The Relationship Between Interaction Time and Reading and Math Achievement for Chapter I Students Using Computer-Assisted Instruction in Grades Three, Four and Five.

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THE RELATIONSHIP BETWEEN INTERACTION TIME AND READING AND MATH ACHIEVEMENT FOR CHAPTER I STUDENTS USING COMPUTER-ASSISTED INSTRUCTION IN GRADES THREE, FOUR AND FIVE

The Louisiana State University and Agricultural and Mechanical Col. PH.D. 1986

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THE RELATIONSHIP BETWEEN INTERACTION TIME
AND READING AND MATH ACHIEVEMENT FOR CHAPTER I STUDENTS
USING COMPUTER-ASSISTED INSTRUCTION
IN GRADES THREE, FOUR AND FIVE

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in
The Department of Curriculum and Instruction

by
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December 1986
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ABSTRACT

The role of computer technology, particularly computer-assisted instruction, in the educational delivery system has steadily increased over the last decade. Although the largest number of CAI programs can be categorized as drill and practice, an increasing number of high quality simulation and tutorial programs are becoming available. The interactive nature of CAI is supported by the learning theories of Piaget, Gagne, and other learning theorists. Research on the topic indicates that CAI has a generally positive effect on student achievement and fosters positive attitudes among students and instructors toward the learning environment.

This research study had two goals. The first was to compare achievement as measured by a standardized achievement test for Chapter I students using CAI in reading and math and the achievement of Chapter I students not using CAI. The second goal of this project was to measure the relationship between computer interaction time and achievement. Findings indicated that reading achievement was higher for students who received CAI in reading and math. Achievement in reading and math was found to be higher for third grade students who received CAI in math compared to fourth and fifth grade students. Findings also indicated that computer interaction time in math was positively related to certain measures of math achievement for third grade students in the study.
CHAPTER I
INTRODUCTION TO THE PROBLEM

Introduction

Computer-assisted instruction (CAI) has intrigued educators since it was first devised in the 1950's. Some of the intrigue can be attributed to the seemingly effortless way students are motivated to continue the pre-programmed pattern of instruction. This motivational aspect was one of the more observable characteristics of CAI which prompted further research and development. Some educators have stated that they very rarely find a student who is not motivated to work with CAI (Blanchard and Smith, 1985; Kuchinska, 1982). This inherent motivation seems to stem from the student's perception of being in direct control of the learning environment as he controls the computer (Ryba and Chapman, 1983; Johansen and Tennyson, 1983). Paradoxically, however, in CAI the computer exerts a higher degree of control over the learning environment than an instructor does in a traditional classroom. Nevertheless, the perceived environmental control ensures direct student interaction with the problem at hand. The immediacy of the learning problem and the insistence by the computer that the student must interact with the learning problem contribute to the inherent motivation.

CAI is most often defined as the instructional technique of placing a learner in an interactive mode
with a computer that has been pre-programmed with a specific sequence of learning activities (Sippl and Sippl, 1982). At the beginning of the instructional period, the computer most often administers a pre-test; the results of this pre-test are used by the computer to determine at what point in the learning activities the student should begin. The computer controls the pace of the activities and the number of repetitions based on correct or incorrect student responses. The student may be asked to refer to printed material to supplement what is viewed on the screen. As the student progresses through the pre-set sequence of questions the computer administers test items to determine retention of the material. Score data is recorded by the computer for review by the student and/or teacher. Many programs of CAI also allow a teacher to administer paper and pencil pre- and post-tests and personally select the level of student placement.

CAI had its beginnings with the first electronic computer, ENIAC (Electronic Numerical Integrator and Computer) developed at the University of Pennsylvania 1945. Since ENIAC was incapable of storing a program, instructions were entered by a series of external, manually controlled switches. Like most other inventions, ENIAC, had precursors (see Stern and Stern, 1983). With its 18,500 vacuum tubes, ENIAC was plagued from the beginning with problems of heat (Shane, 1982; Hall, 1984). The invention of the transistor in 1947 eliminated heat problems and the development of the integrated circuit at Fairchild
Semiconductor in 1949 led to price reductions which made computers more generally available (Mason, Blanchard, and Daniel, 1983). UNIVAC (Universal Automatic Computer) was produced beginning in 1946 for commercial use. By 1950 there were about twelve computers in the United States and about 1,000 programmers, analysts, and operators (Hall, 1984). Within a few years IBM, NCR, Burroughs, GE, and other corporations became actively involved in computer design and development (Stern and Stern, 1983). The development of the microchip by Intel marked the beginning of the Silicon Age (Shane, 1982).

Early computers were unsuited for CAI because they were operated in "batch" mode. Data and programs on cards were loaded into the computer in a group and output was delivered in a batch, usually on a printer. Interaction with the computer based on small amounts of input was not feasible.

The earliest CAI applications were in employee training. Instructional units were prepared to teach those unfamiliar with computers and computer languages the fundamentals of their use (O'Dea, 1971).

Project PLATO (Programmed Logic for Automatic Teaching Operations) began in 1960 at the University of Illinois under the direction of Donald Bitzer with one Illiac I computer serving one terminal. PLATO was intended to automate individualized instruction. Stanford University began a project with a similar intent in 1963 at the
Institute for Mathematical Studies in the Social Sciences. The Stanford Project began with one computer and six terminals, none of which was more than 100 feet away (Mason, Blanchard, Daniel, 1983). Other universities and institutions began to develop CAI; these included Penn State University, Brigham Young University, and the MITRE Corporation (Hall, 1984).

Research concerning CAI as a teaching/learning technique in specific school settings is varied in the scope of the specific topics studied although somewhat limited in generalizability due to the populations selected for testing. Many studies use populations of students with unique characteristics, e.g., learning disabled, educable mentally retarded, prison inmates, pharmacy students, air force student pilots (Diem and Fairweather, 1980; Dowling, 1982; Elfer, 1974; Federico, 1984; Jamison and Lovatt, 1983), thus limiting the generalizability of the findings to other populations. Some studies test the effectiveness of specific computer-assisted instructional programs and materials (Bossone and Weiner, 1973; Gadzella, 1982). Still other studies measure the attitudes of teachers and students to a specific implementation of CAI (Diamond, 1969; Lawton and Gerschner, 1982). Nevertheless, there is some degree of consistency in research findings. These findings are summarized below and discussed in greater detail in Chapter 2.

One consistent research finding is that the use of computers in the classroom for purposes of instruction

A second consistent finding is that CAI in reading produces more learning or the same amount of learning when compared to traditional instruction in reading (Blanchard and Smith, 1985; Balas, 1982; Anelli, 1977; Fletcher and Atkinson, 1972; Campbell and Atkinson, 1975; Marsh, 1983; Dowling, 1982; Gerrell and Mason, 1983; Alessi, Siegel, Silver, and Barnes, 1982; Kearsley, Hunter and Seifdel, 1983). A similar finding is reported in studies measuring math achievement (Balas, 1982; Diem and Fairweather, 1980; Ragosta, 1983).

Some research studies report that less student time is required for mastering certain blocks of material when using CAI as compared to traditional instructional formats (Kulik, Kulik and Cohen, 1980; Kulik, Bangert and Williams, 1983; Orlansky and String, 1979; Kearsley, Hunter, and Seidel, 1983).

Additional studies indicate CAI is especially effective with "special students" classified as compensatory education students (Gernzanik, Lanoza and
Nolan, 1982; Litman, 1973), students with learning disabilities (Trifiletti, Frith, and Armstrong, 1984), adult education students (Himer, 1983) and educable mentally retarded students (Elfner, 1974).

**Theoretical Basis for CAI**

The theoretical basis for CAI is the discovery learning theory of Jean Piaget. Piaget suggests that children move through various sequential stages of learning. As the child moves through each stage of learning he must discover for himself the properties of the concept and the real world. Every aspect of a new task must be placed within a set of temporal and spatial relationships thus establishing a schema which will be used to interpret and learn additional information. Children must be presented with materials and problems in sequential order so that one problem follows another thus permitting the child to "reconstruct" things in his environment and add to existing schema. Repetition further establishes the schema and assists in organizing new information (Piaget, 1973; Evans, 1973; Isaacs, 1972; Furth, 1981; Forman, 1977). This closely parallels the function of the computer in CAI.

As the student moves sequentially through the computer curriculum selecting responses and being presented with new problems based on those responses, the student determines the sequence of presentation for the learning materials. His answers determine which problem will be presented next.
so that new problems are arranged in a "block-building" scheme. It has been suggested by Piaget and others that real understanding comes from inventing and creating the material to be learned; the computer curriculum allows the student to determine the sequence in which materials will be presented, while requiring continuous interaction and active learning. (Piaget, 1972; Furth, 1981; Kuchinskas, 1982; Schantz, 1983; Evans, 1973). The concept of block-building schmata is further developed by the work of Rumelhart and Ortony (1877), Anderson (1977), Anderson and Pichert (1978), Anderson, et. al. (1976), Gumenik (1979).

Statement of the Problem

The brief review of literature presented above reveals four issues concerning CAI which are not addressed in previous studies. The first of these issues concerns achievement for those students who receive CAI when compared to those students who do not receive CAI. Studies of CAI and traditional instruction conclude that students who receive CAI instruction either have more achievement compared to those who did not or have no differences in achievement. However, many of these studies use as a test of achievement an instrument specifically constructed to measure learning for the particular topic of instruction. Few of these studies use a standardized achievement test to measure learning. This raises the issue of whether a broad measurement of learning, such as a standarized achievement test, would produce the same results.
A second issue concerns the element of time and student achievement. Some research suggests that information can be mastered in less time with CAI than with traditional instruction, but not much else is known about the relationship between time, CAI and learning. This information is important because it may be that previous studies which reveal increased achievement with CAI are reflecting the relative novelty of CAI and that prolonged exposure to CAI may or may not produce the same results.

The third issue concerns the impact of CAI on achievement in specific subject areas. Previous studies concerning achievement and CAI utilize only one subject of instruction. This suggests the question of whether CAI would produce similar achievement for different subject areas central to the core curriculum. Stated in other words, is CAI more effective in producing achievement for one subject area (e.g., reading) than another (e.g., math)? A closely related issue is whether CAI in one subject area might generalize to influence achievement in another subject area.

A fourth issue concerns student grade level as related to achievement and CAI. Previous studies have directed attention to a students with specific characteristics (e.g., pharmacy students, student pilots, special education students, college level students). Would similar measures of achievement result if a program of CAI was presented to students at different grade levels? This information is important because it may be that CAI is more effective in
producing achievement at one grade level than another.

Background for this Study

The students used in this study will be Chapter I students in East Baton Rouge Parish Schools. Students in the federally regulated Chapter I program were selected for this study for a number of reasons. First, EBRP school officials decided in 1983-84 to implement CAI with Chapter I students. Second, in order for students to be classified as Chapter I, they must have certain very specific characteristics as identified by federal guidelines. Stated in general terms, Chapter I students must be identified by their teachers as achieving at a level below their present grade level in reading and/or math and be in need of instruction beyond that which can be provided in a regular classroom. Consequently, Chapter I students have more similar characteristics than a classroom of randomly assigned students. A third reason for selecting Chapter I students was because not all Chapter I students receive CAI. Three Chapter I schools chose not to implement CAI; therefore, Chapter I students in these schools can be used as a control group. Chapter I students in grades three, four and five were selected for this study because they comprise the largest number of students serviced by Chapter I teachers in EBRP.
The Chapter I Program.

Chapter I is a federally funded instructional program whose purpose is to provide supplemental instructional in reading and math to students achieving below grade level. In addition to regular classroom instruction, Chapter I students receive additional, supplemental instruction in reading and/or math from a Chapter I teacher and Chapter I teacher's aide. Small class size and the presence of an aide allow the Chapter I teacher to provide one-to-one instruction. Diagnostic and prescriptive instructional records are maintained for each student in the program. Because of the large number of students who qualify for Chapter I and because of a limited number of funded Chapter I teachers, the East Baton Rouge Chapter I program can service only fifteen percent of the students who qualify. Once a student identified as Chapter I begins to achieve at grade level, that student is removed from the program, and returns to the regular classroom full-time.

CAI and Chapter I.

CAI in East Baton Rouge Parish Schools for Chapter I students began in the 1983-84 school year. Its purpose was "to supplement and reinforce classroom instruction by requiring intensive, individual student participation while providing immediate feedback on the accuracy of each response" (Bolin and Glasper, ii:1984). Chapter I teachers and aides were trained to use the materials and equipment
utilized in the CAI. Students assigned to work with the Chapter I teacher spent part of each class period working with the computer in either reading or math or both. Each CAI lesson lasts ten to fifteen minutes per day. Students and teachers compile daily written records of the student's success at the computer.

During the first year of implementation three separate programs of CAI were pilot tested. The programs tested were the Dolphin Curriculum, produced by Houghton Mifflin Company; the PLATO Curriculum; and C.C.C., the curriculum marketed by The Computer Curriculum Corporation of California. After evaluating all three programs in a research study that measured teacher attitudes, ease of implementation, support services, differences in student achievement, and other factors, school officials decided to continue two of the curriculums in the 1984-85 school year. Curriculums chosen for continuation were Dolphin and C.C.C. Both curriculums provide drill and practice activities; both are designed for daily student use in ten to fifteen minute blocks of time. The C.C.C program compiles a running total of student time spent in interaction with the computer; the Dolphin program requires the teacher to record student interaction time. Both programs measure student achievement. After evaluating each program, school officials decided to continue the C. C. C. program and the Dolphin program in the 1984-85 school year.

Lessons on the C.C.C. program are designed to take approximately ten minutes of student time. The computer
records the actual time students spend in interaction with the computer beginning with the time the student logs on the computer and ending with the time the student logs off the computer. Students in the program receive computer-assisted instruction daily. Without the student's knowledge, test items are inserted among practice items. These test items are used to compute an achievement gains score for each student which the computer reports on a monthly basis. Achievement Gains are recorded in the form of grade level equivalents.

Lessons on the Dolphin program are designed to be approximately 15 minutes in length; the teacher is required to manually record start and stop time. The computer does not record student's beginning and ending times. Teachers and supervisors involved in the program both report that data concerning student time on the computer using the Dolphin program is unreliable and often inaccurate because it is not usually recorded immediately after students use the computer and sometimes may not be recorded at all. The Dolphin program also reports an achievement score for each student participating in the program.

Since the C.C.C. program automatically records student time, provides reports of student time and achievement, because these records were made available to the researcher, and because these issues are central to the proposed research, the C.C.C. program of CAI was selected for this study.
Purpose of the Study

The purpose of this study is to address these questions:

First, do students who use CAI have higher achievement than students who do not?

Second, do students who use CAI in a particular subject area (e.g., reading) have higher achievement in that subject area (e.g., reading) than students who use CAI in another subject area (e.g., math)?

