A STUDY OF THE RELATIONSHIP OF SELECTED VARIABLES 
TO READING ACHIEVEMENT IN A COMPUTER-ASSISTED 
INSTRUCTIONAL SETTING

DISSertation

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By

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The focus of this study was to determine the unique contribution of I.Q., gender, instructional organization, time on the computer, classroom instructional time, ethnicity and total instructional time to the predictability of achievement gain in a computer-assisted instructional setting in reading. The sample consisted of 2,000 students in grades three and five from a large suburban school district in the Dallas - Fort Worth area. The students were given the *Iowa Test of Basic Skills* to determine reading achievement gains and the *Cognitive Abilities Test* to determine I.Q. levels. The study was conducted over a five month period during the 1984 - 1985 school year. Using multiple regression, the data were analyzed.

**Conclusions**

1. Students with high or low I.Q.s should be given preference in CAI settings in reading in third grade.
In fifth grade, low I.Q. students should be given preference while other instructional strategies should be considered for high I.Q. students.

2. In CAI settings an increase in total time in reading instruction is not the most appropriate method for raising achievement in third or fifth grade.

3. Achievement gains for American Indians and Blacks may be increased if they are given more time in CAI in reading.

4. Boys and girls benefit equally from CAI in third grade. In fifth grade, girls benefit more than boys.

5. High computer time and high classroom time and low computer time and low classroom time result in the greatest gain for students in grade five.

Research and Recommendations

1. The relationship of computer time and achievement should be explored when graphics, word processing, simulation, gaming and programming are used.

2. This study should be replicated using another CAI software package.
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CHAPTER I

INTRODUCTION

In our modern society where great technological strides are taking place over relatively short periods of time, perhaps the most influential technological innovation of the past century is the microcomputer. The effects of the coming of age of the computer can be seen in almost every aspect of living from something as basic as the calculator to the complexity of systems required for the successful launching of space shuttles like the Discovery. Even the hint that one of the back-up computers might malfunction was enough to delay an intended launch, costing the government literally millions of dollars. Dependency on the computer has become an integral part of our technological society.

The computer became an indispensible tool for the operation of science, business and government over thirty years ago, yet it did not play a major role in American education until 1970 (9). Since 1970, the use of the computer in education both for management and academic instruction has become a million dollar enterprise. In looking at the recent group of reports on the need for educational reform, Cross (2) noted that there appeared to be a tendency for educators "to be stampeded into quick
fix, mechanistic solutions" (p. 172) without delving deeply enough into the complex issues that are really at the basis of the need for reform. Evidence of this tendency can be seen in the current rush of school districts to place their students into computer-assisted instructional programs. At the cost of millions of dollars districts have purchased hardware and software, conducted computer literacy programs for administrators, teachers and students and begun to immerse large student populations in computer-assisted instructional programs in math, reading, science and social studies (7).

Because of the relatively short time that computers have been used for educational purposes, research has been limited. Many of the issues involved in using the computer in an educational setting have yet to be explored. Students are being placed in computer environments en masse without regard to some of the variables that should be considered before that placement is made. While there has been some research as to the impact of the variables of I.Q., ethnicity, gender, time and grade level on achievement in a traditional instructional setting, research with regard to these variables in a computer-assisted instructional setting is extremely limited as populations have been exceedingly small, time on task difficult to document and software less than adequate (1, 3, 4, 5, 8).
The Office of Technology Assessment (6) concluded that:

The so-called information revolution, driven by rapid advances in communication and computer technology, is profoundly affecting American education. It is changing the nature of what needs to be learned, who needs to learn it, who will provide it, and how it will be provided and paid for (p. 3).

This study explores some of the criteria involved in deciding "who needs to learn it" (6, p. 3). Students are being placed into computer-assisted instructional settings without consideration of the appropriateness of this particular teaching strategy for their specific characteristics. This study clarifies some of the variables interacting with reading achievement in a computer-assisted instructional setting in order to help educators determine which students will profit most from this learning experience. School districts can use this information to maximize the potential use of the computer by their students.

Purpose of the Study

The purpose of this study was to explore the variables of I.Q., gender, classroom instructional time, time on the computer, total instructional time, ethnicity, and instructional organization in grades three and five in a computer-assisted instructional setting in order to determine which
of these variables or combination of these variables appeared to be most influential in predicting achievement.

Main Research Questions

1. What is the unique contribution of I.Q. to reading achievement in a combined classroom and computer-assisted instructional setting when the variables of grade level, total instruction time (classroom instructional time and time on the computer), instructional organization, gender and ethnicity are held constant?

2. What is the unique contribution of gender to reading achievement in a combined classroom and computer-assisted instructional setting when the variables of grade level, total instructional time (classroom instructional time and time on the computer), I.Q., instructional organization and ethnicity are held constant?

3. What is the unique contribution of ethnicity to reading achievement in a combined classroom and computer-assisted instructional setting when the variables of total instructional time (time on the computer and classroom instructional time), gender, I.Q., grade level, and instructional organization are held constant?

4. What is the unique contribution of total instructional time to reading achievement in a combined classroom and computer-assisted instructional setting when the
variables of I.Q., gender, grade level, instructional organization and ethnicity are held constant?

5. What is the unique contribution of instructional organization to reading achievement in a combined classroom and computer-assisted instructional setting when the variables of I.Q., gender, grade level, total instructional time (classroom instructional time and time on the computer) and ethnicity are held constant?

6. What is the unique contribution of time on the computer to reading achievement in a combined classroom and computer-assisted instructional setting when the variables of grade level, I.Q., total instructional time, ethnicity, instructional organization and gender are held constant?

7. What is the unique contribution of classroom instructional time to reading achievement in a combined classroom and computer-assisted instructional setting when the variables of grade level, I.Q., total instructional time, ethnicity, instructional organization and gender are held constant?

8. If significant unique contributions are found among these variables, what interactions are significant in predicting reading achievement?

Significance of the Study

More and more, school districts have been committing themselves to large expenditures for purchasing computer
hardware and software. They have relied on the existing body of research to help them in their decision-making process. The fact that the populations studied have been small, the hardware has been unreliable, the quality of the software has been inconsistent and time on task has been difficult to document weakens the value of using the research as a determiner of how computers can best be integrated into the curriculum. Another underlying weakness in the approach is that these districts have been looking at using computers at the elementary and secondary levels while the majority of research available at this point has focused on military and university populations (3).

This study is significant in that it explores some of the variables that are known to have an impact on achievement in a traditional classroom setting in a computer-assisted instructional setting in order to validate them as appropriate for use in deciding which students would profit most from using the computer as an instructional aid. The use of an extensive elementary school population given ample orientation to the hardware and a cohesive instructional software package makes this study invaluable to districts seeking to make decisions about how this new instructional technology can best be implemented.

Definition of Research Variables

I.Q. - refers to the score achieved on the verbal subset of the Cognitive Abilities Test.
**time on the computer** - refers to the amount of time students actually spent on the computer involved in reading comprehensive instruction measured by when they logged on and logged off.

