than by the totally individualized method utilized in this study. The development of comprehension skills among lower-achieving students may require more emphasis on oral discussion, on verifying answers through a search of the text and through the preparation for reading done by the teacher.

To combine CAI and group discussion for the purpose of further developing comprehension skills, Mason suggested that a small group of three to five students be assigned to one computer. Each selection is read silently by the members of the group. The comprehension questions are read aloud, one at a time by the group "reader." Before an answer is chosen and typed into the computer, the group must

4George Mason, loc. cit.
reach consensus. The discussion involved in convincing the members to agree on an answer leads to a greater understanding of the selection by the entire group.

Four other factors should be kept in mind when considering the importance of the gains made by the Experimental Group. The first factor is the limitation of the use of the Computer Center to Chapter I students. This limitation may have imparted some stigma to pupils in the program. This, in turn, may have caused the development of less than positive attitudes toward the CAI. According to Gillet and Temple:

As children grow older they become more dependent on what their peers think of them and less dependent on teacher approval or parental feedback. Added to their growing concern for peer approval, though, is their awareness that reading is extremely important both in and out of school, and failure to master reading can severely affect their self-esteem. Faced with a situation in which they cannot conform to adults' expectations, they may bend every effort to win approval from other students. They may exhibit hostility, defiance, profanity, aggression, and other behaviors that put teachers in an adversary position.5

Second, the rewards or reinforcements provided by the computer program may not have been of the kind or frequency required by the individual student to insure good work. The praise issued by the computer is part of the program and, although randomized in presentation, is still limited to a fixed number of phrases. After several days of

working on the program, it is possible that the standard stock of praise phrases has been seen by the student, and s/he is no longer very much interested in performing in order to see what the computer "says" about the answer.

The third factor to be considered is the discrepancy between the instructional content and the criterion measure. When both materials and measures are products of the same publisher, the pupils can be expected to be more familiar with the content and the format than when these two are produced by two or more different publishers. In such a case, the format of the criterion measure becomes a variable. According to Symonds, "the more common the experiences called for in a test are to the members of the group taking the test, the more reliable the test." 6

Another factor, suggested by Hartwig, is the coordination between supplemental instruction and regular classroom reading instruction. 7 In this case, close coordination of the Computer Center program with that of the classroom was not evident. Teachers may not have utilized reports from the Center to individualize instruction in the classroom, and the Computer Center may not have used


information from the classroom teacher in planning the supplemental program. Reading, 3-6 and Reading for Comprehension are program "packages" and are not individualized for specific students or classes to any greater degree than a purchased reading text would be. Speakers at a recent computer-assisted instruction symposium seemed to agree that the best results could be obtained with a "shell" program. A shell program supplies a format into which each teacher can put his/her own questions, answers, time limits and reinforcements. According to Jensen, "optimal educational results are produced by designing instruction in accord with individual differences." In spite of these shortcomings, the Experimental Group in this study made substantial gains in reading achievement.

Recommendations for Further Study

It seems clear from the findings of this investigation that supplementary computer-assisted instruction in reading, as employed in this study, may be an effective method of increasing reading achievement among Chapter I students in the 4th, 5th and 6th grades. It is recommended that further study in this area be conducted to discover the most effective CAI methods and materials, and to further investigate the effects of specific learner variables on

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reading achievement.

First, it is recommended that in future studies the content of CAI programming be examined to determine to what extent it correlates with material usually covered at the target grade level. The instructional material should also be correlated with the criterion measure used to evaluate the success of the instruction. If the effectiveness of the program is to be judged by the performance of the students on a standardized test, then the correlation of the program content to the material covered by the test should be high.

Second, it is recommended that in future studies of this nature test format and instructional format be reconciled. This will aid students in generalizing from the instruction to the test situation, and may provide a truer picture of the pupil's growth.