Third, do students at a particular grade level (e.g., 3, 4, or 5) who use CAI have higher achievement than students who use CAI in the other two grade levels?

Fourth, what is the relationship between achievement and time spent interacting with the computer for students who use CAI?

Fifth, is the relationship between achievement and time stronger at the third, fourth or fifth grade level?
CHAPTER II
REVIEW OF THE LITERATURE

Introduction

Computer-assisted instruction, computer-managed instruction, computer-based education, and computer-aided instruction are all terms used to refer to the application of computers in a learning environment. Each term has a distinct definition. Computer-assisted instruction (CAI), which is sometimes used interchangeably with the term computer-aided instruction, is most often defined as the educational practice of placing the student in an interactive mode with a computer which has a preprogrammed course of study (Sippl and Sippl, 1982). In more general terms, CAI describes any instruction in which student responses are relayed to a computer for processing, stored in the computer's memory system, used as a basis for feedback and decisions concerning the next appropriate presentation (Mason, Blanchard, and Daniel, 1983).

Computer-managed instruction (CMI) refers to the instructor's use of the computer for record-keeping purposes. The computer may be used to compile and process student-response sheets or instructor-generated evaluations and provide printed summary reports concerning student progress. At its most sophisticated level, CMI provides (1) an assessment of the present level of student knowledge (2) diagnosis of student strengths and weaknesses (3) prescriptive activities to remediate weaknesses and
(4) continuous monitoring of student progress (Mitzel, 1974; Hall, 1984; Mason, Blanchard, and Daniel, 1983).

Computer-based education (CBE) or computer-based instruction (CBI) are more general terms often used interchangeably with computer-aided instruction. CBE and CBI refer to the use of a computer for computer-assisted instruction or computer-managed instruction, or both.

The focus of this paper is computer-assisted instruction.

Development of Computer-Assisted Instruction

CAI is a product of the fourth revolution in communication. According to Shane, (1982) human communication has experienced four revolutions: 1) development of complex speech; 2) writing; 3) movable type printing presses; and 4) telecommunications based upon the microchip. CAI is an integral part of the telecommunications revolution.

One of the earliest recorded uses of CAI is a program developed by IBM in the late 1960s. Its purpose was to teach the fundamentals of computer use to IBM employees who were unfamiliar with computers and computer languages (O'Dea, 1971).

Despite this early implementation, the first computers were unsuited to CAI because they required operation in batch mode, that is, input was received via 80-column punched cards and output was produced on paper (Stern and Stern, 1983). CAI requires that the learner be place in an
interactive mode with the computer as very small amounts of data (student response to questions) are entered. The computer must provide feedback to each student response by presenting new information or a new problem. Although this is possible with a batch loaded card controlled computer, it is neither practical nor efficient in terms of time and ease of use. Another problem of early computers for CAI was the need to keep the computer and its terminals in relative close physical proximity. Early terminals required a physical link via coaxial cable because telecommunications capabilities were slow and expensive. The development of integrated circuits provided the technology for improved cathode-ray tube terminals (Stern and Stern, 1983). All of these technological refinements contributed to more developments in CAI. (Mason, Blanchard and Daniel, 1983; Shane, 1982; Shane, 1984; Hall 1984).

One of the early efforts to develop a systematic approach to CAI was the project developed by the Stanford University Institute for Mathematical Studies in the Social Sciences with the assistance of a grant awarded in 1964 from the United States Office of Education. The Stanford CAI program in reading was developed using one central computer, sixteen terminals with typewriter keyboards, rearview filmstrip and slide projectors and an audiotape system with earphones. Student responses were analyzed and a computer decision determined the next material to be
presented. A low cost version of the program was developed to be used in schools as a supplement to regular classroom instruction. In this low cost version, the keyboard was limited, audio presentations were used extensively, and the filmstrip and slide projectors were eliminated. The program was intended for use twelve minutes a day with students in grades 1-3; when implemented, it received favorable attention (Mason, Blanchard and Daniel, 1983; Coburn, et. al, 1982).

Another program of CAI was under development at the University of Illinois during the same time period as the Stanford project. Under the direction of Donald Bitzer, the Coordinated Science Laboratory developed PLATO (Programmed Logic of Automatic Teaching Operations). The PLATO Early Reading Program was implemented in 1971 and funded by the National Science Foundation. This program had four goals: 1) create a complete K-6 computer based curriculum in reading; 2) build in the possible use of a variety of instructional modes thus permitting teachers to use their own styles of teaching; 3) take full advantage of the advanced technology of the PLATO terminal; and 4) demonstrate the feasibility of the resulting curriculum. PLATO IV now has lessons ranging from elementary level subjects to review for the G. E. D. and many professional level subjects. PLATO terminals are presently in use in schools, prisons, job centers and universities. Control Data Corporation (CDC) markets PLATO IV hardware and software. Software for PLATO is developed at the
University of Illinois, the University of Delaware, the University of Ottawa and field tested at Florida State University (Mason, Blanchard and Daniel, 1983; Coburn, et al., 1982).

An independent company, the Computer Curriculum Corporation (CCC) of Palo Alto, also markets its own CAI curriculum software. The president of the company is Patrick Suppes who was instrumental in much of the CAI work at Stanford. Nine different reading and math courses are offered for drill and practice.

The MITRE Corporation, in cooperation with Brigham Young University, has developed a program of CAI called TICCIT (Time-Shared, Interactive, Computer Controlled, Information Television). TICCIT is demonstrated and field tested at Phoenix Community College and Northern Virginia Community College.

In addition, courseware for CAI is also provided by a large number of independent institutions, corporations, and textbook publishers. Independent reviews and evaluations of some of these programs are provided by MICROSIPT, a project begun in 1978 by the Northwest Regional Educational Laboratory; by MECC, the Minnesota Educational Computer Consortium; by CONDUIT, an educational agency in Iowa; and by various other agencies and publications.

One factor which has contributed to the limited amount of high quality courseware available to educators is high development costs. Melmed (1982) estimated that
development costs range from $3,000 to $50,000 per hour of CAI.

**Types of CAI Courseware**

There are three general types of CAI courseware programs: tutorial, drill and practice, and simulation, sometimes referred to as demonstration (Gagne, Wager and Rojas, 1981; Coburn, et al. 1982; Hall, 1984; Mason, Blanchard and Daniel, 1983; Bonner, 1984; Olds, 1984; Parker, Barry and Exner, 1984; Hartley and Lovell, 1977). Tutorial programs are designed to provide initial instruction in a concept or subject area (Gagne, Wager, and Rojas, 1981; Dreyfus and Dreyfus, 1984). They are self-contained and can stand alone for instructional purposes. Tutorial CAI courseware is totally self-explanatory once it has been loaded into the computer; it requires no interaction with a human teacher. Examples of this kind of courseware include foreign language tutorials and self-taught computer programming.

A second kind of CAI courseware is drill and practice. Drill and practice courseware is sometimes referred to as the "electronic worksheet" (Coburn, et al., 1984.) In this type of instruction the learner responds with brief answers to a series of practice activities or problems presented at the appropriate level for the learner based upon results of a pre-test. The computer "re-cycles" a learner through review questions and more practice problems.
on the same instructional level until a predetermined level of achievement has been reached, then the computer presents more difficult problems and practice.

Drill and practice courseware has the potential for being an inefficient learning method, particularly if the student must rely on "trial and error" (Gagne, Wager, and Rojas, 1981; Bonner, 1984; Parker, Barry and Exner 1984; Hall, 1984; Coburn, et. al., 1984; Hartley and Lovell, 1977.) This problem might be overcome if the student receives instruction from a teacher so the drill and practice CAI becomes reinforcement and a review of previously taught material (Coburn, et. al., 1984). Drill and practice courseware is available for all grade levels and subject areas ranging from map-reading skills, math computation, spelling, vocabulary, to review for the GED, SAT and other standardized tests.

Simulation courseware is intended to supplement instructional programs. Its purpose is to provide the learner with an opportunity to apply previously learned problem solving skills to a specific "real-life" situation (Gagne, Wager, and Rojas, 1981; Olds, 1984; Blanchard, 1984; Hartley and Lovell, 1977). Feedback is pre-programmed to permit the learner to "experience" the consequences of decisions. The primary advantage of simulation courseware is that it provides experience without the expense or danger of full-scale mock-up (Roblman and Edwards, 1983; Coburn, et. al. 1984; Hall, 1984). Examples of simulation courseware are programs for chemistry and other sciences,
driver education, and pilot training.

Some CAI courseware emphasizes one type of program over another, while other courseware programs combine all three types of programs. The curriculums discussed by this study, namely the Computer Curriculum Corporation and the Dolphin Program by Houghton Mifflin, are drill and practice programs designed to reinforce instruction by a classroom teacher.

Theoretical Basis for Computer-Assisted Instruction

The learning theory of Jean Piaget closely matches the instructional procedures utilized in CAI. One of the basic premises of Piaget's learning theory is the concept of student participation in the construction of the learning materials. This is required if the student is to "rediscover" known facts about his environment (Piaget, 1977; Isaacs, 1972). According to Piaget, instruction is most effective and efficient if the child is encouraged to "...construct his own materials" (Piaget, 1973). In order to do this

...teachers must present children with materials and situations and occasions that allow them to move forward. It is not a matter of just allowing children to do anything. It is a matter of presenting to the children situations which offer new problems, problems that follow one another. You need a mixture of direction and freedom...the child must reconstruct things in his environment. (Evans, 1973:82).

Through repetition the child establishes a schema which assists in organizing further learning. The schema
allows every feature of a new task to be placed within a set of temporal and spatial relationships (Evans, 1973; Forman, 1977; Furth, 1981). The concept of schema, as it relates to the reading-learning process, is further developed by the work of Rumelhart and Ortony (1977) who suggest that existing schemata provide the framework for acquisition and organization of new information. (See also Anderson and Pichert, 1978; Anderson, et. al., 1976; Gumenik, 1979.)

CAI programs require the student to be actively engaged with the learning materials (Kuchinkas, 1982). The computer will wait patiently for a student response but will not proceed with the program of learning until the student responds. Information is presented sequentially, in small amounts and only when previous material has been mastered. As the student moves through the program he "constructs" his own materials by the responses he makes. This "stimulation and guidance..." needed by students can only be provided by a "...highly reactive teaching medium" (Kulik, 1981) such as the computer. Experimentation is encouraged as students are allowed to "discover things for themselves" (Fisk, 1984). In this way, each student's "path" through CAI materials will be unique. With the assistance of the computer, each student will find ways to make the abstract become concrete (Fisk, 1984; Hartley and Lovell, 1977). Computers facilitate "linking the skills students learn in the classrooms to the real world" (Judd, 1983:121). Allowing students to discover information and
assisting students to make the abstract more concrete closely parallel what Piaget describes as the ideal learning situation (Piaget, 1973; Isaacs, 1972). If this new information is presented in small increments so that the student can "make connections" with his personal previously existing schemata then some of the problems of incomplete schemata in immature students (described by Anderson, 1977) may be avoided.

R. M. Gagne has suggested that the use of computers in education is affecting instructional design of non-computer materials. Gagne suggests computers have created a "major change in the shift from behaviorist, stimulus-response psychology to what is now generally called cognitive learning psychology or the information-processing theory of learning and memory" (Gagne, 1977; see also Lipsitz, 1982; Meierhenry, 1982). Blair and Lobello (1984) believe that the computer is changing education because students who use computers are discovering far more than teachers could otherwise lead them to discover without the computer.

Not all educators would agree that computers have had a favorable impact on education. Some state that computers have affected the way we process information, but voice concern that students

...will develop an overreliance on input-output devices so that the computational and logical functions of a computer can undermine the development of the same faculties in children. The computer may distance children from action thus interfering with learning at previous levels (Zajonc, 1984:570).
Sardello argues against the introduction of computers into education because the use of computers will "destroy education by transforming computer users into a culture of psychopaths" (1984:631). Sardello believes that the basis for the threat to education from computers can be found in the claim that teaching programming teaches thinking processes. Sardello believes that if computers could teach thinking processes then the need for formal classroom instruction would be eliminated and dependence upon CAI "can promote a loss of concern for things of the world" (1984:635).

"Educational fads"...like computers..."can no longer be afforded by the U. S.," according to Bernstein (1983:109). However, others have suggested that breakthroughs in technology may end the debate over whether or not to continue the implementation of computers in education. As research discovers more about human thought, computers can be constructed to more perfectly mirror human thought. Once this has been accomplished, these computers can then be used to guide instructional processes (Hilbun and Maxcy, 1983).

Hilbun and Maxcy (1983) suggest that educators use caution if they are considering the implementation of computers. They list three specific disadvantages of using the existing computers in the instructional process. These disadvantages include: 1) computers are unsophisticated in heuristic and global thought; 2) computers feel no emotion;
3) computers are not ethically or culturally relativistic. It is their belief that these disadvantages are so significant that computers may not even belong in some or many classrooms.

The belief that technology may assist educators to solve the dilemma of computers in the classroom is supported by Snider (1983:115)

..."along the way"...to improved technology in education..."we may be disabused of our consuming reverence for information. At some point we may be forced to reject the 'filling station' concept of schooling"...

and move closer to a concept of schooling that allows for student discovery.

Other professional educators believe that this lack of emotion is actually an advantage because minority and educationally disadvantaged students perceive the computer to be an impartial instructor and are therefore more willing to accept instruction and direction from a computer than a person (Blair and Lobello, 1984). In Judd's (1983) opinion computers are more "humanistic" than teachers could ever be because computers can be made to adapt to each individual student's needs.

Gagne, Wager and Rojas (1977) have suggested that in order to ensure quality CAI and maximize the potential of the computer in the classroom instructional programs should be prepared and evaluated in terms of nine events of instruction. These events of instruction are as follows: 1) gain student's attention; 2) inform student of lesson objective; 3) stimulate recall of prior learning; 4)
present stimuli with distinctive features; 5) guide learning; 6) elicit performance; 7) provide informative feedback; 8) assess performance and 9) enhance retention and learning transfer (Gagne, Wager and Rojas, 1981:20). The more closely the CAI program follows these events of instruction the more efficient and effective the program will be as an instructional tool.