**gender** - refers to the identification of students as American Indian, Oriental, Hispanic, Black or Other.

**grade level** - refers to the assignment of students to a particular class in the vertical structure of the school system, most commonly termed as grade level. Levels for this study were third and fifth grades.

**reading achievement gain** - refers to the difference in student performance which occurs as a result of classroom instruction and computer-assisted instruction as measured by the pretest and posttest scores on the Iowa Test of Basic Skills, using the pretest as a covariate for the posttest.

**computer-assisted instruction** - refers to a teaching procedure which involves the student in an interaction with a computer program, a work terminal and a visual monitor. Immediate feedback of results is possible in this modality.
classroom instructional time - refers to the time set aside by the classroom teacher for reading comprehension instruction.

total instructional time in reading - refers to a combination of classroom instruction in reading comprehension and a computer-assisted instructional program in reading comprehension designed by WICAT Systems, Incorporated for Primary Grades, Kindergarten - 3 and grades 4 - 8.

instructional organization - refers to the determination of the classroom as self-contained when one teacher instructs one consistent set of students in all content areas and non self-contained in all other instances including team-teaching, ability grouping by class or departmentalization.

Limitations

1. The unique characteristics of the school district may limit generalizability.

2. The instructional quality of computer software varies greatly and may hinder generalizability.

Assumptions

1. The hardware and software were operational on a consistent basis for all students involved in the study.
2. All students had equal facility in manipulating the hardware and software.

3. All teachers adhered to their scheduled time for reading comprehension instruction as consistently as possible.


CHAPTER II

SYNTHESIS OF RELATED LITERATURE

Initially computers in education were used for the purposes of research and administrative bookkeeping. The use of the computer as an instructional aid began to be reached in the early 1950's (43). The first actual implementation of computer-assisted instruction in the classroom occurred in Illinois in 1959. It was called PLATO I (Programmed Logic for Automatic Teaching Operations). PLATO II replaced PLATO I in 1962 as a result of improved technology and study continued with PLATO III in 1964 and PLATO IV in 1970. The results of the PLATO studies were conclusive in favor of computer assisted instruction and the utility of the computer as an educational tool was validated (77).

With the seeming success of the use of the computer in instruction, several colleges and universities undertook their own investigations. The University of Pittsburgh (1964), Harvard College (1965), Florida State University (1965), Pennsylvania State University (1965) and the University of Texas (1965) were among these. Results culled from these studies further strengthened the use of computer-assisted instruction as a method for supporting the traditional instructional mode.
During the late 1960's, the invention of simplified programming languages and the development of the micro chip led to an increase in learner access to computers and a broadening of the role that computers might play in the educational process (43). As a result, many studies which compared computer-based education with conventional teaching methods were undertaken. Most of these involved the use of an experimental group which underwent instruction through computer-assisted programs and a control group which underwent instruction through conventional teaching methods (1, 25, 37, 46, 73). In a review of their meta-analysis of ten studies, Visonhaler and Bass (76) reported that children who were taught using computer-assisted instruction had a significant advantage over those who were not. Performance gains for children in elementary school who were using computers for drill and practice were one to eight months above those children receiving traditional instruction only.

In a report on the "Effects of Computer-based Education on Elementary School Pupils," Kulik, Kulik and Bangert-Drowns (43) concluded that:

In the typical application, students received approximately 26 hours of CAI—15 minutes per day, for 4 days a week, and for a total of 26 weeks. The effect of this instruction was to raise student achievement scores by 0.48 standard deviations, or from the 50th to the 68th percentile. A gain of this magnitude is roughly equal to a gain in grade-equivalent scores of 5 months (p. 12).
The positive impact of computer-assisted instruction on student achievement seems to be supported by the research. There are, however, other factors which also have an impact on student achievement. Studies have shown that I.Q., gender, instructional organization, grade level, ethnicity and time have an effect on student achievement in a traditional instructional setting (11, 17, 21, 29, 65). These variables may also have an effect on student achievement in a computer-assisted instructional setting (23, 38, 52, 53, 61) but researchers have suggested that some of the previous findings with regard to traditional instructional settings may not necessarily hold true in computer-assisted instructional settings. Willis (79) stated:

We simply do not know enough to answer concisely and accurately all the questions related to how computers should be used in schools, what subjects they make the most contributions to, and the cognitive skills they develop. Again, we have theories. But theories, at best, point to potentials and possibilities, not answers (p. 8).

Researchers have supported further exploration of these variables before any conclusions as to their positive or negative effect on achievement can be drawn.

Reading and Computer-assisted Instruction

In 1964, under the guidance of IBM and Stanford University, a program using the computer for basic reading
was started in an elementary school in East Palo Alto, California. The success of this initial program was reported by Atkinson and Hansen (6) and led to other research efforts. The University of Illinois began using the PLATO system in the early 1970's. Most programs which were developed during the early 1970's received limited funding and little local support (16). As a result, only a few really made an impact. Serlin (66) developed a program at an elementary school in Massachusetts. High school students helped first and second graders by programming comprehension and vocabulary questions from stories the children had previously read. The first and second graders were able to receive instructions and answer the questions on individual teleprinters. The Bell Telephone Laboratories in Red Bank, New Jersey sponsored a program called Operation Bootstrap in 1972. Blanchard (16) described the program as follows:

Students would read a passage and if they encountered a word they did not know they could dial a computer (stimulated by a Bell employee) giving a number code to represent the unknown word....Students would hear the word pronounced, spelled and used in context, if desired (p. 432).

One of the earliest and largest programs in computer-assisted instruction in reading was in the Chicago Public School System. In 1979, over 12,000 students received instruction daily on 850 terminals. Reading instruction
was used in grades two through six and emphasized decoding, study skills and literal and figurative comprehension (51).

The Houston, Texas area public schools operated the largest computer-assisted instructional program serving more than one school district. In the 103 districts served by this program, approximately 20,000 students received daily instruction in reading skills and comprehension in grades one through twelve and adult basic education (60).

Public schools in Dallas, Texas initiated bilingual reading programs to provide instruction in Spanish and English. They were used with first graders who were learning to read English (16).

A mean achievement again of 20% over a period of four years on the California Test of Basic Skills was reported by schools in Los Nietos, California (48). Students in grades three through six took part in the project. Teachers noticed that the students who had been the most difficult to handle were particularly attracted to this medium.

Bergeron and Geoffrion (13) reviewed the efforts at the University of New Hampshire to teach reading to handicapped children using CARIS (Computer Animated Reading Instruction). Children were taught vocabulary skills through the use of a light sensitive screen. Results showed significant gains for these children.
In a discussion of computer-assisted reading programs that were being provided by the University of Ohio to school districts in the area, Hirschbuhl (40) noted that districts were supporting the programs because they felt that computer-assisted instruction in reading could help develop basic reading skills. He stated that:

The outcome of this treatment seems to indicate that there is rather strong evidence that CAI has a desirable impact on basic reading skills achievement when measured by standardized tests (p. 6).