Third, it is recommended that in future studies data are collected for a period longer than one year. It is possible that all the positive effects of CAI are not immediately apparent. In such a case, use of CAI in a highly transient district may be a questionable practice.

Fourth, it is recommended that in future studies the "time out" option in programs be deleted, and that pupils be allowed as much time as necessary to carefully consider the answer choices. Time should be allowed for a student to get help on questions which are not fully understood. This may do much to eliminate the problems of impulsiveness and guessing.
Fifth, it is recommended that in future studies close ties be maintained between the Computer Center and the classroom. The CAI should be a fully integrated part of the pupil's day, rather than an isolated, unrelated adjunct.

Sixth, it is recommended that future studies of CAI in reading include a variety of students at different grade levels, including beginning readers.

Finally, it is recommended that future studies of CAI in reading include measures of the affective domain.

Summary

The findings of this study indicate that supplementary computer-assisted instruction in reading may be an effective method of increasing reading achievement in low-achieving, Chapter I pupils in grades 4 to 6. Pupils in this investigation who received CAI made gains in Reading Grade Placement, as measured by the CTBS, comparable to gains made by average and above-average pupils. Greater raw score gains were made on the Vocabulary Subtest than were made on the Comprehension Subtest.

Fourth, fifth and sixth graders receiving CAI did not make gains differentially. However, 6th graders had higher mean scores than 5th and 4th graders, and 5th graders had higher mean scores than 4th graders.

The variables of Sex and Ethnicity were not found to be efficient predictors of achievement in reading in this investigation. Boys and girls and Hispanics and Anglos
performed alike on the CTBS, regardless of the type of instruction received. A statistically significant relationship between the variables of **Ethnicity** and **Type of Instruction** was found to exist. That is, Hispanics in the Experimental Group had lower mean scores than Anglos in the Experimental Group. Conversely, Hispanics in the Control Group had higher means than Anglos in that group. Hispanic pupils who received one year of CAI made greater gains than their Anglo peers who received the same instruction.

When programs are selected to aid the low-achiever in reading, the author suggests that they correlate highly with the regular classroom program and the criterion measure. These programs need to be adaptable to the individual characteristics of the learners, and to provide satisfactory reinforcement for expended effort. When children are served by a "pull out" program, close communication must be maintained between the program coordinator and the classroom teachers. Educational materials should be selected for their demonstrated effectiveness, rather than for their novelty.
BIBLIOGRAPHY
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Books


**Periodicals**


Rudell, R. B. "Reading Instruction in First Grade with Varying Emphasis on the Regularity of Grapheme-Phoneme Correspondences and the Relation of Language Structure of Meaning." Reading Teacher, 19 (1966), 653-60.
"Reading Instruction in First Grade with Varying Emphasis on the Regularity of Grapheme-Phoneme Correspondence and the Relation of Language Structure to Meaning--Extended into Second Grade." Reading Teacher, 20 (1967), 730-39.


Unpublished Sources


Huddleston, Ervin Leroy. "A Comparative Study of the Effectiveness of Four Reading Programs as They Relate to the Reading Achievement of Selected Middle School Students." Doctoral dissertation, Texas Technical University, 1980.


Webster, Bennie Marie. "An Investigation of Locus of Control and Reading Achievement Levels of Selected College Freshman Students." Doctoral dissertation, East Texas State University, 1980.


Other Sources


California State Department of Education, Office of Compensatory Education. Telephone interview. (Sacramento, California, July 16, 1982).


Mason, George. "Reading Clinics and the Use of the Computer: They'll Do More Than You May Have Thought." Address at the Computers and Reading/Learning Difficulties Symposium, (Oakland, California, February 6, 1983).


Phi Delta Kappa. Practical Applications of Research. Newsletter from the Center on Evaluation, Development and Research, 4 (June, 1982).


Senf, Gerald M. Keynote Address at the Computers and Reading/Learning Difficulties Symposium. (Oakland, California: February 5, 1983).