**Extent of the Use of Computers in Louisiana Schools**

Although discussions concerning the introduction of computers into the classroom are not free from issue or differences of opinion, computers are being used in increasing numbers each year by school districts throughout the State of Louisiana. Hubbell and McCandless (1982) have surveyed schools throughout Louisiana to learn the extent of computer use. They reported that that in 1982, 78% of all Louisiana schools had at least one computer in the school, that most computers were used in secondary schools. 53% of the schools that had computers used them to teach math, 43% used their computers for computer science, 25% used computers for language arts, 24% used computers for science, 18% used computers for business, 16% used computers for gifted and talented classes, 10% used computers for social studies, and 2% used computers for industrial arts. As these statistics show, computers have had and are continuing to have a significant impact on schools in Louisiana.
Contemporary Research
Concerning Computer-Assisted Instruction

Much has been learned and can be learned through research about CAI and its use in the schools. However, any review of literature concerning CAI would be incomplete without first acknowledging a phenomenon reported by Campbell (1980) as a result of research concerning implementation of computers in the instructional program of several Mississippi schools. She noted that in experiments which compare CAI and traditional instruction, teachers of the control groups, whose performance would be compared to experimental groups using CAI, often provided more drill and practice for the control students than was customary so that these students would not be "beaten" by the computer. Campbell calls this the "John Henry Effect" (1980). It is important to recognize that this phenomenon may be present in any research involving CAI and traditional classroom instruction.

Research reported in the literature can be categorized into one of three classifications based on the primary topic of concern: student/teacher attitude toward CAI; student achievement as related to CAI; and the amount of student time required to complete an instructional unit using CAI.

Research Concerning Attitudes Toward CAI

Of the three categories of research, studies
concerning student/teacher attitudes toward CAI offer the most consistent findings. The findings of the six research studies concerning attitudes described below generally report favorable student attitudes toward the use of the computer in instruction. These studies are representative of the studies reported in the literature. Negative student attitudes toward the use of a computer in the classroom are seldom reported in the literature.

In a study of CAI in the Philadelphia School District, Diamond (1969) reports that students who used CAI had positive attitudes toward computers and computerized instruction. Students in this study had such strong positive attitudes toward the computer that Diamond questioned whether higher achievement gains reported for CAI students could be attributed to the CAI or to a more positive attitude toward the instructional setting. Chandler (1984) reports that the research studies he reviewed found students have a positive attitude toward using the computer in the classroom but that teachers, as a group, do not share student's enthusiasm for the new technology. He believes that teacher's reluctance to accept CAI is based on the belief that the computer will change the traditional role of teachers.

In a review of literature on attitudes toward computers and computerized instruction, Lawton and Gerschner (1982:51) found that children perceive computers as having "infinite patience," never showing "frustration, never forgetting to correct or praise and always
individualizing learning."

Kulik, Bangert and Williams (1983) report findings of a meta-analysis study of 51 independent research studies of computer-based teaching in grades 6 - 12. They suggest that students who use CAI tend to develop positive attitudes toward the computer and the course of study.

Heiner (1983) reports on a community college program using computers to teach basic skills and occupational skills to adults. He found that CAI increased student's desire to overcome identified skill deficiencies.

Anelli's study (1977) of third grade girls and boys using CAI drill and practice in reading to supplement regular instruction found that although students showed initial enthusiasm for the program, this enthusiasm declined after eight hours of machine instruction.

Despite the variety of research settings and subjects, studies concerning student attitudes toward the use of CAI are generally consistent in reporting that students view CAI positively.

Research Concerning Student Achievement

Research concerning student achievement and CAI is less consistent in its findings. A mixture of positive and negative outcomes concerning achievement is reported, although the majority of research studies indicate an increase in achievement for students who use CAI compared to those students who do not. A number of studies
reporting on achievement and CAI use the techniques of meta-analysis. Studies using meta-analysis and reporting positive achievement gains will be discussed first. The second category of achievement studies will be those studies reporting results of one project only. A third category will be studies reporting negative achievement gains for CAI.

Meta-Analysis, Achievement and CAI. Bartley (1978) completed one of the first meta-analysis studies in the area of CBI and student achievement. She found that the average effect of CBI in math was to raise achievement by .41 standard deviation, or from the 50th percentile to the 66th percentile.

Independent evaluations of 59 college level computer-based teaching programs were subjected to meta-analysis by Kulik, Kulik and Cohen (1980). They report that CAI produced significant gains in achievement when compared to traditional teaching methods.

Burns and Bozeman (1981) used meta-analysis to integrate findings on CAI in math. They report an overall average effect of .45 for CAI tutorial instruction and .34 for drill and practice CAI.

Meta-analysis techniques were used by Kersley, Bunter and Seidel (1983) on 50 major research projects concerning CBI between 1959 - 1982. They report an increase in learning for the those students using CBI compared to those who did not.
Rulik, Bangert, and Williams (1983) used meta-analysis on 51 studies of CAI. They report CAI had a strong effect on student achievement, particularly in later studies. They believe this was due to more appropriate use of CAI and improved technology. Studies of CAI that were shorter in duration produced stronger effects than those that were longer in duration. The effects of CAI seem especially strong and clear in studies of disadvantaged and low aptitude students; much smaller effects were reported in studies of talented students.

A study analyzing results from ten independent research projects revealed a "substantial advantage" for CAI in terms of overall achievement (Vinsonhaler and Bass, 1972). Elementary children seemed to benefit most from drill and practice. Average achievement gains reported were one to eight months over children who received only traditional instruction.

In summary, studies using meta-analysis techniques generally report a positive relationship between CAI and student achievement.

**Studies of Achievement and CAI.** The majority of individual research projects report positive achievement gains for students using CAI when compared to scores of students not using CAI.

In a study still in progress, Blanchard and Smith (1985) report tentative findings that students who interact with text on the computer have long-term retention rates
thirty percent better than those students who interact with the same text printed on paper.

Joiner (1977) reports on the use of the Computer Curriculum Corporation's program in the Memphis Public School system. He found CAI produced more achievement in math than reading, though students who used CAI scored consistently better in both reading and math than students who did not use CAI.

Rogosta (1983) reports on a four year study of CAI in reading, math and language arts. Each program raised scores on standardized and curriculum specific tests.

A study of 48 eleventh graders using three different treatment groups was reported by Johansen and Tennyson (1983). The three treatment groups each used CAI with different levels of learner control. The levels of control are described as follows: 1) advisement-learner-control; 2) partial learner-control; and 3) learner control. They report that group 1 (advisement-learner-control) performed best on all tasks. Johansen and Tennyson (1983:236) conclude that to process new information, a...

...learner has to take into account not only development of a simple coding scheme, but also the perceptual understanding of the information in reference to a level of final performance. Learner control is a powerful management strategy.

Johansen and Tennyson state that learner control in CAI was especially important when subjects in the study are advised of the levels of mastery expected.

Eighth grade males who used CAI were the subjects of a
study reported by Jamison and Lovatt (1983). For purposes of this research students were classified as the best behaved or worst behaved and the best or worst achievers. Results of this study led researchers to conclude that CAI is particularly effective for high achievers and behavior problems because of the individual nature of instruction.

The rate of progress during CAI reading instruction and scores on standardized tests of initial reading skill were correlated in a study by Campbell, Lindsey and Atkinson (1975). They found that CAI was a better predictor of achievement than reading readiness tests.

A four year longitudinal study of CAI in reading and math in the Los Angeles school system was reported by Ballas (1982). He found that CAI had a greater effect on math achievement than achievement in reading. Reading achievement was found to increase most in the first year of the program.

Alessi, Siegel, Silver and Barnes (1982) report findings of a study of 36 adults which concerned the effectiveness of CBI in reading and math. They found that those students who studied reading on the computer increased achievement more on posttests than those students who studied math on the computer.

Based on a study reported by Elfner in 1974, CAI also seems effective with educable mentally retarded students. Forty EMR student were the subjects of a study involving CAI described by Elfner (1974). Higher achievement was reported for all students in the study. Interestingly, he
found that students who took longer to respond to individual computer questions had higher achievement gains than those students who responded immediately.

A five year study of juvenile delinquents who used CAI at Neeles School in California was reported by Dowling, (1982). Findings indicated that CAI increased reading levels one month for each month in the program.

The Adult Detention Center in Bexar County, Texas, used the Plato Basic Skills Math and Reading Program. Diem and Fairweather (1980) report that students in the program made greater gains in math than reading. They further report that materials in the reading program were viewed as too juvenile by adult students and that the lack of audio to accompany the screen display was frustrating to many students.

When CAI was used with learning disabled students for 40 minutes a day the computer group showed twice the yearly achievement gain when compared to the control group in a study reported by (Trifiletti, Frith and Armstrong, 1984).

Vernon (1983) found that elementary students receiving CAI learn more than students who do not use CAI.

Litman (1973) reports on the results of a program of CAI used with 21 compensatory education schools in Chicago. The average achievement gain for eight months of compensatory education for non-CAI students was 5.8 months. The average achievement gain for CAI students was 8 months.
Software used in this program was produced by the Computer Curriculum Corporation delivered by a UNIVAC 418-III.

A CAI project at Stanford involved 100 first graders using CAI for 20 minutes per day. Half the students studied reading, half studied math. Each group became the control group for the other. On the California Achievement Test, the reading group scored "significantly higher in vocabulary, form class, phonetic discrimination, pronunciation and recognition." Differences in comprehension were not significant. Results indicated that sex differences normally associated with reading scores and first grade students were minimized because of the emphasis on analysis not memorization (Marsh, 1983).

Nolan and Ryba (1984) used case study techniques to research CAI and elementary students. They report that CAI produces the best results when used as a teacher adjunct.

A study of CAI used to teach analysis of professional drug literature to adults was reported by Pearson and Gibson (1983). They state that CAI instruction was preferred by students to traditional manual examination and produced the best results in terms of retention.

Simulation CAI courseware was used in a study of U. S. Air Force Student Pilots to teach weapons deployment compared to noncomputerized training. Students using computers completed significantly more tasks on actual aircraft systems and made significantly fewer errors than the control group. Results support use of the computer as a low cost alternative to traditional training (Poblman and
Residents of Menard Prison in Illinois used the Plato G. E. D. materials. Siegel and Simutis (1979) found that a higher percentage of those residents who reviewed for the G. E. D. using CAI materials passed the test than those residents who reviewed in a traditional manner.

The U. S. Navy Personnel Research and Development Center found that individual differences were significantly related to differences in mastery learning in general and, particularly, in mastery learning with CMI (Federico, 1984).

Forty-four matched pairs were used by Fletcher and Atkinson (1972) to study CAI used with first graders. Findings indicate that CAI had a significant effect on achievement gains in reading; that boys were helped more by CAI than girls; and the most significant results were in sentence and paragraph comprehension, both areas which received little direct attention in the CAI.

Gadzella (1982) investigated the use of CAI to teach study skills. She reports that the experimental group which received CAI showed significant score increases while scores for the control group which received no CAI actually showed decreases in scores.

In a study of fifth graders, Gerrell and Mason (1983) found that comprehension of written passages was higher for computer chunked passages than for a traditional format.

Gerzanick, Lanoza and Nolan (1982) used CAI to
remediate secondary students. They report that students who used CAI achieved significantly higher test scores in math and language arts than those students who were remediated without CAI. An unexpected result was that the experimental group showed a more positive self-concept after the CAI experience than before. The control group showed no improvement in self-concept and "continued to fail" (1982:51).

CAI may be most effective with elementary students (Kulik, 1981). Students at this level seem to respond best to the constant stimulation and non-emotional guidance provided by the computer.

Edwards, Norton, Taylor, Weiss and Dusseldorp (1975) caution that while CAI almost always produces more achievement that traditional instruction, these achievement gains may not show up on long term retention tests.

These studies reveal many, highly varied findings. Results of these studies can be summarized by the following six points:

1. CAI produces more retention of instructional material.

2. Research is inconclusive on the question of whether CAI is equally effective in math and reading.

3. CAI is more beneficial to students if they can exert control over the program using advice from the computer or an instructor.

4. Research is inconclusive concerning the question of whether CAI is best for a particular group of students
(e.g., educable mentally retarded, juvenile delinquents, learning disabled, compensatory education, remedial education, adult learners, good achievers, behavioral problems) or all students.

5. Research is inconclusive concerning the question of whether CAI is best for elementary, secondary, college level or adult students.

6. Research is inconclusive concerning the question of whether CAI is best when used as a teacher adjunct.

Research Concerning CAI and Time

There are only a few studies dealing with the amount of student time required to learn the material using CAI when compared to traditional instructional techniques.

In a study using meta-analysis techniques, Kulik, Bangert and Williams (1983) found that use of the computer reduced "substantially the amount of time students needed for learning."

Edwards, Norton, Taylor, Weiss and Dusseldorp (1975) report CAI often reduces the amount of time required for student learning.

Kulik, Kulik and Cohen (1980) report findings of a study using meta-analysis which show that a reduced amount of time was needed for instruction.

Research Indicating Negative Findings for CAI

A number of studies report negative findings for CAI. Interestingly, some of these studies report a combination
of negative and positive findings.

Orlansky and String (1979) reviewed 30 research projects covering 18 years of CAI use in military training. They concluded that CAI "saved time, caused greater attraction among instructors and produced no learning differences."

In a study of basal reading instruction in 40 different classes Hendon (1976) compared traditional teacher management systems and computer supported teacher management systems. He reports results favoring basal reading instruction without computer managed support. This study included no direct CAI.

A study by Jelden (1981) of 201 college students involved CAI sessions lasting 30 - 45 minutes each. Student self reports in this study rated the use of nicknames by the computer as the strongest motivator to do well. Students also complained of "eye strain" after 30 minutes.

A study by Steele, Battista and Krockover (1982) included an experimental and a control group of high ability fifth graders. The experimental group received CAI. Both groups were tested using the Metropolitan Achievement Test; there were no significant differences in scores for the two groups. Steele did report favorable results for CAI in affective terms and overall computer literacy.

Bossone and Weiner (1973) studied the teaching of basic skills on the computer compared to more traditional
instruction. They found no differences in achievement.

Boettcher, Alderson and Saccucci (1981) compared the effects of CAI on student learning in "cognitive categories of knowledge" and instruction through printed materials. They found no differences in achievement.

In a study by Carver and Hoffman (1981), high school students who read poorly were trained how to use the PLATO IV computer. They practiced reading 50 - 70 hours individually over the period of the study. The effect of such repeated practice sessions was small.

In a study of three instructional approaches to the teaching of the use of the Readers' Guide, Zsiray found that CAI and lecture produced identical results and both were more effective than independent reading.

**Experiential Knowledge of CAI**

While research may be the most reliable source of information about the use of CAI, experiential knowledge can provide information of a different type. The literature contains many articles written by educators who have worked with CAI and have recorded their observations and experiences.

A number of writers report using computers to teach language arts; these programs usually include word processing. Articles concerning CAI/word processing are discussed first, followed by other experiential articles pertinent to this study.
Womble (1984) describes the advantages grade ten students found in using a word processor for English class. She reports that students spent more time revising their own writing on the computer than they did when they wrote directly on paper and that students could better determine what changes were needed. She also reports that students using a word processor found it easier to "develop a sense of audience."