Blanchard (46) reported that through the use of satellite computer-assisted instruction, reading programs were being made available in Alaska. Through funding by the National Institute of Education and the state of Alaska, RCA launched the ALASCOM satellite. Thirty remote villages were hooked up to computers at the Northwest Regional Educational Laboratory in Portland, Oregon, and were to receive educational information and reading instruction.

Computer-assisted instructional programs in reading have become more and more commonplace in today's schools. While the computer will not replace the reading teacher, it can and "is supporting teachers in their attempts to deliver quality...individualized reading instruction" (16).

Achievement and Computer-Assisted Instruction

Teachers and researchers have tried to aggregate the results from the large volume of studies on computer-
assisted instruction conducted over the past ten years. The problems they have encountered include small populations, difficulty with hardware in terms of quality and reliability, lack of adequate training and poor quality software. All of these factors have made any comparisons of results difficult to validate.

Suppes and Morningstar (71) looked at computer-assisted instruction in Russian class. They found that students who were involved in the computer-assisted setting performed better than the best student in the non computer-assisted setting.

In 1970, Bitzer and Alpert (15) studied twenty students in a medical science class who were taught solely by computer-assisted instruction. Results showed that these students performed at least as well as the students in classes taught by traditional methods.

Lewellen (45) found that students in computer-assisted instructional settings outperformed students in traditional instructional settings on standardized tests.

In looking at students studying German, Allen (2) found that students who were involved in a program using computer-assisted instruction learned significantly more than students who were involved in a more traditional program of instruction.
Tsai and Pohl (74) studied the effectiveness of computer-assisted instruction as a separate instructional tool as well as in combination with traditional instruction. They did not observe differences in student performance on homework assignments or projects. However, they did find significant differences in final exam scores. Students who had been exposed to both types of instruction achieved higher scores than those students who had had only one type of instructional setting (either computer instruction only or traditional instruction only).

Vinsonhaler and Bass (76) conducted a meta-analysis on ten studies in the area of achievement and computer-assisted instruction in elementary school. They found that children who were in computer-assisted instructional programs showed performance gains of one to eight months over children who were in traditional instructional programs.

Edwards, Norton, Taylor, Weiss and Dusseldorp (25), in reviewing nine studies, found that computer-based education often produced better results than conventional teaching alone. However, when computers were used as a supplement to conventional teaching, results were always better for these groups.

After conducting a meta-analysis on twenty-five studies which involved computer-assisted instruction and achievement examination scores, Kulick, Kulick and Bangert-Drones (43) concluded that:
students from the CAI class received the better examination scores; in no study did students from the conventional class get better scores on a final examination in course content (p. 10).

They also reported that out of these twenty-five studies, twenty of them showed that the difference between computer-assisted instruction and traditional instruction was statistically significant in favor of the computer-assisted setting.

Many studies have shown that there is a positive relationship between use of the computer as an educational tool and student achievement. Because of the problems with early studies, researchers suggest that educators continue to look at this variable with large populations, reliable hardware and quality software.

I.Q. and Computer-Assisted Instruction

Sattler (65) stated that the correlation between a child's I.Q. test score and performance on other school tests or grades is about .60. While there are some students with high I.Q. scores who are low achievers and some students with low I.Q. scores who are high achievers, the majority of students who are low achievers are those students with lower I.Q. scores. For this reason literature on low-achieving students as well as students with high and low I.Q.'s will be covered in this review.
As early as 1964, studies were conducted to determine whether or not a "technological device" could be used to teach early reading. Martin (50) looked at early reading in the Freeport Public Schools using the Edison Responsive Environment Instrument. Twenty-two children were chosen from a kindergarten in Freeport and matched on age, sex, race, intelligence, left and right handedness, hearing, vision, language maturity and socioeconomic status. Students were exposed to the Edison Responsive Environment Instrument (E.R.E.) for 30 minute sessions over a five month period. Actual time at the E.R.E. ranged from 22 to 36 hours. Results showed that the kindergarten children and the mentally retarded children taught through the use of E.R.E. had greater gains in reading than did children taught by enriched conventional methods. Moreover, the scores of the slower children showed gains which were as significant as those of the more intelligent children. Martin concluded that had the experiment continued, greater differences between the control and the experimental group might have been noted. He suggested follow up studies be conducted to further clarify some of his findings.

In 1972, Molnar (54) reported that results of studies conducted by Bunderson showed that while lower-level students required more time on the computer than average and above average students, they eventually reached their
objectives more often than lower-level students who had not been exposed to computer-assisted instruction. A study by Tait, Hartley and Anderson (72) further validated this finding. In their study, students with lower initial levels of achievement scored the greatest gains on posttests.

Several studies were undertaken to look at computer-assisted instruction with Title I students (46, 49). Litman's (46) study of a computer-assisted instructional system in 21 elementary schools in Chicago showed that students achieved a gain of nearly one month for each month they were in the program. Prior to the introduction of a computer-assisted program of instruction, all students in the study had been achieving at at least one year below grade level. Lysiak (49), in studying students in grades three through seven in eight elementary and four middle schools, found that when given ten minutes of practice daily in a computer-assisted instructional setting students made at least a one month gain in achievement per month of instruction. Elementary school teachers indicated that they felt that computer-assisted instruction was beneficial to low-achieving students.

Caldwell and Rizza (19) studied a computer-based system of reading instruction for adults who were non-readers. The adults who participated in this program had
mastered skills at a level above the third grade but below the eighth grade. Results showed that the participants gained an average of one year after less than 12 hours of instruction. The authors felt that a computer-based basic skills program could be a significantly effective method for alternative instruction with low achievers.

A model designed for gifted students was developed by the Baldwyn Separate School District in Mississippi in 1981. Along with other innovative programs, seven gifted high school students were given direct instruction on the computer. Results showed no significant gain in California Achievement Test scores but there were notable gains on specific tests particularly computer programming.

In order to determine whether the impact of computer-assisted instruction was responsive to the learner's level of intelligence, Porinchak (59) investigated a reading program at the secondary school level. Sixty-five subjects were selected using the scores obtained on the Wechsler Intelligence Scale for Children--Revised. Reading scores were taken from their educational records and students were placed in average or below average groupings. Results showed that while computer-assisted instruction appeared to be equally effective for the average student, the below average student appeared to benefit more from the computer-assisted instructional setting. However, statistical significance could be not ascertained.
Fanning (27) sought to compare students in the fourth, fifth and sixth grades in terms of time on task and achievement. The 80 children included in the study were in a Title I program in a small school district in Pennsylvania. One of the questions that Fanning put forth was whether or not reading achievement correlated significantly with intelligence. The data showed that the null hypothesis could not be rejected.