First grade students who used the Bank Street Writer word processing program were the subjects of a study by Starshine and Fortson (1984). The students typed in words and sentences, read what they wrote, talked about it and edited the text. To overcome spelling problems experienced by most first graders, students were encouraged to spell words as they sounded. They report the following example as typical (1984:242):

Casey: I like to play ball at the YMCA.
Laurie: Shadow and I wint hoping dwon the red brik road.
Cammie: I wish I wur a bune rabit.

Starshine and Fortson report that students immediately recognized the value of being able to easily edit words and sentences.

Southwell (1982) has developed a series of CAI programs to teach writing skills. He reports success in using them with grade school students.

Smith and Gray report (1983) using a word processor to help grade school students improve their reading and writing skills.
The results of informal interviews with teachers and students who used word processing software on an IBM were reported by Schwartz (1982). The results of these interviews were as follows: 1) students prepared more carefully for writing assignments; 2) writers were less defensive about making changes; 3) writers found that the terminal encouraged the flow of words; 4) writers revised more objectively; 5) writers with poor handwriting and spelling problems hated writing less because these problems diminished; and 6) use of the terminal promoted cohesiveness in the writing.

Schwartz (1983) reports that using a word processor to teach writing increases student's skill in organization.

Rodrigues (1984) describes the advantages of using computers to teach writing, especially during the invention stage of composition.

Seventh and eighth graders in Maryland and Virginia were selected to participate in a pilot program using word processing software and microcomputers in English classes (Hunter, 1983). Once students learned the basics of how to operate the system they were able to work independently and devised techniques for group editing of student writing, including ways to move sentences and paragraphs from one student's paper to another. As a result of her experience with this program, Hunter (1983) reports two primary difficulties with integrating computers into secondary classrooms: 1) the good software which is available does not always fit the existing curriculum and
2) the inflexibility of the teacher's workday inhibits time to experiment with new equipment and software.

As a result of her observations of students who use word processing in English classes, Bennings (1983) predicts that within a few years all schools will have writing labs containing 10 - 15 microcomputers and a variety of word processing software programs available for student and teacher use.

A discussion of the uses of computers in educating exceptional children is presented by Stallard (1982). He suggests that using computers with exceptional children accomplishes the following: 1) provides individualized instruction; 2) increases management efficiency; 3) extends the ability of schools and districts to monitor the educational process; 4) increases availability of diagnostic and testing services; 5) helps children compensate by extending their abilities.

The U. S. Army has utilized CAI to assist in its literacy effort. Blanchard (1984) reports that 54% of all enlisted personnel read at levels less than ninth grade. In order to better prepare these individuals to serve in the military, the Army Research Institute for Behavioral and Social Sciences is developing innovative programs. Some of the techniques and devices created by the Army Research Institute include the following: 1) the "Hand-Held Tutor", a small computer used to teach vocabulary in a game format; 2) "disco", a computer with audio to teach test-
wiseness, how to study, physical relaxation (for reduced test anxiety) and positive self-talk; and 3) a computer-interactive movie presentation, designed to teach land navigation (Blanchard, 1984).

Steffin has suggested that the use of computers in the schools will most benefit the teaching of thinking skills because computers counteract convergent thinking, in other words, thinking that is characterized by rote learning and a narrow view of what is correct. Steffin believes that divergent thinking (characterized by the belief that any set of correct responses has more than one element) is promoted by the interactive nature of the computer which provides immediate feedback, variability in presentation, and neutrality of response and privacy.

Some professional educators urge caution as computers are added to the schools. Pritchard's (1982) observations have led him to conclude that computers require a certain learning style that is characterized by: 1) manual dexterity at the keyboard; 2) attention to detail and accuracy; 3) aptitude for learning visibly; 4) degree of physical passivity and a willingness to sit still; 5) preference for working alone; 6) strong intuitive and diagnostic ability. He argues that while computers have many uses and should be included in school curriculums, not all students are naturally inclined to become proficient computer users.

Administrators who add computers to their schools are cautioned not to view them as a panacea (Railsback, 1983).
Specifically, administrators are cautioned not to do three things: 1) treat the addition of computers to the school as magic; 2) rush for publicity after the addition of computers to the school; and 3) add computers to classrooms by administrative decision without teacher input.

The overall impact of computers on education has been considered by Shane (1982). He makes four predictions about the future of computers and education. First, computers will result in less emphasis on teacher led math drills and more emphasis on the meanings of numbers and recognition of possible solutions. Second, ways will be found for microcomputers to facilitate work in traditional classrooms, especially English, science, and foreign language. Third, schools will gradually place more emphasis on adult education as the population over 30 years of age recognizes a need for "retrofitting" for the information age.

**Summary and Conclusions**

Since its beginning in the 1960's, educators have recognized the potential of CAI. This is revealed by the number of projects to develop computer based curriculums and the number of computers in the schools both nationally and in Louisiana.

Generally, computer based curriculums and CAI programs designed to supplement the existing curriculum can be classified into three categories: drill and practice, simulation, and tutorial (Gagne, Wager and Rojas, 1981;

Using a computer in the teaching/learning process is supported by the learning theory of Piaget. This is particularly evident in the concept of the student's active participation in the "construction" and selection of learning materials within the computer program (Evans, 1973; Forman, 1977; Furth, 1981; Piaget, 1977; Isaacs, 1972; Kulik, 1981; Fisk, 1984; Hartley and Lovell, 1977; Judd, 1983; Kuchinkas, 1982).

Gagne, Wager and Rojas (1981) have suggested nine events of instruction which CAI programs must include to make use of sound learning theory.

Although educators are not in agreement about "how" or "why" computers should be added to the schools (Sardello, 1984; Zajonc, 1984), and some question that computers may be "dehumanizing" education (Hilbun and Maxcy, 1983), others express confidence that improved technology will provide solutions to these problems (Snider, 1983).

Research findings concerning CAI are consistent in two areas. First, student and teacher attitudes are generally positive concerning CAI when CAI is compared to more traditional instructional methods (Chandler, 1984; Kulik, Bangert and Williams, 1983; Diamond, 1969; Lawton and Gerschner, 1982; Heiner, 1983; Anelli, 1977).

Despite the consistency of the findings, each of these
studies must be viewed with a certain amount of skepticism. In discussions with this writer, administrators who have placed computers in teacher's classrooms admit that the decision of where to place a computer was not based on random selection. The teachers who were asked to use CAI as part of the instructional program either volunteered or were selected by administrators because of an expressed interest in the new technology. This "selection" factor might significantly influence the outcome of studies which research student and teacher attitudes toward CAI.


The results of any study comparing a control group receiving traditional instruction with an experimental group
receiving CAI must be examined with caution because of the "John Henry Effect" discussed by Campbell (1980).

Experiential knowledge concerning CAI indicates that computers have already had a significant impact on the way teachers and students view education (Shane, 1982; Shane, 1984; Steffin, 1983; Hennings, 1983; Blair and Lobello, 1984) and that despite expressed concern about the availability of quality courseware (Melmed, 1982; Hunter, 1983), teachers and students are devising ways to use the existing hardware and software effectively in classrooms (Zaharias, 1983; Caldwell, 1984; Johnson and Sterkel, 1984; Womble, 1984; Starshine and Fortson, 1984; Smith and Gray, 1983; Schwartz, 1982; Hunter, 1983; Schwartz, 1983). Most of all, experiential knowledge shows educators that more research is needed. "We cannot improve our schools without first determining how to cope..." with the age of information (Shane, 1982).

Some issues are not thoroughly addressed by the literature. One of these issues is whether long term exposure to CAI positively effects standardized achievement test scores. This is the first issue addressed by this study.

A second issue not thoroughly addressed by the literature is the relationship between the amount of time spent in interaction with CAI and achievement. Some researchers have concluded that CAI can reduce the amount of time needed to master certain blocks of instructional
material (Kulik, Bangert and Williams, 1983; Kulik, Kulik and Cohen, 1980; Edwards, Norton, Taylor, Weiss and Dusseldorp, 1975). What is not addressed by the research literature is the nature of the relationship between CAI, time, and achievement. To research this relationship, time must be viewed in terms of the number of minutes of actual computer use by a student participating in CAI. The second issue addressed by this study is time and its effect on achievement.
CHAPTER III
METHODOLOGY

Introduction

The review of selected research literature presented in Chapter II suggests that four issues concerning CAI have not been thoroughly investigated. This study will provide further insight into these issues.

Tested are two general hypotheses. The first relates to confirming a relationship which is inferred from the review of literature; namely, that students exposed to CAI will show higher levels of achievement than students without CAI experience. The second hypothesis tests the relationship between the amount of computer interaction time, and achievement, and grade level.

Before stating the research hypotheses and describing data collection, research design and analysis procedures, it is necessary to describe the sample population, materials and procedures, and the operational definitions which are used.

Sample Population

The subjects for this research will be Chapter I students using the Computer Curriculum Corporation's (CCC) program of CAI in grades 3, 4, 5 for the school years 1983-84 and 1984-85 in EBRP Schools. In addition, Chapter I students at schools not using any form of CAI will be used as a control group. Schools using CCC in grades 3, 4, 5 in 1983-84 were Broadmoor, North Highlands, Crestwood, Park,
Beechwood and Ryan. Schools using CCC in grades 3, 4, 5 in 1984-85 were Broadmoor and Park. Chapter I schools not using any form of CAI in 1983-84 or 1984-85 were Merrydale, Greenville, and Brownfield.

Total number of students in CCC in 1983-84 was approximately 230. Total number of students using CCC in 1984-85 was approximately 100. Total number of students in the control group in 1983-84 was approximately 100. Total number of students in the control group in 1984-85 was approximately 100.

EBRP Schools were selected for several reasons. First, the researcher's home is in East Baton Rouge Parish; this facilitated the collection of data and on-site visitations. Second, school corporation officials indicated that the data needed for this study would be made available to the researcher. Third, data needed for this research project was being collected but not analyzed in the manner proposed by this study. It is the researcher's belief that analysis of this data will be of use to EBRP Schools for planning and evaluation purposes.

**Procedures and Materials**

**CAI Monthly Reports.** The CCC program routinely compiles a report of student progress. The end of the year report totals all other reports and provides all available information on each student in the program and includes school attended, grade level, individual student computer identification number, student name, total number of
minutes spent on the computer and achievement gains in grade level equivalents. Reports for 1983-84 and 1984-85 will be used as a source of data in this study.

**Achievement Tests.** All students in the EBRP Chapter I Program are tested twice each year, in October and April using the Comprehensive Assessment Program Achievement Test, published by Scott, Foresman, and Company. Results are used by the school system as a pretest and posttest. Scores from the 1983-84 and 1984-85 school year will be utilized in this study.

**Data Collection**

Data collection will be facilitated by the use of a Data Collection Sheet (see Appendix A). Students using CCC will be identified through the use of the End of Year Report which lists the student, identifies the school, the subject area (e.g., reading or math), the number of minutes of computer interaction, and that student's Achievement Gains Score. The End of Year Reports are stored at the Instructional Resource Center in the office of the Director of Federal Programs, Dr. Houston Jenks. Pre and posttest achievement test scores from the Comprehensive Assessment Program will be found for each CAI student by using records stored at the EBRP School Research Department. Achievement test scores for Chapter I students not using CAI will be found by first obtaining a list of Chapter I students at schools not participating in CAI and then using this list to locate test scores. At no time will students, teachers,
Research Design, Research Variables and Operational Definitions

To test the research questions stated in Chapter I it will be necessary to consistently operationalize key research variables. These are explained below.

Experimental Groups

There are three Experimental Groups in this study.

1. Experimental Group I contains those students who have received at least one month of CAI instruction in both reading and math.

2. Experimental Group II contains those students who have received at least one month of CAI instruction in reading only.

3. Experimental Group III contains those students who have received at least one month of CAI instruction in math only.

Control Group

The Control Group in this study is composed of students who received no CAI in reading or math.

Primary Independent Variables

There are two Independent Variables of primary importance to this study.

1. Interaction Time. The first Primary Independent
Variable in this study is interaction time, referred to as the I-TIME variable throughout this study. The findings of previous studies indicate that a relationship exists between the amount of computer interaction time and achievement. These studies suggest that the amount of student time needed for learning may be reduced if students receive CAI. Chapter I schools participating in CAI are collecting data on Interaction Time in terms of the total number of minutes the student spent interacting with the computer. The computer tabulates and reports each month the total number of minutes each student spent in interaction with the computer. The End of Year report provides the total number of minutes each student spent in interaction for that year. To test this variable, I-TIME is operationalized in two specific ways:

1. I-TIME versus NO-I-TIME Exposure. By definition, the control group has NO-I-TIME.

2. I-TIME-MINUTES will be the independent variable which measures the number of minutes of CAI exposure.

2. Grade Level. A second Primary Independent Variable in this study is student grade level. This is an important variable in this study because a review of the literature does not indicate whether CAI makes a more significant difference in achievement, if any, at specific grade levels. Stated in other words, how does the grade level of a student (e.g., 3, 4, 5) affect CAI attributed achievement?
Each Experimental Group and the Control Group contains students from grades three, four and five. To test this variable achievement will be measured within each Experimental Group by grade level.

**Secondary Independent Variables**

There are two independent variables of secondary importance to this study.

1. **Effects of School Setting.** Schools will be identified for purposes of a control variable to determine whether achievement or non-achievement is specifically related to certain schools more than others or if achievement is generally distributed across different schools.

2. **Effects of Year of Instruction.** Since instruction took place in the 1983-84 and 1984-85 school years, data from these two years will be compared to determine if there are significant differences in results related to the year of instruction.

**Dependent Variables**

The dependent or outcome variable in this study will be the measured amount of student achievement. Student achievement will be operationalized as the Differential Achievement Score and Achievement Gains. Each is explained below.

1. **Differential Achievement Score:** A differential achievement score (DAS) will be calculated for each student in the study for reading and math. The source of this
information will be the Comprehensive Assessment Program Test (CAPS) administered each fall and spring to Chapter I students by the EBRP Schools. To compute the DAS the Equal Interval Score (EIS) will be used. The EIS is computed on a scale of 0-999. Scores can be added and subtracted for purposes of comparison. The pre and posttest EIS for math and reading will be recorded for each student. The pretest scores will be subtracted from the posttest scores to obtain the DAS.

This procedure will approximate ratio data and satisfy the assumptions needed for regression analysis.

2. Achievement Gains: The Achievement Gains Score (AGS) is the score computed by the computer as part of the CAI program and reported monthly in written form for each student participating in the program. Each student's achievement level is continuously monitored by the CAI program so these scores are the most current assessment of student learning. The Achievement Gains Scores are reported in terms of grade level equivalents. This score is the measured difference between the student achievement level when a particular student began CAI and that same student's present achievement level.