A review of the studies regarding I.Q. and computer-assisted instructional programs reveals some interesting questions. Some studies suggest that low I.Q. or low-achieving students have greater gains in achievement in computer-assisted instructional settings than they do in traditional instruction settings (20, 28). Other studies suggest that while low I.Q. and low-achievers appear to make greater gains in a computer-assisted setting, high I.Q. and high-achieving students seem to show no appreciable difference in achievement. According to researchers, the relationship of I.Q. and reading achievement in a computer-assisted instructional setting continues to need exploration.

Ethnicity and Computer-assisted Instruction

While many studies have touched on the issue of ethnic differences and their impact on achievement in computer-assisted instructional settings, only a few have actually used ethnicity as the main focus of their research.
Atkinson and Suppes (8) studied a program in primary grade reading and arithmetic for culturally deprived children. The experimental population was approximately 80% Black. From 1966 to 1968 they received various combinations of computer-assisted instruction and traditional classroom instruction. The researchers found that students who were exposed to computer-assisted reading instruction scored significantly better on the California Achievement Test in Reading as well as on a test developed by the project.

Nabors (56) undertook a study to compare the academic achievement and problem-solving abilities of Black pupils in the intermediate grades who were in a traditional self-contained classroom with those who were in a computer-supported classroom. He found a significant difference in levels of achievement and problem-solving abilities in favor of those children in the computer-supported setting.

The Emergency School Aid Act funded its first program in the Los Nietos Elementary School District in California in 1977. Los Nietos had a high ratio of Spanish-speaking migrant children in its population. Students in grades three through six were exposed to elementary reading, math and language arts in a computer-assisted instructional setting. Results showed significant increases in achievement. Teachers noted some attitudinal changes as well. The children were very enthusiastic about working on the
computers and even those children who had been difficult to handle in the regular classroom appeared to be particularly attracted to this new instructional strategy (48).

Saracho (64) sought to look at the effects of computer-assisted instructional programs on the basic skills achievement and attitudes towards instruction with Spanish-speaking migrant children. In comparing two groups of children from the third through sixth grade, Saracho found that students in computer-assisted settings had significantly greater achievement gains.

Big Lake, Texas, was the site of a microcomputer pilot project undertaken in 1981. While the initial purpose of the pilot was to explore the use of the computer with slow learners, the project expanded to include 550 students in grades Kindergarten through 12 (all the students in the Big Lake system). Fifty-six percent of these students had Spanish surnames. Scores on the Science Research Associates (SRA) tests showed marked improvement in both math and reading. Difficulty in documenting time and limited hardware hampered the results (22).

Kester (42) looked at the issue of using computer-assisted instruction for basic skills at Los Angeles Community College. The population was comprised of 96% minority groups, the majority of which were from low-income families and most had low levels of academic achievement.
Results showed that students who used computer-assisted instruction to supplement regular instruction scored greater gains in reading than those who did not use computer-assisted instruction. While there was a significantly greater improvement in the reading skills of the computer-assisted group, they also had a greater rise of attrition. Kester suggested that additional studies be undertaken to investigate whether there might be some particular student characteristics that are tied to greater success in a computer-assisted instructional setting than others.

Ortmann (58) studied the effectiveness of a computer-assisted reading program on students in grades four through six. The California Test of Basic Skills was used to measure the achievement of the 340 students in her study. Results showed that after a year of supplementary computer-assisted instruction in reading, low achieving Hispanics made greater gains in reading than low achieving Anglos.

The question of the impact of ethnicity on achievement is still an issue. As early as 1970, Hess and Tenesakis (39) reported that the ability of the computer to "duplicate the task-related functions of the teacher...together with the child's attribution of charisma, expertise, and trustworthiness to CAI" (p. 98), provided a relationship between student and computer that in many essential ways parallels that of the student and the teacher. Because the student-
teacher relationship has as one of its variables—subjectivity, which is non-existent in the student-computer relationship, Hess and Tenezakis addressed this phenomenon as being a distinct advantage in using computer-assisted instruction with low-income, minority children and children with less than successful academic experiences who may feel that the teacher has prejudged them in some way. They have suggested that computer-assisted instruction may have particular value in teaching children who normally consider themselves as objects of prejudice or discrimination to have a more realistic view of themselves in the learning situation.

Gender, Reading Achievement and Computer-assisted Instruction

The impact of gender on reading achievement has been a topic of research for many years. Many studies have showed that girls have a decided advantage over boys in reading during the elementary years (33). The factors which account for this difference, however, are not so easily uncovered. Bentzen (12) felt that the difference in achievement was due to slower maturation on the part of males. Monroe (55) suggested that perhaps certain constitutional factors might be held accountable for the difference. Gallagher (32) gave heredity as a major cause. Sheridan (67) noted that girls tend to have a greater interest in verbal skills due to
their lack of interest in athletic or mechanical activities. Betts (14) concluded that girls seem to be promoted on a lower scale in terms of achievement than boys and that girls use reading as a recreational activity more often than boys. Societal expectations can be held accountable for differing achievement levels according to Smith and Dechant (68) and Bank, Biddle and Good (10).

It is generally accepted that girls will achieve at higher levels than boys in reading during the elementary years in a traditional instructional setting. The question of whether or not this is also true in other instructional settings (i.e. a computer-assisted instructional setting) is not quite so clear cut.

The issue of gender and its impact on achievement in a computer-assisted instructional setting was reported by Fletcher and Atkinson in 1972 (30). Their data suggested that while computer-assisted instruction is beneficial to both sexes, it appears to be relatively more effective for boys. Lockheed (47) cited computer-assisted instruction as an example of a task which tends to impact more favorably on males than females.

In looking at achievement with and without computer-assisted instruction, Merritt (52) explored the variables of self-concept, anxiety, attitude toward the teacher and attitude toward school. A determination of achievement
differences according to grade level and sex was also made. The 144 sixth and seventh graders were predominantly Black from rural, lower socioeconomic backgrounds. Results showed significantly higher gains for the experimental groups in achievement. The variables of self-concept, anxiety, attitude toward teacher and attitude toward school showed no differences for sixth grade girls, seventh grade girls or seventh grade boys. However, there were significant differences for sixth grade boys in favor of computer-assisted instruction on the same variables.

In looking at the effect of time on task for a Title I remedial program for the educationally disadvantaged, Fanning (27) collected data on a total of 80 students in the fourth, fifth and sixth grades. While he found no achievement differences with regard to time on task, he did find that boys did significantly better when receiving five periods of instruction than when receiving three periods of instruction.

Ortmann's study (58) on the effectiveness of computer-assisted instruction in reading with Chapter I pupils in grade four through six showed no significant differences in achievement with regard to gender.

The question of the influence of gender on achievement in a computer-assisted setting has yet to be definitively
answered. Studies indicate that further investigation of this variable is necessary.