**General Hypothesis I**

Students exposed to CAI in a specific subject area (e.g., reading, math) will have statistically higher differential achievement test scores (DAS) in that subject
area than students in the control group.

**General Hypothesis II**

Within specific grade levels (e.g., 3, 4, 5), the differential achievement score and the Achievement Gains Scores will vary as a function of the amount of recorded student computer interaction time.

**Data Analysis**

To test General Hypothesis #1, data will be analyzed to address these questions:

1. Do students in the Experimental Groups (those students who received CAI) have statistically higher levels of achievement in reading and math, as tested by CAPS than the Control Group (students who did not receive CAI)?

2. Do students in Experimental Group I (those students who received CAI in reading and math) have statistically higher levels of achievement in reading and math, as tested by CAPS, than students in the Control Group?

3. Do students in Experimental Group II (students who received CAI in reading only) have statistically higher levels of achievement in reading, as tested by CAPS, than students in the Control Group?

4. Do students in Experimental Group III (students who received CAI in math only) have statistically higher levels of achievement in math, as tested by CAPS, than students in the Control Group?
5. Do students in Experimental Group II (those students with CAI in reading only) have higher achievement in reading than Experimental Group III (those with CAI in math) and Experimental Group I (those with CAI in reading and math)?

6. Do students in Experimental Group III (those with CAI in math only) have higher achievement in math than Experimental Group II (those with CAI in reading only) and Experimental Group I (those with CAI in reading and math)?

7. Do students in Experimental Group I (those with CAI in reading and math) have higher achievement at grade 3, 4, or 5?

8. Do students in Experimental Group II (those with CAI in reading only) have higher achievement at grade 3, 4, or 5?

9. Do students in Experimental Group III (those with CAI in math only) have higher achievement at grade 3, 4, or 5?

To test these hypotheses, a one-way analysis of variance involving the twelve groups (4 x 3 factorial structure) will be performed to allow contrasts among the means utilizing Scheffe's method for multiple comparisons.

It is estimated that with a sample size of approximately 330 each cell will contain an N of 10 or more. However, due to the nature of the data, this may not be possible.
The review of the literature suggests to this researcher that there should be significant differences in achievement for students exposed to CAI and those who are not.

To test General Hypothesis #2, data will be analyzed to address the following questions:

1. For students in the Experimental Groups, at the third, fourth, and fifth grade level, what is the relationship between Achievement Gains, DAS and I-TIME-MINUTES?

2. For third grade students in Experimental Groups I, II, and III, what is the relationship between Achievement Gains, DAS and I-TIME-MINUTES, how does this relationship compare to the same relationship computed for fourth and fifth grade students?

3. For fourth grade students in Experimental Groups I, II, and III, what is the relationship between Achievement Gains, DAS and I-TIME-MINUTES, how does this relationship compare to the same relationship computed for third and fifth grade students?

4. For fifth grade students in Experimental Groups I, II, and III, what is the relationship between Achievement gains, DAS and I-TIME-MINUTES, and how does this relationship compare to the same relationship computed for third and fourth grade students?

5. For all students in Experimental Group I (those with CAI
in reading and math) what is the relationship between Achievement Gains, DAS and I-TIME-MINUTES?

6. For all students in Experimental Group II (those with CAI in reading only) what is the relationship between Achievement Gains, DAS and I-TIME-MINUTES?

7. For all students in Experimental Group III (those with CAI in math only) what is the relationship between Achievement Gains, DAS and I-TIME-MINUTES?

Stated in other words, for all Experimental Groups, each individual Experimental Group, and for each grade level of all groups, what is the relationship between Achievement Gains, DAS and recorded time spent in interaction in terms of I-TIME-MINUTES?

To test these hypotheses, a one-way within-group analysis of covariance will be performed involving nine groups (3 x 3 factorial structure) with time in minutes as the covariate.

It is estimated that with an Experimental Group sample size of approximately 330 each cell will contain an N of 10 or more. However, due to the nature of the data, this may not be possible.

Based on the review of the literature, this researcher believes that Achievement Gains and DAS should be directly related to I-TIME.
Assumptions and Limitations of the Study

There are several assumptions and limitations associated with this study. These are discussed below.

1. An assumption of this study is that the Computer Curriculum Corporation's program of CAI does provide appropriate drill and practice for reading and math skills.

2. An assumption of this study is that the Achievement Test scores used in this study are the results of properly administered tests.

3. An assumption of this study is that the teachers and teacher's aides directing the CAI experience have been appropriately trained to work with the program.

4. An assumption of this study is that there is a correspondence between time and effort.

5. An assumption of this study is that the Achievement Gains Score reported by the CCC program is an accurate reflection of student achievement.

6. An assumption of this study is that the Chapter I students participating in CAI have no essential differences from Chapter I students not participating in CAI.

7. An assumption of this study is that data needed for analysis have been encoded with a minimum of error.
CHAPTER IV

REPORT OF FINDINGS

Introduction

This chapter presents a report of the statistical procedures employed in hypothesis testing and an analysis of the findings. This chapter is organized into three sections: 1) summary of descriptive data for the sample 2) report of testing of Hypothesis I; and 3) report of testing of Hypothesis II.

Summary of Descriptive Data

Data were collected on a total of 584 students in the Chapter I program for grades three, four and five, from nine different schools. Incomplete score data existed for 38 cases, resulting in a reduction of the sample size to 546. Of this number 157 were third graders, 187 were fourth graders, and 202 were fifth graders. Of the sample, 103 received CAI in math and reading and were assigned to Group 1; 54 students received CAI in reading only and were assigned to Group 2; 217 students received CAI in math only and were assigned to Group 3. Students receiving no CAI numbered 172; these were assigned to Group 4. The number of students in each group and grade is recorded on Table 1.

The experimental schools in this study were Park, Broadmoor, North Highlands, Beechwood, Ryan, and Crestworth; each participated in the Computer Curriculum
TABLE 1

FREQUENCIES BY GROUP AND GRADE CLASSIFICATION

<table>
<thead>
<tr>
<th>GROUP</th>
<th>GRADE</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
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<td>16</td>
</tr>
<tr>
<td>1</td>
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<td>4</td>
<td>3</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>59</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>65</td>
</tr>
</tbody>
</table>
Corporation program of CAI during 1983-84. Park and Broadmoor also participated in the program during 1984-85. Only six students at Park and seventeen at Broadmoor participated in the program for two years. Only the first year of scores reported for each student was included in the study. The control schools in this study were Merrydale, Greenville, and Brownfield. None of these schools participated in CAI for 1983-84 or 1984-85. The number of students by school and year is listed in Appendix C.

The Comprehensive Assessment Program Test (CAPS) is administered to all Chapter I students as a pretest and as a posttest. CAPS scores are recorded as equal interval scores on a scale of 0 - 999; these scores can be added or subtracted for purposes of comparison. Descriptive data concerning the CAPS scores for the sample population are listed in Appendix D. Difference (DIF) and percent of gain (PGAIN) scores were calculated for reading and math. The means of these variables (DIFR, DIFM, PGAINR, and PGAINM) by group and grade are listed on Table 2.

Computer interaction time was recorded in minutes by the computer used by the student for CAI. Time was recorded from the minute the student entered a personal identification number and continued until the student entered the code indicating the end of the session. Time was converted into hours and minutes. Computer interaction time in reading (CTR) ranged from one hour sixteen minutes to seventeen hours forty-three minutes. Computer interaction time in math (CTM) ranged from two hours ten minutes
to nineteen hours thirty-three minutes. The mean CTR and CTM by group and grade is recorded on Table 3.

The CAI program used by Chapter I students reported a computer achievement score, a rough equivalent of an achievement test score, based on student responses to test items interspersed with the practice items. Computer achievement scores were reported on a monthly basis. The final computer achievement score recorded for each student receiving CAI was used in the study. Computer achievement in reading (CAVR) ranged from 236 to 567. Computer achievement in math (CAVM) ranged from 162 to 635. The mean CAVR and CAVM by group and grade is listed on Table 4.

**Testing of Hypothesis I**

The objective of Hypothesis I was to test for differences in achievement between the three experimental groups which received CAI and the control group. The underlying assumption of this hypothesis was that students receiving CAI should have higher achievement levels than those students who did not receive CAI. To test this hypothesis, two one-way analyses of variance involving nine groups (3 x 3 factorial structure) were used. The use of two one-way analyses of variance tests was necessary because not all scores existed for all groups. Group 1 received CAI in math and reading; both reading and math pre- and posttest achievement test scores were available. Group 2 received CAI in reading; only reading pre- and posttest achievement scores were available. Group 3 re-
ceived CAI in math; only math pre- and posttest achievement scores were available. Contrasts among the means were used to test the hypotheses as discussed below. The level of significance was set at 0.05.

Stated in the null form, Hypothesis I holds that:

There are no statistically significant differences in achievement test scores for students exposed to CAI and those who are not.

In summary, findings for Hypothesis I indicated that Group 1 had higher achievement than Group 2 and Group 4 as measured by DIFR and PGAINR, but Group 2 was not significantly different from Group 4.

No significant differences were found for DIFM or PGAINM between Group 1 and Group 4, or between Group 3 and Group 4.

When grade levels were compared grade 3 had consistently higher DIFM, PGAINM, DIFR, and PGAINR than grade 4 or grade 5. Means of DIFR, PGAINR, DIFM, and PGAINM are recorded on Table 2.

A detailed report of these findings is presented below.

**Report of Findings for Hypothesis I**

In order to test Hypothesis I, nine specific questions were formulated. The data were analyzed to address each. Question #1 concerned overall differences among the student groups. Questions #2 – 6 concerned differences between specific experimental groups. Questions #7 – 9 concerned differences by grade levels.
**TABLE 2**

**MEAN SCORES FOR DEPENDENT VARIABLES**

**BASED ON COMPREHENSIVE ASSESSMENT PROFILE (CAPS)**

**BY GROUP**

<table>
<thead>
<tr>
<th>GROUP/GRADE</th>
<th>N</th>
<th>DIFR</th>
<th>PGAINR</th>
<th>DIFM</th>
<th>PGAINM</th>
</tr>
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<tr>
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<td>37.375</td>
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<td>0.0024</td>
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<td>10.539</td>
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<td>21.333</td>
</tr>
</tbody>
</table>

*DEPENDENT VARIABLES INCLUDE DIFR, PGAINR, DIFM, PGAINM

DIFR = POSTTEST READING - PRETEST READING
PGAINR = POSTTEST READING - PRETEST READING/PRETEST READING
DIFM = POSTTEST MATH - PRETEST MATH
PGAINM = POSTTEST MATH - PRETEST MATH/PRETEST MATH

*** = MEAN NOT AVAILABLE BECAUSE GROUP 2 RECEIVED CAI IN READING ONLY AND GROUP 3 RECEIVED CAI IN MATH ONLY
## TABLE 3

**MEAN SCORES OF INDEPENDENT VARIABLES CTR AND CTM**

**BY GROUP**

<table>
<thead>
<tr>
<th>GROUP/GRADE</th>
<th>N</th>
<th>CTR MEAN</th>
<th>CTM MEAN</th>
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<tr>
<td>1 3</td>
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<td>3 5</td>
<td>63</td>
<td>***</td>
<td>1286.3509</td>
</tr>
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</table>

* CTR = COMPUTER INTERACTION TIME FOR CAI IN READING

* CTM = COMPUTER INTERACTION TIME FOR CAI IN MATH

*** = TIMES NOT AVAILABLE BECAUSE GROUP 2 RECEIVED CAI IN READING ONLY AND GROUP 3 RECEIVED CAI IN MATH ONLY
TABLE 4
MEAN OF DEPENDENT VARIABLES CAVR AND CAVM*
BY GROUP

<table>
<thead>
<tr>
<th>GROUP/GRADE</th>
<th>N</th>
<th>MEAN CAVR</th>
<th>MEAN CAVM</th>
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</tr>
<tr>
<td>3</td>
<td>5</td>
<td>63</td>
<td>***</td>
</tr>
</tbody>
</table>

* CAVR = READING ACHIEVEMENT SCORE REPORTED BY CAI PROGRAM (RANGE 0 TO 999)
* CAVM = MATH ACHIEVEMENT SCORE REPORTED BY CAI PROGRAM (RANGE 0 TO 999)
*** = SCORES NOT AVAILABLE BECAUSE GROUP 2 RECEIVED CAI IN READING ONLY AND GROUP 3 RECEIVED CAI IN MATH ONLY


**Question #1:** Are there differences in reading and math achievement for students who received CAI and those who did not?

A one-way analysis of variance was calculated individually with each measure of achievement as the dependent variable. Statistically significant differences among the scores were found for DIFM (PR = 0.0046), PGAINM (PR = 0.0001), DIFR (PR = 0.0008), and PGAINR (PR = 0.0001). The specific nature of these differences was tested and findings are reported as answers to the questions which follow.

**Question #2:** Do students in Experimental Group 1 (those who received CAI in reading and math) have statistically higher levels of achievement in reading and math, as tested by CAPS, than students in the Control Group?

A comparison of the means for DIFR for Group 1 and Group 4 indicated a significantly higher (PR = 0.0007) mean score for Group 1 (mean = 32.0941) than for Group 4 (mean = 27.5919). Likewise, Group 1 was found statistically different from Group 4 (PR = 0.0002) in percent gain. The mean PGAINR for Group 1 was 0.0735; for Group 4 it was 0.0633.

When Group 1 and Group 4 were compared on DIFM and PGAINM, no significant differences were found (PR = 0.3132). The mean DIFM scores for Group 1 and Group 4 were 32.0941 and 27.5919, respectively, while for PGAINM, the
means of Group 1 and Group 4 were 0.0735 and 0.0633.

**Question #3:** Do students in Group 2 (students who received CAI in reading only) have statistically higher levels of achievement in reading, as tested by CAPS, than students in the Control Group?

Achievement measured by DIFR for Group 2 was not statistically different compared to Group 4 (PR = 0.7787); similar results were obtained when PGAINR for Group 2 was compared to PGAINR for Group 4 (PR = 0.7755). The mean DIFR for Group 1 was 13.2671; the mean DIFR for Group 4 was 11.6407. The mean of PGAINR for Group 2 was 0.0343; for Group 4 the mean PGAINR was 0.0306.

**Question #4:** Do students in Group 3 (those who receive CAI in math only) have statistically higher levels of achievement in math than the control group?

No statistically significant differences in achievement were found between Group 3 and Group 4 for DIFM (PR = 0.2166) or for PGAIMM (PR = 0.1762). The mean for DIFM for Group 3 was 31.8830; for Group 4 the mean DIFM was 27.5919. The mean for PGAIMM for Group 3 was 0.0742; for Group 4 the mean PGAIMM was 0.0633.

**Question #5:** Do students in Group 2 (those who receive CAI in reading only) have higher achievement in reading than Group 1?

There was a statistically significant difference in reading achievement for Group 1 and Group 2 as measured by
DIFR (PR = 0.0505). Mean DIFR for Group 1 was 25.5557, and the mean DIFR for Group 2 was 13.2671.

A statistically significant difference was also found for PGAINR between Group 1 and Group 2 (PR = 0.0296). The mean PGAINR for Group 1 was 0.0665; the mean PGAINR for Group 2 was 0.0343.

**Question #6:** Do students in Group 3 (those who receive CAI in math only) have higher achievement in math than Group 1?

There were no statistically significant differences between Group 3 and Group 1 for DIFM (PR = 0.9612) or PGAINM (PR = 0.9444).

**Question #7:** Do students in the experimental groups have higher achievement at grades 3, 4, or 5?

This question was originally subdivided to address each experimental group individually. However, as the data was being recorded and analyzed, it became apparent that Questions 7, 8, and 9 should be collapsed into a single question. The absence of posttest math scores for Group 2, and the absence of posttest reading scores for Group 3 made it more feasible to compare grade levels for all experimental groups rather than do paired group comparisons as originally planned.

Statistically significant differences were found for DIFM between grades 3 and .5 (PR = 0.0003) and between grades 4 and 5 (PR = 0.0071). Comparison of the means for DIFM indicated that grade 3 had higher achievement (mean DIFM = 37.8983) than grade 4 (mean DIFM = 30.6993) or grade
5 (mean DIFM = 22.3681), and that achievement of grade 4 was also higher than grade 5.

For PGAIM, differences were statistically significant between grades 3 and 5 (PR = 0.0001) and grades 4 and 5 (PR = 0.0032). Comparison of the mean PGAIM indicated that grade 3 had the highest level (PGAIM = 0.0868), followed by grade 4 (PGAIM = 0.0510), followed by grade 5 (PGAIM = 0.0135).

Statistically significant differences were found for DIFR between grades 3 and 5 (PR = 0.0031) and between grades 4 and 5 (PR = 0.0036). Comparison of the means for DIFR indicated that achievement was highest for grade 3 (mean DIFR 31.0000), followed by grade 4 (mean DIFR = 22.0796), followed by grade 5 (mean DIFR = 5.1547).

For PGAINR, differences were statistically significant between grades 3 and 5 (PR = 0.0001) and between grades 4 and 5 (PR = 0.0046). Mean PGAINR for grade 3 was 0.0868; mean PGAINR for grade 4 was 0.0510; mean PGAINR for grade 5 was 0.0135.

**Summary of Findings for Scheffe's Test of Pairwise Comparisons**

The Scheffe Test of Pairwise Comparisons was used to aid in the interpretation of findings. Findings for this test are discussed in detail in Appendix E. In summary, differences were found between experimental groups and control groups in four instances. For PGAIM, Group 33 had higher achievement than Control Group 45. For PGAINR,
Group 13 had higher Achievement than Control Groups 43, 44, and 45. Other differences consistently found a group containing third grade to score higher than groups used for comparison. For PGAINM, Group 33 had higher scores than Group 35 or 34. For PGAINR, Group 13 had higher scores than Groups 43, 44, 15, 45, and 25. For DIFR, Group 13 had higher scores than Group 25. However, achievement as reported by CAVR and CAVM consistently found groups containing fourth and fifth grade students to have higher achievement than other groups. For CAVR, Group 25 was higher than 13 and 23; Group 14 was higher than 13. For CAVM, Group 14 was higher than 13 and 33; Group 15 was higher than 33; Groups 34 and 35 were higher than Group 33.

Testing of Hypothesis II

The objective of Hypothesis II was to test the relationship between achievement and computer interaction time for each experimental group. The underlying assumption of this hypothesis was that the amount of computer interaction time should be positively related to achievement. In other words, as computer interaction time increased, achievement should increase proportionately. To test the relationship between time and achievement for each group, a one-way within group analysis of covariance was performed. The level of significance was set at 0.05. Findings for the analysis of covariance are discussed below. The Pearson correlation coefficient was also used to
test the correlation between computer time and each measure of achievement within each group.

Stated in the null form, Hypothesis II holds that:

There are no statistically significant relationships between achievement and computer interaction time.

Statistical testing consisted of a one-way within-group analysis of covariance. In summary, findings produced no significant relationships for the variables CTR in relationship to DIFR or PGAINR. There were statistically significant relationships found for the variable CTM in relationship to DIFM and PGAINM. The significant relationships were explained by Groups 33 and 34. CTR was found to be negatively related to CAVR at a significant level; this relationship was explained by Groups 14 and 24. CTM was positively related to CAVM at a significant level; this relationship was explained by Groups 34 and 35.

A detailed report of these findings is presented below.

Report of Findings for Hypothesis II

In order to test Hypothesis II, seven specific questions were formulated concerning the relationship between time and achievement in reading and math for the experimental groups. Data were analyzed to address the issues raised by these questions. For purposes of clarity, findings are reported by groups and grades.

To test the relationship between time and reading achievement, the analysis involved only Groups 1 and 2 for
grades 3, 4, and 5. The analysis revealed that overall the six relationships between CTR and DIFR were not significant (PR = 0.756). A similar lack of significance was found for CTR and PGAINR (PR = 0.6143). There were no significant differences between the slopes for Group 1 and Group 2 for DIFR (PR = 0.9000) or for PGAINR (PR = 0.9005). The six slopes for DIFR and PGAINR are shown on Table 5.

To test the same relationships in math, the analysis involved only Groups 1 and 3 for grades 3, 4, and 5. The analysis revealed that overall the six relationships between CTM and DIFM were significant (PR = 0.0012); a similar level of significance was found for the relationships between CTM and PGAINM (PR = 0.0019). The six slopes for CTM, DIFM, and PGAINM are shown on Table 6. There were significant differences between Group 1 and Group 3 for DIFM (PR = 0.0490) and marginally significant differences for PGAINM (PR = 0.0529). The average slope for DIFM Group 1 was -0.0042 and for Group 3 was 0.0309. The average slopes for PGAINM for Group 1 and Group 3 were 0.000 and 0.000. T - tests were computed for individual groups. Significant relationships between CTM and DIFM and between CTM and PGAINM were found for Groups 33 and 34.

The same procedures were followed to test the relationship between CTR and CAVR. The analysis revealed that overall the six relationships were significant (PR = 0.0081). The six slopes for CTR and CAVR are shown on Table 5. T - tests were computed for individual groups.
Significant negative relationships were found between CTR and CAVR for Groups 14 and 24.

The relationship between CTM and CAVM was also tested. The analysis revealed that overall the six relationships were significant (PR = 0.0002). The six slopes for CTM and CAVM are shown on Table 6. T-tests were computed for individual groups. Significant positive relationships were found between CTM and CAVM for Groups 34 and 35.

The three slopes for DIFR and PGAINR by grade are listed on Table 7 as are the slopes for DIFM and PGAINM.

**Pearson Correlation Coefficient**

*for Hypothesis II*

The Pearson Correlation Coefficient was computed to test the correlations of CAVR and CAVM with other variables. Both negative and positive correlations were found.

Although the computer reported achievement score (CAVR and CAVM) was supposed to be related to the CAPS test results, CAVR negatively correlated with DIFR for Group 13. CAVM negatively correlated with DIFM for Groups 13 and 14. Correlations between CAVR and DIFR, and CAVM and DIFM were positive for all other groups.

Statistically significant correlations were found for Group 15 for CTM negatively correlated with DIFM and for CAVM positively correlated with DIFM. For Group 2, two statistically significant correlations were found; these were in Group 24 for CTR negatively correlated with CAVR and for CAVR positively correlated with DIFR. Group 3 had
a total of six statistically significant relationships. For Group 33, CTM was positively correlated with DIFM. For Group 34, CTM was positively correlated with DIFM, and CTM was positively correlated with CAVM. For Group 35, CTM was positively correlated with CAVM, and CAVM was positively correlated with DIFM.

Implications of these findings are discussed in Chapter V.
TABLE 5

ANALYSIS OF COVARIANCE
FOR ALL EXPERIMENTAL GROUPS AND GRADES
FOR THE DEPENDENT VARIABLES DIFR, PGAINR, AND CAVR
AND THE INDEPENDENT VARIABLE CTR

<table>
<thead>
<tr>
<th>GROUP</th>
<th>GRADE</th>
<th>DIFR</th>
<th>PGAINR</th>
<th>CAVR</th>
</tr>
</thead>
<tbody>
<tr>
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<td>3</td>
<td>0.0097</td>
<td>0.0000</td>
<td>-0.0607</td>
</tr>
<tr>
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<td>4</td>
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</tr>
<tr>
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</tr>
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<td>3</td>
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<td>0.0000</td>
<td>-0.0049</td>
</tr>
<tr>
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<td>4</td>
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<td>-0.0000</td>
<td>-0.0940</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
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<td>-0.0000</td>
<td>0.0477</td>
</tr>
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</table>
TABLE 6

ANALYSIS OF COVARIANCE

FOR ALL EXPERIMENTAL GROUPS AND GRADES

FOR THE DEPENDENT VARIABLES DIFM, PGAINM AND CAVM

AND FOR THE INDEPENDENT VARIABLE CTM

<table>
<thead>
<tr>
<th>GRADE</th>
<th>GROUP</th>
<th>DIFM</th>
<th>PGAINM</th>
<th>CAVM</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-0.0001</td>
<td>0.1470</td>
</tr>
<tr>
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</tr>
<tr>
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<td>-0.0001</td>
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</tr>
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<td>0.0001</td>
<td>0.0236</td>
</tr>
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<td>4</td>
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<tr>
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<td>5</td>
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</tr>
</tbody>
</table>
### Table 7

**Analysis of Covariance**

**For Grade Levels**

**For the Dependent Variables DIFR and PGAINR**

**And the Independent Variable CTR**

**And for the Dependent Variables DIFM and PGAINM**

**And the Independent Variable CTM**

**Estimate (slope)**

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<th>PGAINR</th>
</tr>
</thead>
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<td>0.0000</td>
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<tr>
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<td>-0.0000</td>
</tr>
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<td>-0.0000</td>
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</table>

<table>
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<th>PGAINM</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-0.0000</td>
</tr>
<tr>
<td>4</td>
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</tr>
<tr>
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</tr>
</tbody>
</table>
CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

The computer has become an increasingly important component of the educational delivery system in the United States during the last decade. The magnitude of the computer's impact on education was indicated by a recent national survey of state level Departments of Education. This survey found that 16 states have established line items in their budgets for computer use in schools; 28 states are involved in state or regional level software evaluation; 11 states require schools to integrate computers in the curriculum; and six states require students to pass a computer competency test or otherwise demonstrate computer skills (Barbour, 1986).

Computers are used by teachers and school administrators for record keeping, as part of the instructional management system, as a tool in test preparation and test scoring, and more recently as part of the instructional program in the form of computer-assisted instruction. The rapid spread of CAI has been delayed by several factors, including: 1) lack of quality courseware which supports present curriculum objectives; 2) high cost of developing quality courseware; 3) high cost of hardware; 4) lack of adequately trained instructional personnel to manage a program of CAI; and 5) lack of research concerning the
effectiveness of CAI as an instructional technique.

The movement to integrate computers into the regular curriculum is supported by learning theorists and educational researchers. The experimental, sequential nature of
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effectiveness of CAI as an instructional technique.

The movement to integrate computers into the regular curriculum is supported by learning theorists and educational researchers. The experimental, sequential nature of the learning process described by Piaget (1973; Isaacs, 1972; Piaget, 1971) closely mirrors the structured series of learning events in a CAI program.

Further support for CAI is found in schema theory. According to this theory of information processing, the learner systematically attaches newly acquired information to previously existing schemata. (Evans, 1973; Anderson and Pichert, 1978; Forman, 1977; Furth, 1982, Rumelhart and Ortony, 1977). CAI establishes within the program an interconnecting web of information that is revealed as the student progresses through the material presented. So an individual's unique schemata is reinforced by the schematic nature of the CAI program.

The importance of direct instruction and active student involvement in the instructional process to overall achievement gains (Berliner and Rosenshine, 1977; Jackson, 1968; Fisher, et. al., 1978; Kean, et. al., 1979) are themes echoed by advocates of CAI (Kuchinkas, 1982; Fish, 1984; Hartley and Lovell, 1977; Rosenshine and Stevens, 1984).

Computers in general and CAI in particular will have a long-lasting and fundamental affect on education. Gagne believes that computers have changed the way we view the learning process from a theory of stimulus-response to a
theory of information processing (Gagne, 1977; also Lipsitz, 1982; Meierhenry, 1982).

While some educators believe computers to be a threat to traditional educational methods (Sardello, 1984), others suggest that the same technology which creates problems for educators may contribute to the solutions of those problems (Snider, 1983). Instead of creating a cold, impersonal educational environment, computers may actually be more "humanistic" than teachers because computers are totally impersonal and unprejudiced (Blair and Lobello, 1984; Judd, 1983).

Existing research has suggested positive effects on achievement for those students using CAI compared to students not using CAI. This seems a particularly consistently finding for math achievement (Diem and Fairweather, 1980; Ballas, 1982; Joiner, 1977), although other studies find a strong relationship between CAI and reading achievement (Blanchard and Smith, 1985; Rogosta, 1983; Alessi, et al., 1982).

This study addressed two issues central to further implementation of CAI. First, is there a measurable difference in reading and math achievement test scores for students who have reviewed CAI in reading and math when compared to scores of students who have not received CAI? The focus of this question was whether the supposed more efficient format of CAI compared to traditional instructional formats would contribute to a change in student
achievement which would be discernible by comparison of routinely administered achievement tests. The review of literature suggested that students receiving CAI would have higher achievement than students with similar characteristics who did not receive CAI. This issue is important to future planning and implementation of CAI programs. If a clear answer to this question resulted from statistical analyses of the data, this information would be value to teachers and administrators responsible for planning such programs.

A second issue was also addressed by this study; namely, does a relationship exist between the amount of time a student spends working with CAI and that student's achievement? In other words, as the amount of time a student spends working in CAI increases, does achievement increase at a proportionate rate? The review of literature suggests there may be a positive relationship between time and achievement.

Conclusions and Implications

The specific findings reported in Chapter IV generally support these conclusions and implications.

Hypothesis I

Hypothesis I, that students who were exposed to CAI would have higher achievement test scores that those students who were not exposed to CAI, held only for certain groups and grades. Findings which supported this hypothesis are discussed below.
Achievement in reading, as measured by DIFR and PGAINR, was higher for experimental Group 1 than for control Group 4. It might be expected that since Group 1, which received CAI in reading and math, had higher achievement in reading than Group 4, a similar relationship should exist between Group 2, which received CAI in reading only, and Group 4. However, this expected relationship was not found. There were no significant differences in reading achievement between Group 2 and Group 4. Reading achievement was found to be higher for Group 1 in comparison to Group 2. Closer examination of reading scores for Group 2 indicate a negative DIFR for Group 2, grade 5. This negative score for one grade level within the group would significantly affect the computation of the mean for the entire group.