Grade Level and Computer-assisted Instruction

After searching the existing literature on grade level and its impact on computer-assisted instruction, only a few studies were found that dealt with this issue. In a review of a computer-assisted instruction Title I project, Lavin and Sanders (44) were asked to determine whether the addition of a computer-assisted instructional program in reading and mathematics to a regular Elementary Secondary Education Act Title I program would provide students with greater gains in achievement than the Title I program alone. Results from a three year survey showed a significant gain in favor of the computer-assisted program. The authors also found that there was no interaction between the treatment and grade level although grade level was often a significant effect.

In comparing the achievement scores of sixth and seventh graders in a rural school district in Mississippi receiving computer-assisted instruction in reading with those who were not, Merritt (52) found that little difference on the variables of self-concept, anxiety, attitude toward school and attitude toward teacher could be found for sixth and seventh grade girls and seventh grade boys. The sixth grade boys, however, showed significant
differences in favor of computer-assisted instruction on the same variables. Merritt suggested that further study on these variables as well as I.Q. and parental attitudes be undertaken. He also felt that larger samples from different school systems and different socioeconomic backgrounds might help to clarify some of the questions raised in his study.

In order to determine the effectiveness of computer-assisted instruction in reading, Ortmann (58) looked at 340 third, fourth and fifth graders in the Manteca Unified School District in California. Using a non-randomized pretest/posttest design, she looked at the variables of grade level, sex and ethnicity. Results showed that neither sex nor ethnicity were reliable predictors of reading achievement. With regard to grade levels, students at all levels seemed to make comparable gains.

While it is thought that computer-assisted instruction in the elementary school has a positive impact on other student achievement (43), differences as to grade level, if there are differences, have yet to be ascertained.

Instructional Organization, Achievement and Computer-assisted Instruction

Instructional organization has been an issue for educators for a long time and much controversy still exists as to the best method for grouping students. Those who support homogeneity in ability grouping suggest that it
allows pupils to advance at their own rate along with others of comparable ability and achievement. Others say it challenges the pupil to do his best in an environment which provides some competition. Still others give it credence by saying that it allows the pupil more individual time with the teacher (57).

In contrast to these points of view, some educators feel that ability grouping is not advantageous. Test data may vary from one situation to another and the groupings may be too dependent on the validity of the data. Teachers may assume the pupils are all the same and forget that they have differences. Students may be stigmatized by being placed in a particular group. Furthermore, pupils of less ability may be able to profit from experiences with those who have greater ability (57).

During the 1970's little attention was focused on how the characteristics of students affect on processes or outcomes (35). Rosenbaum (62) hypothesized that perhaps the confusion of results with regard to grouping was due to a failure to control for instructional methods that were used or a difference in the instructional processes among the various groups in the studies. He also suggested that the "absence of any instructional guidelines for teaching different ability groups seems to affect teaching practices" (p. 370).
The effects of class composition in relationship to the mix of student aptitude in third and fourth grade classes were examined by Beckerman and Good (11). Results showed that classes which contained a larger percentage of high ability students were more advantageous for both the high and low ability students.

Evertson (26) compared average and low ability classes which were taught by the same teachers. He found that the classes with lower ability students seemed to have more off-task, inappropriate and disruptive behaviors. Teachers also seemed to be affected negatively in terms of the quality of their teaching when in classes where students were of lower ability.

Veldman and Sanford (75) studied class ability levels and found that better learning environments were associated with classes of higher mean ability. They also found that both high ability and low ability students achieved better in higher ability classes. Veldman and Sanford concluded that there are still many variables yet to be explored in validating the effectiveness of ability grouping.

Researchers suggest that the question of instructional organization and its contribution to achievement in a computer-assisted instructional setting be investigated. They feel that educators may gain further insights into the question of ability grouping.
Time-on-task and Achievement

During the 1970's, much of the research in education centered around the issue of time-on-task. The bulk of this research seemed to support the notion that the more time spent in a particular subject area, especially reading or math, the higher the achievement in that area (3, 5, 17, 21, 29, 63, 69).

Recently, the relationship of achievement and time spent in learning has been questioned (18, 31, 41). Some of the uncertainty as to the validity of the initial correlation has to do with the complexity of the time variable. Gettinger (34) stated that while "time spent on learning is an important determinant of achievement... results from studies...are inconsistent and...ambiguous in their implications" (p. 618). There are many different types of time that have an impact on achievement like exposure time, engaged time and teacher-directed time. Moreover, the methods used to measure time are often less than adequate. Observation appears to be the major tool used in determining the amount of time spent making it extremely subjective and difficult to document precisely. Some researchers feel that the inconsistencies are due to poor theoretical models. They feel that many investigators have omitted a "time-needed-for-learning factor"—that is, students may differ in the
amount of time they need to learn the material, and therefore the relationship between time and achievement may be intricately tied to this need (41). In studying time and its relationship to achievement, Frederick and Walberg (31) found that time can be considered only as a very modest predictor.

A review of the present literature leads one to believe that the issue of time and its relationship to achievement is still not fully resolved. Researchers suggest that further exploration is necessary.

Time in Computer-assisted Instruction and Achievement

The issue of time and achievement has always been and continues to be an intriguing topic for researchers. The introduction of computers into the instructional setting has added yet another dimension to this crucial issue.

In describing the studies of Bunderson, Molnar (54) stated that lower—level students need more time in a computer—assisted instructional setting than average or above—average students. Moreover, he concluded that computer—assisted instruction has a favorable impact on the ability of low level students to achieve their objectives. More of them reached their objectives in the computer—assisted setting than in the traditional setting. A similar finding was reported by Tait, Hartley and Anderson (72).
They found that students with low initial levels of achievement made the greatest pretest/posttest gains.

St. Aubin (70) sought to explore the use of computer-assisted instruction with the handicapped in a south suburban area of metropolitan Chicago. One hundred and ninety-eight students were selected for the project. Results showed that the computer-assisted programs in reading, math and language arts had a positive impact on the students' academic growth. St. Aubin suggested that there appears to be some correlation between student progress and on-line exposure. Further study was indicated.

An investigation into the relationship of time spent on computer-assisted instruction and reading improvement was conducted by Anelli (4) in New Jersey. Subjects were 121 third and fourth graders who received reading instruction on the computer for either 20 or 40 minute time periods. Achievement was measured by posttest scores on the Stanford Achievement Test and by changes in the grade levels on the computer-assisted instructional program. There were three treatment levels involving both boys and girls. Some students received less than four hours of exposure to computer-assisted sessions and others received four or more hours on the computer. Results showed that total time, length of computer-assisted sessions and frequency of computer-assisted sessions had no appreciable effect on
achievement. Anelli concluded that there was no support for the findings of other studies that computer-assisted instruction can be used to improve the performance of the disadvantaged nor could sex differences in achievement be minimized using this strategy.

Easterling (24) investigated the effects of computer-assisted instruction in reading and math as supplements to regular classroom instruction. Using a total of 66 fifth graders from a suburban school district in the Dallas-Fort Worth area, Easterling found that students using the SRA Computer Drill and Instruction series in reading and math for 15 minutes twice a week over a period of 16 weeks did not make a significant improvement on the California Achievement Test. She suggested that a larger sample be considered giving students more time in the computer-assisted instructional setting.