Specific explanations for the negative achievement score are not present in this study. Nevertheless, it is possible to speculate on probable causes. Group 2, grade 5, had the lowest mean CTR of all groups (869.6539 compared to a high of 1139.8182). It is possible that this group did not receive enough CAI to result in an achievement difference. Another possible explanation of the negative score is that students in this group perceived the CAI experience differently than other students who received CAI. Research reported by Soar (1973) and Stallings and Kashowitz (1974) suggests that negative achievement may result if teachers work with one or two students at a time,
but positive achievement results if teachers work with groups of three to seven or whole groups. If students in Group 2, grade 5, perceived the CAI experience as an individual group in which they were the only member, this may have contributed to the negative achievement score. Further, if students in this group perceived the CAI experience as "play" or "unbusinesslike," this perception may have also contributed to negative achievement (Rosenshine and Stevens, 1984).

Achievement in math, as measured by DIFM and PGAINM, was not found significantly different for experimental Group 1, which received CAI in reading and math, compared to control Group 4. Neither were significant differences found for math achievement between Group 3, which received CAI in math only, and Group 4; nor were differences found between Group 1 and Group 3.

The absence of differences in achievement between experimental and control groups must be cautiously accepted. Research reported by Elfer (1974) suggests that CAI is most effective in producing higher achievement for those students who take a longer period of time to consider an answer before responding. It is possible that no differences were found between experimental and control groups for CAI in math because students receiving CAI did not spend a long enough period considering answers before responding. This concern was voiced by EBRP Chapter I teachers to this researcher. Teachers in the program at Broadmoor and Park Elementary Schools stated that their
Chapter I students often answered a question on the computer immediately without considering all the answers from which to choose. Research reported by Edwards (1975) suggests another possible explanation for the lack of differences between experimental and control groups. Results of his research indicated that while CAI almost always produces more achievement than traditional instruction, achievement gains may not show up in tests of long term retention.

Comparisons of reading and math achievement for individual grades within groups produced findings supportive of Hypothesis I in two instances. Reading achievement, as measured by PGAINR, was significantly higher for experimental Group 1, grade 3, in comparison to control Group 4, grades 3, 4, and 5. Math achievement, as measured by PGAINM, was found to be significantly higher for experimental Group 3, grade 3, in comparison to control Group 4, grade 5. It is important to note that in both the instances of higher achievement discussed above, a group containing third grade students was found to have higher achievement than students in the control group. A possible explanation for this difference is suggested by research reported by Fisher, et. al. (1978). Findings of this study indicated the importance of a high rate of success for younger children when answering questions, and that the rate of success was directly related to overall achievement. It may be that students in this study perceived
their personal rates of success in CAI as high and this success was reflected in measures of achievement. Another factor which may have had impact on this group's scores, is that younger children tend to view new experiences more seriously than older students. As a consequence, these students may have approached CAI in a more "businesslike" manner and this attitude contributed to their higher levels of achievement (Rosenshine and Stevens, 1984). This difference may also indicate that third grade students respond in a more positive way to CAI than fourth and fifth grade students, and as a consequence, computer drill and practice may contribute in some manner to higher achievement for these students.

Implications from findings for this hypothesis are inconclusive. While reading achievement was higher for Group 1 than for Group 4, this difference seems to be accounted for primarily by the achievement of Group 1, grade 3. The high achievement of the third grade students was not shared by the fourth and fifth grade students in Group 1. The mean DIFR score of Group 1, grade 4 (22.2500) was almost identical to the DIFR mean of Group 2, grade 4 (21.9091). There was even less difference in mean DIFR between Group 1, grade 5 (10.6170) and mean DIFR of Group 4, grade 5 (10.5385). Clearly, the differences found in reading achievement between Group 1 and Group 4 and between Group 1 and Group 2 are due to the mean DIFR of Group 1, grade 3 (43.8000).

These factors combined with the negative mean DIFR of
Group 2, grade 5, make statements concerning higher reading achievement for students receiving CAI in reading tenuous at best. The lack of findings to support higher math achievement for students receiving CAI in math, with the exception of Group 3, grade 3, compared to Group 4, grade 5, of the Control Group, make statements relating significantly increased math achievement as measured by achievement test scores to CAI in math unsupported by the testing of Hypothesis I. However, even this statement must be modified when the variable of time is considered.

Hypothesis II

Hypothesis II, that computer interaction time would be related to achievement, was found to hold for math but not for reading. Findings are discussed below.

Computer time in math (CTM) was significantly related to achievement in math as measured by DIFM and PGAINM for Group 3, grades 3 and 4. In addition, CTM was significantly related to CAVM for Group 3, grades 4 and 5.

Implications of these findings are important to this study because they directly support Hypothesis II. While peripheral factors not controlled by this study undoubtedly influenced the outcomes, it is clear that there was a positive relationship between the amount of time students spent on CAI in math and achievement in math for students in Group 3, grades 3 and 4. In other words, as the amount of time a student in Group 3, grades 3 and 4, spent on CAI in math increased, that student's achievement in math in-
creased proportionately.

Despite the findings for groups and grades outlined above, these findings did not hold for all groups and grades which received CAI in math. The Pearson correlation coefficient (discussed in Appendix F) indicated that CTM was negatively correlated with math achievement as measured by DIFM for Group 1, grades 5; this correlation was statistically significant. Although not significant, the same negative correlation between CTM and DIFM was found for Group 1, grades 3 and 4. Nevertheless, CTM was positively correlated with CAVM for all these groups.

Implications of these findings are that computer interaction time in math positively influenced achievement in math as measured by the program of CAI. However, for reasons not specified by this study, this relationship is not reflected in math achievement scores measured by DIFM for Group 1, grades 3, 4 and 5. Further, there is a statistically significant positive correlation between CAVM and DIFM for Group 1, grade 5, but a non-statistically significant negative correlation between CAVM and DIFM for Group 1, grades 3 and 4. The inability to generalize math achievement as measured by the computer (CAVM) to math achievement as measured by the Comprehensive Assessment Program Test (DIFM and PGAINM) suggests several possibilities. First, the two measures of achievement may not be thoroughly compatible. Second, students may not be able to transfer the drill and practice of the CAI program to other
testing situations. Third, the lapse of time between the
drill and practice of CAI and classroom testing may influ-
ence test outcomes. This is supported by research reported
by Edwards, et. al. (1975); they cautioned that results of
CAI may not show on achievement test scores.

In contrast, findings for Pearson correlations invol-
ving CTR were even less uniform than findings for correla-
tions involving CTM. For some groups, CTR was negatively
correlated with reading achievement variables, for some
groups the correlation was positive; and for some groups
there was no measurable correlation.

Several implications can be drawn from relationships
for CTR and measures of reading achievement. First, the
lack of significant relationships between CTR and DIFR or
PGAINR make the CAI program in reading questionable as an
appropriate supplement to classroom instruction and sug-
gests that additional research is needed. Second, the
testing program incorporated in the CAI program may not be
compatible with the CAPS test. Third, students may not be
able to uniformly transfer computer drill and practice in
reading to classroom activities. Fourth, and perhaps most
importantly, these findings may reflect the difficulty of
constructing a reading test that actually tests reading
skills.

As early as 1952, Anderson and Dearborn raised the
issue of whether standardized reading tests actually test
reading skills. These tests require students to

...do something else to indicate how much and
how well he has understood, and that something may
make the test... just so much a simon-pure test of
reading and thus in part a test of something else
besides reading...(Anderson and Dearborn, 1952,
page 302)

Researchers have noted that questions on standardized
reading comprehension tests can sometimes be answered with­
out reading the text (Anderson and Dearborn, 1952; Marr and
Lyons, 1980; Tuinman, 1974). It may be that both the CAPS
test and the assessment of achievement used by the CAI
program are examples, in whole or in part, of this phe­
nomena. In any event, testing a student's reading know­
ledge is a nebulous task compared to testing that same
student's math knowledge.

Additional Findings

As the results of statistical testing were analyzed
for differences in achievement between experimental and
control groups, several peripheral differences were found
which are of interest to this study. These differences are
discussed below.

Students in grade 3, regardless of the experimental
group classification, had consistently higher achievement
as measured by DIFR, PGAINR, DIFM, PGAINM, than students in
grades 4 and 5. Further, students in grade 4 had con­
sistently higher achievement as measured by these same four
variables than students in grade 5.

There are several possible implications for this
finding. First, it is possible that students in grade 3
were significantly different in ability than students in
grades 4 and 5. This, however, seems unlikely since all students in this study were classified as Chapter I students prior to the beginning of the study. Second, the CAPS test may be "easier" due to the difficulties of preparing academic tests for young children for grade 3 students than for students in grades 4 or 5. Third, students in grade 3 may have responded more positively to the special treatment of the Chapter I program and this response was reflected in achievement. Fourth, it is possible that inconsistent procedures were used to administer the CAPS test and these inconsistencies influenced student scores. Another peripheral difference found in the course of data analysis was that achievement as measured by the variables CAVR and CAVM was consistently higher for experimental groups containing fourth and fifth grade students when these groups were compared to third grade students. Several possible implications can be drawn from this finding. First, students in grades 4 and 5 may have responded more positively to the program of CAI and this response was reflected in achievement measured by the computer. Second, this particular group of fourth and fifth grade students may not test well on traditional paper and pencil tests due to deficiencies in test-taking skills, but this lack of "test-wiseness" was not reflected in the computer measures of achievement.
Limitations and Assumptions of the Study

In addition to the limitations and assumptions of the study discussed in Chapter III, other limitations and assumptions became apparent during data analysis. These are discussed below.

1. An assumption of the study was that there was a relationship between the drill and practice provided by the program of CAI and the skills tested by CAPS. The negative achievement measured by DIFR of Group 2, grade 5, and the mixture of negative and positive correlations for reading make the assumed relationship between the CAI program in reading and reading achievement test scores questionable.

2. An assumption of this study is that administrative policies concerning the length of time students remained in the Chapter I program did not affect overall achievement. This study recorded time in minutes, but made no record of the days or weeks a student spend working with CAI. Administrative procedures encouraged the removal of students from the Chapter I program when that student began to work on grade level. The impact of this policy on this study may have reduced achievement gains. It was an assumption of this study that the effects of this policy were minimal.

3. An assumption of this study is that extraneous factors not controlled by the study, but which might influence achievement, were minimal.

4. An assumption of this study was that the "John Henry Effect" (Campbell, 1980) was minimal. It is assumed
that the Chapter I teachers of students in the control group did not exert extra effort or provide unusual amounts of drill and practice activities to students in the control groups.

**Suggestions for Future Research**

Several suggestions for future research can be inferred from earlier discussions. Two areas need special attention. First, the impact on achievement of newly implemented CAI programs must be systematically researched. Findings from such research may indicate early in the program that changes or adjustments in the policies regulating the program may be needed to maximize its effectiveness. Second, when planning the implementation of a program of CAI, a survey measuring attitudes and perceptions of those involved in the program should be administered early in the program and then again the program had been in operation for a period of time. This procedure would produce information useful in interpreting score results and in identifying potential problem areas.

The acceptance level of educators for CAI is increasing. Long term research projects will be essential if practitioners are to fully utilize this new technology.
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Appendix A

Data Encoding Sheet

Card Col Variable

Part 1: All Research Subjects Information

1. Assigned Research ID
2. EBRP Student ID

Student Name

3. School Code
4. Class Code
5. Year data recorded: 1) 83-84 2) 84-85

Teacher Name

6. Grade Level: (3, 4, 5)

7. Research Group Classification:
   1) Control Group
   2) Experimental 1
   3) Experimental 2
   4) Experimental 3

8. Pretest Achievement Score: Math
9. Pretest Achievement Score: Reading
10. Posttest Achievement Scores: Math
11. Posttest Achievement Scores: Reading

Part 2: Experimental Group Information

12. Reading Comprehension: Total Gain
13. Reading Comprehension: Total Time
14. Reading Comprehension: Course Average
15. Math: Total Gain
16. Math: Total Time
17. Math: Course Average

109
APPENDIX B

ABBREVIATIONS USED IN THIS PAPER

GG = Group and grade.

DIFR = Difference in reading score on the CAPS tests when pretest score is subtracted from the posttest score.

DIFM = Difference in math score on the CAPS test when pretest score is subtracted from the posttest score.

PGAINR = percent of gain score for reading. Determined by subtracting the pretest reading score from the posttest reading score and dividing by pretest reading score.

PGAINM = percent of gain score for math. Determined by subtracting the pretest math score from the posttest math score and dividing by the pretest math score.

CTR = computer interaction time in reading. Determined by the time reported by the computer used by students for CAI. Reported in hours and minutes.

CTM = computer interaction time in math. Determined by the time reported by the computer used by students for CAI. Reported in hours and minutes.

CAVR = computer average in reading. A score reported by the CAI program for each student. Roughly equivalent to an achievement test score. Range of 0 to 999.

CAVM = computer average in math. A score reported by the CAI program for each student. Roughly equivalent to an achievement test score. Range of 0 to 999.

CAPS TEST = Comprehensive Assessment Program Test. Administered by East Baton Rouge Parish Schools to all students in the Chapter I program. Scores range from 0 to 999.

13, 14, 15 = Group 1, grades 3, 4, 5. Group 1 received CAI in math and reading.

23, 24, 25 = Group 2, grades 3, 4, 5. Group 2 received CAI in reading only.

33, 34, 35 = Group 3, grades 3, 4, 5. Group 3 received CAI in math only.