In evaluating the differences in achievement for Title I students involved in a program of computer-assisted instruction in reading in Pennsylvania for three periods per week as opposed to those in the five periods per week group, Fanning (27) found that most differences could not be attributed to time. The only hypothesis that appeared to have significant value was one that related to sex differences in achievement. He found that boys in the group that received computer-assisted instruction five times per
week did significantly better than those who received the instruction three times per week.

Kulik, Kulik and Bangert-Downs (43) conducted a meta-analysis of 29 studies on computer-based education. Their findings on time revealed that computer-assisted instruction had a positive effect on achievement at the elementary school level.

In a typical application, students received approximately 26 hours of CAI—15 minutes per day, for 4 days a week, and for a total of 26 weeks. The effect of this instruction was to raise students achievement...from the 50th to the 68th percentile (43).

Investigations concerning time on the computer have failed to produce any definitive data regarding the parameters necessary for success using this educational strategy. Researchers have suggested that more studies be conducted in order to qualify and quantify this important variable.

Summary

After reviewing the literature on computer-assisted instruction it is obvious there are still many questions which remain to be answered. As Willis (79) so aptly stated:

In this period of rapid development, we are bound to make mistakes, and schools systems are bound to waste money and resources. We simply do not know enough to answer all the questions related to how computers should be used in schools, what subjects they make the most contributions to, and the cognitive skills they help to develop (p. 8).


27. Fanning, J. M. An analysis and comparison of the results of 'time on task' of a title I remedial reading project for students receiving five periods of instruction a week vs. a group of students receiving three periods of instruction a week. (Doctoral Dissertation, Temple University, 1983). Dissertation Abstracts International, 44/04-A, 1332, University Microfilms (Order No. AAD83-21258).


35. Good, T. L. Classroom research: what we know and what we need to know. Austin, Texas: Research and Development Center for Teacher Education, The University of Texas at Austin, 1982.


52. Merritt, R. L. Achievement with and without computer-assisted instruction in the middle school. (Doctoral Dissertation, University of Southern Mississippi, 1982). Dissertation Abstracts International, 44/01A, 34), University Microfilms (Order No. AAD83-11071).


58. Ortmann, L. N. The effectiveness of supplementary computer-assisted instruction in reading at the 4-6 grade level (four-six). (Doctoral Dissertation, University of the Pacific, 1983), Dissertation Abstracts International, 45/01-A, 140, University Microfilms (Order No. AAD84-10506).


CHAPTER III

PROCEDURES

Research Design

This study was designed to look at the relationship of the variables of I.Q., gender, ethnicity, instructional organization, total instructional time, classroom instructional time and time on the computer to reading achievement in a combined classroom and computer-assisted instructional setting in grades three and five. The experimental design chosen for this study was the One-Group Pretest-Posttest design. Borg and Gall (1) recommend that this type of design be used when it is impossible to obtain a control group as was the case in this study. The pretest and posttest used to measure achievement was the Iowa Test of Basic Skills subset in reading comprehension given in October of 1984 and late April of 1985. Borg and Gall (1) cite some major problems with using change scores to measure achievement gain. Change scores which are calculated by merely subtracting the pretest score from the posttest score do not allow for the fact that:

1. the range of difficulty of the test items may be very great,
2. there may be regression toward the mean,
3. all points of the test are not at equal levels,
4. a given score may reflect different levels of ability for different students, and
5. the higher the correlation between the pretest and posttest scores, the lower the reliability of the change (gain) score.

Taking these problems into account, the actual change in score was determined by using the pretest score as a covariate for the posttest score. The residual scores (those parts of the posttest scores that could not be accounted for by the pretest scores) were then used to calculate the change in achievement.

Borg and Gall (1) also state that the major limitation to this type of study is the assumption that the changes on the dependent variable are not due to extraneous factors. In order to reduce the likelihood of the extraneous variables altering the posttest results they suggest that the time between the pretest and posttest be kept to a minimum and that the independent variables be relatively stable (not likely to change unless direct action is taken by the experimenter). The independent variables of gender, ethnicity, instructional organization, time on the computer, classroom instruction time, total instructional time and I.Q. considered in this study were reasonably stable.
Campbell and Stanley (3) also see some limitations to this type of design. Several threats to internal validity were cited including history, maturation, testing and instrumentation. Due to the absence of a control group, history and maturation could not be eliminated as threats to validity. Since there was a seven month gap between the administration of the first test and the administration of the second test, there was some control on test-retest contamination. The classroom teacher was responsible for the administration of the tests in both the fall and the spring and the identical test was given each time as well. This served to control for threats to internal validity with regard to instrumentation.

The use of stratified random sampling and identical pretest and posttest minimized threats to external validity. According to Ferguson (5), "... the general purpose of randomization is to protect the validity of the experiment by controlling the biasing influence of extraneous variables" (p. 225). Multiple regression was used to analyze the data in order to determine the relationship of the variables to achievement, the unique contribution of each variable to achievement when the other variables were held constant and the interactions of any of the variables with one another if significance was found. Multiple regression allows the researcher to measure the magnitude of the whole
relationship of a variable to the dependent variable as well as the ability to measure the partial or unique relationship of that variable over and above that of other variables involved with the dependent variable (4). Cohen and Cohen (4) stated:

Multiple regression/correlation analysis (MRC) is a highly general and therefore very flexible data-analytic system that may be used whenever a quantitative variable (the dependent variable) is to be studied as a function of, or in relationship to, any factors of interest (expressed as independent variables). The sweep of this statement is quite intentional:

1. The form of the relationship is not constrained; it may be simple or complex, for example, straight line or curvilinear, general or conditional, or combinations of these possibilities.

2. The nature of the research factors expressed as independent variables is also not constrained; they may be quantitative or qualitative, main effects or interaction in the analysis of variance sense, or covariates as in the analysis of covariance. They may be characterized by missing data. They may be correlated with each other, or uncorrelated... They may be naturally occurring ("organismic") properties like sex or diagnosis or I.Q., or they may be consequences of planned experimental manipulation ("treatments"). They may be single variables or groups of variables. In short, virtually any information whose bearing on the dependent variable is of interest may be expressed as research factors (p. 3).

Description of the Computer-assisted Instructional Setting

The computer-assisted instructional setting in reading comprehension involved the students' participation in a program designed by WICAT Systems, Incorporated. The instructional approach in reading for the primary grades:
... requires the learner to deeply process information by generalizing from examples instead of by learning through straight drill .... The emphasis of the curriculum is on developmental reading skills.... Lessons are composed of several activities that are interleaved with one another. Complete, interactive instructions are available through one keystroke.... Mastery is determined by the learner's performance on successive exercises.... Words and patterns are retested and reviewed in many lessons, not just learned and tested from within one lesson (7).

The reading curriculum for grades 4 - 8 addresses thinking skills which are:

... fundamental to reading comprehension.... The curriculum is designed to improve students' ability to think both abstractly and concretely, to deal in fact and opinion, and to master non-literal and literal concepts.... The curriculum features automatic pacing of students according to performance, individualized reading levels, according to protocol [Deletion, Inference, Graphic Interpretation and Argumentation], and individualized feedback for each student response (8).

Each participating school contained a computer laboratory with 30 terminals connected to a mainframe located in the building.

In the summer of 1984 teachers, administrators and other staff were given a general overview of the system. During the following months, additional in-service was given for each piece of curriculum presented. Math was introduced first in late September. Reading was introduced in early November.
Prior to entry into the computer-assisted environment students were given 100 minutes of computer lab orientation over a 10 day period. Included in this orientation was an introduction to the keyboard, the specific keystrokes required to manipulate the WICAT hardware and software, laboratory procedures and an on-site visit to the laboratory.

During the students' time on the computer, either 30 minutes per week, 40 minutes per week, 50 minutes per week or 60 minutes per week depending on the particular school, the classroom teacher and the systems manager (the para-professional who handles the technical interface between the hardware and the instructional presentation) were always in attendance. Students had their own terminal for the entire period in the laboratory. Student time on the computer was recorded when students logged on and logged off. The program in reading instruction was implemented gradually during the month of December, 1984.

Population

Students considered for inclusion in this study were from the third and fifth grades in a suburban school district in the Dallas/Fort Worth area. All students selected had participated in the WICAT computer-assisted instructional program in reading and had completed the fall administration of the Cognitive Abilities Test and the
Iowa Test of Basic Skills and the spring administration of the Iowa Test of Basic Skills. All students who satisfied these criteria were placed in the sample pool. From the total sample pool of approximately 4,200 students, 2,000 students were randomly selected, stratified on the basis of grade level, gender and instructional organization. Due to incomplete data and the need to keep the instructional settings proportional to those in the district, the final sample included 500 girls and 500 boys from the third grade and 463 girls and 463 boys from the fifth grade.

Instrumentation

The Cognitive Abilities Test, grade 3 - 12, multilevel edition, verbal subtest which includes vocabulary, sentence completion, verbal classification and verbal analogies was used to measure student I.Q. This test is very similar in form to other measures of verbal ability or scholastic ability. Raw scores from the Cognitive Abilities Test are changed into universal scales which are normalized with a mean of 100 and a standard deviation of 16 and can be equated with I.Q. (2). The reliability of the raw scores as measured by the K-R 20 is very high (.87 - .96) (2).

The Iowa Test of Basic Skills, Primary Battery, Grades 3 - 9, subset reading comprehension was given in order to determine student achievement level in reading. The same
form of the test was administered for both pretest and posttest scores in order to insure test/re-test reliability. The repeated measures effect was held to a minimum due to the seven months intervening between the tests.

The test is organized to provide one continuous test in each area for all grades. This allows children in a specific grade to start and stop at different levels. The reliability coefficients range from .84 to .96 for the major tests and from .70 to .93 for the subtests. The composite reliabilities for the whole test are also high, ranging from .97 to .98 for differing grades. The ITBS is thought to be an excellent means for measuring basic skills (2).

Procedures for Collection of Data

Permission to include approximately 4,200 students who completed the instruments and took part in the WICAT program (2,100 from the third grade and 2,100 from the fifth grade) was obtained from the school district. The measurement instruments were administered by the teachers in the classroom. Make-up tests for those students absent during the initial administration were given by the school guidance counselors. The Cognitive Abilities Test was given routinely in October along with the Iowa Test of Basic Skills. The second administration of the Iowa Test of Basic Skills was given in the Spring of 1985.
Individual student total instructional time in reading figures were determined by summing the scheduled classroom instruction time in reading and the time on the computer in reading. Classroom time was based on the master schedule of each school as verified by the individual classroom teacher. Time on the computer statistics were maintained by the host computer when the students logged on and off. School district records were used to determine the instructional organization for each class.

Procedures for Analysis of Data

After the second administration of the Iowa Test of Basic Skills in the spring of 1985, the data were analyzed by computer using multiple regression. Through the use of full and restricted models, the researcher determined the unique contribution of the variables of I.Q., total instructional time, classroom instructional time, time on the computer, gender, ethnicity and instructional organization in grades three and five to gain in reading achievement in a combined classroom and computer-assisted instructional setting. The unique contribution that each variable made to predictability over and above the other independent variables was determined through a comparison of the full model with each restricted model. The statistical models were constructed as follows:
FULL MODEL: Achievement gain is a function of gender, ethnicity, I.Q., total instructional time (classroom instructional time and time on the computer combined) and instructional organization.

\[ \hat{Y} = a_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 \] (7, p.69)

where, \( \hat{Y} \) was equal to achievement gain;

\( a \) was equal to the intercept;

\( b \) was the regression coefficient applied to the independent variable; and

\( X \) was the independent variable.

RESTRICTED MODELS:

1. Achievement gain is a function of gender, ethnicity, I.Q., classroom instructional time and time on the computer. In this instance \( R^2 \) was obtained excluding instructional organization.

2. Achievement gain is a function of gender, ethnicity, I.Q., classroom instructional time and instructional organization. In this instance \( R^2 \) was obtained excluding time on the computer.

3. Achievement gain is a function of gender, ethnicity, I.Q. and instructional organization. In this instance an \( R^2 \) was obtained excluding total instructional time which would be the combination of classroom instructional time and time on the computer.

4. Achievement gain is a function of gender, ethnicity, classroom instructional time, time on the computer, and instructional organization. In this instance an \( R^2 \) was obtained excluding I.Q.
5. Achievement gain is a function of gender, time on the computer, classroom instructional time, I.Q., and instructional organization. In this instance an $R^2$ was obtained excluding ethnicity.

6. Achievement gain is a function of ethnicity, time on the computer, classroom instructional time, I.Q. and instructional organization. In this instance an $R^2$ was obtained excluding gender.

7. Achievement gain is a function of ethnicity, time on the computer, I.Q., gender and instructional organization. In this instance an $R^2$ was obtained excluding classroom instructional time.

By comparing each restricted model with the full model using the formula:

$$F = \frac{(R^2_y \cdot 12 \ldots k_1 - R^2_y \cdot 12 \ldots k_2) / (k_1 - k_2)}{(1 - R^2_y \cdot 12 \ldots k_1) / (N - k_1 - 1)}$$

(5, p. 97)

where $R^2_y \cdot 12 \ldots k_1$ was equal to the full model;

$R^2_y \cdot 12 \ldots k_2$ was equal to the restricted model;

$k_1$ was equal to the degree of freedom for the full model;

$k_2$ was equal to the degrees of freedom for the restricted model; and

$N$ was equal to the number in the population,

the unique contribution of each variable was determined.