43, 44, 45 = Group 4, grades 3, 4, 5. Group 4 was the Control Group. Group 4 received no CAI as part of a regular program of classroom instruction.
APPENDIX C

DISTRIBUTION OF SAMPLE POPULATION

BY SCHOOL AND YEAR

<table>
<thead>
<tr>
<th>EXPERIMENTAL GROUP SCHOOLS</th>
<th>1983-84</th>
<th>1984-85</th>
<th>1983-85</th>
</tr>
</thead>
<tbody>
<tr>
<td>PARK</td>
<td>66</td>
<td>53</td>
<td>18</td>
</tr>
<tr>
<td>BROADMOOR</td>
<td>31</td>
<td>24</td>
<td>7</td>
</tr>
<tr>
<td>NORTH HIGHLANDS</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEECHWOOD</td>
<td>40</td>
<td></td>
<td></td>
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<tr>
<td>RYAN</td>
<td>26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRESTWORTH</td>
<td>77</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONTROL GROUP SCHOOLS</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MERRYDALE</td>
<td>50</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>GREENVILLE</td>
<td>39</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>BROWNFIELD</td>
<td>19</td>
<td>19</td>
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</tr>
</tbody>
</table>

TOTAL SAMPLE POPULATION     584
APPENDIX D

COMPREHENSIVE ASSESSMENT PROFILE (CAPS)

PRETEST AND POSTTEST SCORES

FOR READING AND MATH

RANGE, MEDIAN AND MEAN

<table>
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<th>RANGE*</th>
<th>MEDIAN</th>
<th>MEAN</th>
</tr>
</thead>
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<tr>
<td>READING SCORES</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>PRETEST</td>
<td>312-587</td>
<td>439.0</td>
<td>432.171</td>
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<tr>
<td>POSTTEST</td>
<td>315-562</td>
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<td>443.802</td>
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<tr>
<td>MATH SCORES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRETEST</td>
<td>325-578</td>
<td>467.5</td>
<td>462.859</td>
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<tr>
<td>POSTTEST</td>
<td>318-618</td>
<td>493.0</td>
<td>489.456</td>
</tr>
</tbody>
</table>

* RANGE POSSIBLE = 0 TO 999
APPENDIX E

FINDINGS FOR ANALYSIS OF VARIANCE USING
SHEFFE'S TEST OF PAIRWISE COMPARISONS
FOR HYPOTHESIS I

To further test the relationships among the groups, pairwise comparisons were tested using Scheffe's method. Each group was compared with all other groups for dependent variables DIFM, PGAINM, CAVM, DIFR, PGAINR, and CAVR. The level of statistical significance was set at 0.05. Scheffe tends to be a conservative measure (Hinkle, Wiersma, and Jurs: 1982). It may indicate that differences between the means are not significant when in fact they are significant.

When pairwise comparisons of group means for the variable DIFM were tested using Scheffe, no significant differences were found.

For the variable PGAINM, Group 33 was found significantly different from Group 35; Group 33 was also found to be different from Group 45. The mean PGAINM of Group 33 was 0.0981; the mean of Group 35 was 0.0450; the mean of Group 45 was 0.0442. Achievement as measured by PGAINM was higher for Group 33 than for Group 35 or Group 45.

When the dependent variable DIFR was tested, Group 13 was significantly different from Group 25. The mean DIFR for Group 13 was 43.8000; the mean DIFR for Group 25 was -0.3077. Achievement as measured by DIFR was higher for
Group 13 than for Group 25.

Testing PGAINR produced significant differences between Group 13 and Group 43, between Group 13 and 44, between 13 and 15, between 13 and 45, and between 13 and 25. The mean PGAINR for Group 13 was 0.1236, for Group 43 the mean PGAINR was 0.0386. PGAINR for Group 44 was 0.0294, for Group 15 it was 0.0245, for Group 45 it was 0.0238 and for Group 25 the mean was 0.0024. As measured by PGAINR, achievement was higher for Group 13 when compared to Groups 43, 44, 15, 45 and 25.

When CAVR was tested, significant differences were found between Group 13 and Group 25, between 23 and 25, and between 13 and 14. The mean CAVR for Group 13 was 290.9333; the mean for Group 14 was 369.2750. The mean CAVR for Group 23 was 272.0000; the mean for Group 25 was 406.5555. As measured by CAVR, achievement was higher for Group 25 compared to Groups 13 and 23. Group 14 had higher CAVR when compared to Group 13.

Testing of CAVM produced significant differences between several pairs. Differences were found between Group 13 (mean = 293.8125) and Group 14 (mean = 368.0750). Group 15 (mean = 359.2553) was different from Group 35 (mean = 284.7159). Differences were found between Group 14 (mean = 368.0750) and Group 33 (mean = 284.7519). Group 15 (mean = 359.2553) was found different from Group 33 (mean = 284.7159). Differences were found between Group 33 (mean = 284.7159) and Group 34 (mean = 347.6363). Group 33 (mean = 284.7159) was found different from Group 35 (mean =
CAVM was higher for Group 14 compared to Group 13 and 33. Group 15 had higher CAVM compared to Group 33. CAVM was higher for Group 34 and 35 when compared to Group 33.

Findings for the Scheffe pairwise comparisons are listed on Table E1.
### TABLE E1

**Analysis of Variance Using the Scheffe Test of Comparisons**

**Significant Differences Between Groups by Variable**

**And Means for Those Variables**

<table>
<thead>
<tr>
<th>Group/Grade With Significant Differences by Variable</th>
<th>Group/Grade</th>
<th>Mean of Contrasted Variable</th>
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<tbody>
<tr>
<td><strong>Variable: DIFM</strong></td>
<td></td>
<td></td>
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<tr>
<td>None</td>
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<tr>
<td><strong>Variable: PGAINM</strong></td>
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<tr>
<td>33 -- 35</td>
<td>3</td>
<td>0.0981</td>
</tr>
<tr>
<td>33 -- 45</td>
<td>3</td>
<td>0.0450</td>
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<td>4</td>
<td>0.0442</td>
</tr>
<tr>
<td><strong>Variable: DIFR</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 -- 25</td>
<td>1</td>
<td>43.8000</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>-0.3077</td>
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<tr>
<td><strong>Variable: PGAINR</strong></td>
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<tr>
<td>13 -- 43</td>
<td>1</td>
<td>0.1236</td>
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<tr>
<td>13 -- 44</td>
<td>4</td>
<td>0.0386</td>
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<tr>
<td>13 -- 15</td>
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<tr>
<td>13 -- 45</td>
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<td>0.0245</td>
</tr>
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<td>13 -- 25</td>
<td>4</td>
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<td>0.0024</td>
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### VARIABLE: CAVR

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### VARIABLE: CAVM

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<tr>
<td>33</td>
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</table>
APPENDIX F

REPORT OF FINDINGS FOR
PEARSON CORRELATION COEFFICIENT
FOR ALL EXPERIMENTAL GROUPS AND GRADES

The Pearson Correlation Coefficient was used in preliminary data analysis. Findings are summarized in Chapter iv and discussed in detail below. Tables for Pearson Correlations are presented at the end of this Appendix.

Group 13

Findings for third grade students in Group 1 indicated that CTR was correlated with DIFR at a weak positive level \(r = 0.23643\). CTM was correlated with DIFM at a weak negative level \(r = -0.10836\). CTR was correlated with CAVR at a moderate negative level \(r = -0.52686\). CTM was correlated with CAVM at a weak positive level \(r = 0.24369\). CAVR was correlated with DIFR at a weak negative level \(r = -0.11284\). CAVM was correlated with DIFM at a moderate negative level \(r = -0.32603\). None of these Pearson correlations were found to be statistically significant.

Group 23

Achievement was correlated with time for third grade students in Group 2. Findings indicated that CTR was correlated with DIFR at a moderate positive level \(r =
CTR was correlated with CAVR at a weak negative level \((r = -0.20891)\). CAVR was correlated with DIFR at a low positive level \((r = 0.13205)\). None of these findings were statistically significant.

**Group 3**

Findings for third grade students in Group 3 were as follows. CTM correlated with DIFM at a weak positive level \((r = 0.26508)\). CTM correlated with CAVM at a weak positive level \((r = 0.15452)\). CAVM correlated with DIFM at a low positive level \((r = 0.40726)\). Statistical significance was found for CAVM positively correlated with DIFM \((PR = 0.0001)\) and for CTM positively correlated with DIFM \((PR = 0.0154)\).

In summary, for grade 3, statistically significant relationships were found between CTM and DIFM and between CAVM and DIFM.

**Group 14**

When the Pearson correlation coefficient was calculated for all fourth grade students in Group 1 the following results were obtained. CTR correlated with DIFR at a weak negative level \((r = 0.22900)\). CTM correlated with DIFM at a weak negative level \((r = -0.10836)\). CTR correlated with CAVR at a moderate negative level \((r = -0.33056)\). CTR correlated with CAVM at a weak positive level \((r = 0.17422)\). CAVR correlated with DIFR at a moderate positive level \((r = 0.40512)\). CAVM correlated with DIFM at a weak negative level \((r = -0.17273)\).
No statistical significance was found for any correlation in this group.

**Group 24**

Findings for the Pearson correlation coefficient for fourth graders in Group 2 were as follows. CTR correlated with DIFR at a weak negative level \((r = -0.09085)\). CTR correlated with CAVR at a moderate negative level \((r = -0.49376)\). CAVR correlated with DIFR at a moderate positive level \((r = 0.69217)\).

Statistical significance was found for the positive correlation of CAVR with DIFR \((PR = 0.0004)\) and for the negative correlation of CTR with CAVR \((PR = 0.0195)\).

**Group 34**

Pearson correlation coefficients were computed for fourth grade students in Group 3. CTM correlated with DIFM at a low positive level \((r = 0.34989)\). CTM correlated with CAVM at a low positive level \((r = 0.32556)\). CAVM correlated with DIFM at a weak positive level \((r = 0.21223)\).

For fourth grade students in Group 3 statistical significance was found for CTM correlated with DIFM \((PR = 0.0046)\) and for CTM correlated with CAVM \((PR = 0.0076)\).

In summary, for grade 4, statistically significant relationships were found between CTM and DIFM, and between CTM and CAVM. Additionally, a significant negative relationship was found for CTR and CAVR and a significant positive relationship was found for CARV and DIFR.
**Group 1**

Pearson correlation coefficients were calculated for all fifth grade students in Group 1. CTR was correlated with DIFR at a level of no correlation (r = 0.00229). CTM was correlated with DIFM at a moderate negative level (r = -0.32580). CTR correlated with CAVR at a level of no correlation (r = -0.01064). CTM correlated with CAVM at a weak positive level (r = 0.23704). CAVR was correlated with DIFR at a moderate positive level (r = 0.34384). CAVM was correlated with DIFM at a moderate positive level (r = 0.39520).

Statistical significance was found for CTM correlated with DIFM (PR = 0.0271) and CAVM correlated with DIFM (PR = 0.0066).

**Group 2**

Pearson correlation coefficients were calculated for fifth graders in Group 2 with the following results. CTR was correlated with DIFR at a weak negative level (r = -0.07660). CTR was correlated with CAVR at a low positive level (r = 0.37924). CAVR was correlated with DIFR at a weak positive level (r = 0.01315).

Statistical significances were found for CTR positively correlated with CAVR (PR = 0.0511).

**Group 3**

Findings of Pearson correlation coefficient for fifth graders in Group 3 produced the following. CTM was corre-
lated with DIFM at a weak positive level \((r = 0.20242)\). CTM was correlated with CAVM at a low positive level \((r = 0.38579)\). CAVM was correlated with DIFM at a low positive level \((r = 0.41320)\).

Statistical significances were found for CAVM correlated with DIFM \((PR = 0.0014)\) and for CTM correlated with CAVM \((PR = 0.0018)\).

In summary, for grade 5, statistically significant relationships were found between CTM and CAVM, between CAVM and DIFM, between CTR and CAVR, and between CTM and DIFM. Pearson correlations are reported on Tables F1 - F9.

The schemata used to interpret Pearson correlation coefficients are listed on Tables Fl0 and Fll.
**TABLE F1**

**GUIDE #1 FOR INTERPRETING PEARSON CORRELATION COEFFICIENT***

<table>
<thead>
<tr>
<th>Correlation Coefficient</th>
<th>Description</th>
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<tr>
<td>+1.00</td>
<td>perfect positive correlation</td>
</tr>
<tr>
<td>+0.80</td>
<td>strong positive correlation</td>
</tr>
<tr>
<td>+0.50</td>
<td>moderate positive correlation</td>
</tr>
<tr>
<td>+0.10</td>
<td>weak positive correlation</td>
</tr>
<tr>
<td>0.00</td>
<td>no relationship</td>
</tr>
<tr>
<td>-0.10</td>
<td>weak negative correlation</td>
</tr>
<tr>
<td>-0.50</td>
<td>moderate negative correlation</td>
</tr>
<tr>
<td>-0.80</td>
<td>strong negative correlation</td>
</tr>
<tr>
<td>-1.00</td>
<td>perfect negative correlation</td>
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**TABLE F2**

GUIDE #2 FOR INTERPRETING

PEARSON CORRELATION COEFFICIENT*

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<th>Interpretation</th>
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<tr>
<td>-0.70 TO -0.90</td>
<td>HIGH NEGATIVE CORRELATION</td>
</tr>
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* Source: Hinkle, Wiersman, and Jurs, 1983.
### TABLE F3

**PEARSON CORRELATION COEFFICIENT FOR GROUP 13**

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Pearson Correlation Coefficient/Prob > R: Under HO: RNO = 0/ Number of Observations
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## TABLE F5

**PEARSON CORRELATION COEFFICIENT FOR GROUP 15**

Pearson Correlation Coefficient / Prob > R : Under HO : RHO = 0 / Number of Observations

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### TABLE F7

**PEARSON CORRELATION COEFFICIENT FOR GROUP 24**

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Pearson Correlation Coefficient / Prob > : R : Under HO : RHO = 0 / Number of Observations
**TABLE F8**

**PEARSON CORRELATION COEFFICIENT FOR GROUP 25**

Pearson Correlation Coefficient / Prob > : R : Under HO : RHO = 0 / Number of Observations

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**PEARSON CORRELATION COEFFICIENT FOR GROUP 33**

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**TABLE F11**

**PEARSON CORRELATION COEFFICIENT FOR GROUP 35**

Pearson Correlation Coefficient / Prob >: R: Under HO:RHO = 0 / Number of Observations

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VITA

Betty Archambeault is a graduate of Indiana State University, with B. S. and M. S. Degrees in English Education. She taught reading and English in the elementary grades in Indiana and was the reading teacher at a state correctional facility for juveniles. She was Coordinator of Development English at Vincennes University Junior College.

After moving to Orlando, Florida, she was employed by the Orange County School District as a teacher of English and served on two curriculum writing teams for the District. She was also employed on a part time basis as an English instructor by Valencia Community College.

In 1980 she joined the faculty of Catholic High School, Baton Rouge, a private college preparatory institution for young men. She presently teaches reading and computer literacy.

She is the author of a chapter on computer assisted instruction in a text to be published in 1987, co-author of two textbooks, co-author of four instructor's manuals for college level texts, and co-author of an article concerning correctional employee reading problems.

She is married to William G. Archambeault, Ph. D.; they are the parents of two children, John and Marie.
DOCTORAL EXAMINATION AND DISSERTATION REPORT

Candidate: Betty Josephine Conaway Archambeault

Major Field: Curriculum and Instruction

Title of Dissertation: The Relationship Between Interaction Time and Reading and Math Achievement for Chapter I Students Using Computer-Assisted Instruction in Grades Three, Four and Five

Approved:

[Signatures]

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

[Signatures]

Date of Examination:

November 21, 1986