When all computations were completed, the resulting data were entered into tables in order to simplify reporting and interpretation.


CHAPTER IV

RESULTS OF THE STUDY

The purpose of this study was to explore the variables of I.Q., gender, classroom instructional time, time on the computer, total instructional time, ethnicity and instructional organization in grades three and five in a computer-assisted instructional setting in reading in order to determine which of these variables or combination of variables appeared to be most influential in predicting achievement. The data collected for this statistical analysis included: (1) demographic information on each student regarding sex, ethnicity, grade level, and instructional organization of the reading classroom, (2) student achievement scores on the reading comprehension subtest of the Iowa Test of Basic Skills for the fall and spring of the 1984 - 1985 school year, (3) student scores on the Cognitive Abilities Test for the fall of the 1984 - 1985 school year, (4) individual computer time data recorded when the students logged on and off the computer, and (5) classroom time in reading reported by the individual classroom teacher. A discussion of the results follows.
Demographic Information

Of the 30 schools included in the study, four were eliminated prior to statistical analyses due to a lack of complete information regarding time. Using stratified random sampling, two thousand students were selected from the original population of 4,200 on the basis of grade level and gender. Due to attrition and the need to keep the instructional settings proportional to those in the district, the final sample consisted of 1,000 students from the third grade and 926 from the fifth grade. The specific data for grade three are contained in Table I.

<table>
<thead>
<tr>
<th>Non-Contained</th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>203</td>
<td>203</td>
<td>406</td>
</tr>
<tr>
<td>Contained</td>
<td>297</td>
<td>297</td>
<td>594</td>
</tr>
<tr>
<td>Total</td>
<td>500</td>
<td>500</td>
<td>1,000</td>
</tr>
</tbody>
</table>

The specific data for grade five are contained in Table II.
TABLE II
GRADE FIVE POPULATION BREAKDOWN

<table>
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<tr>
<th></th>
<th>Boys</th>
<th>Girls</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Contained</td>
<td>273</td>
<td>273</td>
<td>546</td>
</tr>
<tr>
<td>Contained</td>
<td>190</td>
<td>190</td>
<td>380</td>
</tr>
<tr>
<td>Total</td>
<td>463</td>
<td>463</td>
<td>926</td>
</tr>
</tbody>
</table>

The ethnic background of the students was similar to that of the general school population. Specific data are detailed in Table III.

TABLE III
ETHNICITY BREAKDOWN - TOTAL POPULATION

<table>
<thead>
<tr>
<th>Ethnic Origin</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Indian</td>
<td>11</td>
<td>.6</td>
</tr>
<tr>
<td>Oriental</td>
<td>89</td>
<td>4.6</td>
</tr>
<tr>
<td>Hispanic</td>
<td>201</td>
<td>10.4</td>
</tr>
<tr>
<td>Black</td>
<td>121</td>
<td>6.3</td>
</tr>
<tr>
<td>Other (including Caucasians)</td>
<td>1,504</td>
<td>78.1</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>1,926</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>
Achievement Scores

The reading comprehension scores from the Iowa Test of Basic Skills were obtained from each student's record for both the fall and the spring administration. The Iowa Test of Basic Skills reports three types of norms: grade equivalents, age equivalents and standard scores. Grade equivalents were used for this study. The school year is divided into ten month segments and scores should be interpreted accordingly (i.e. a score of 3.23 translates as approximately third grade, second month).

The gain scores were calculated using the fall scores as covariates for the spring scores in order to compensate for those parts of the spring scores which could be accounted for by the fall scores. The residual scores were equated with achievement gain and the mean score for achievement gain became zero. After the differences between the residual scores and zero were calculated, significance was determined through an analysis of variance.

Cognitive Abilities Test

Student scores from the Cognitive Abilities Test were also obtained from individual student records. An analysis of the third grade showed a mean score of 100.6 with a standard deviation of 13.4. Fifth grade analysis revealed a mean score of 102.7 with a standard deviation of 14.2.
Time Data

The classroom reading time was identified by the individual classroom teacher. The time on the computer was measured by subtracting the time the student logged on from the time the student logged off. Total time was computed by adding the classroom time and the computer time. Results for both grade three and grade five can be seen in Table IV.

TABLE IV
TIME DATA FOR GRADE THREE AND GRADE FIVE IN MINUTES

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Time Label</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum Time</th>
<th>Maximum Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Classroom</td>
<td>11,188.935</td>
<td>2,467.677</td>
<td>6,800.00</td>
<td>20,400.00</td>
</tr>
<tr>
<td></td>
<td>Computer</td>
<td>649.912</td>
<td>238.978</td>
<td>9.00</td>
<td>2,253.00</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>11,838.847</td>
<td>2,436.132</td>
<td>7,343.00</td>
<td>20,822.00</td>
</tr>
<tr>
<td>5</td>
<td>Classroom</td>
<td>9,774.395</td>
<td>1,220.070</td>
<td>6,800.00</td>
<td>15,300.00</td>
</tr>
<tr>
<td></td>
<td>Computer</td>
<td>524.276</td>
<td>171.666</td>
<td>15.00</td>
<td>1,289.00</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>10,928.672</td>
<td>1,218.167</td>
<td>7,403.00</td>
<td>17,797.00</td>
</tr>
</tbody>
</table>

Statistical Analysis

The Statistical Package for Social Sciences was used to analyze the data. The data for each grade level were entered separately. If significance was found when the full model was compared with the restricted model for each of the
variables, further analysis was conducted. A listing of the interactions can be found in Table V.

TABLE V

VARIABLE INTERACTION CATEGORIES FOR GRADES THREE AND FIVE

<table>
<thead>
<tr>
<th>Total Time and I.Q.</th>
<th>Organization and Computer Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Time and Organization</td>
<td>Organization and Reading Time</td>
</tr>
<tr>
<td>Total Time and Ethnicity</td>
<td>Organization and Ethnicity</td>
</tr>
<tr>
<td>Total Time and Grade Level</td>
<td>Organization and Grade Level</td>
</tr>
<tr>
<td>Gender and I.Q.</td>
<td>Computer Time and Ethnicity</td>
</tr>
<tr>
<td>Gender and Computer Time</td>
<td>Computer Time and Grade Level</td>
</tr>
<tr>
<td>Gender and Reading Time</td>
<td>Reading Time and Ethnicity</td>
</tr>
<tr>
<td>Gender and Ethnicity</td>
<td>Reading Time and Grade Level</td>
</tr>
<tr>
<td>Gender and Grade Level</td>
<td>Grade Level and Ethnicity</td>
</tr>
<tr>
<td>I.Q. and Organization</td>
<td>I.Q. and Reading Time</td>
</tr>
<tr>
<td>I.Q. and Computer Time</td>
<td>I.Q. and Ethnicity</td>
</tr>
<tr>
<td>I.Q. and Grade Level</td>
<td></td>
</tr>
</tbody>
</table>

The full model stated that achievement gain is a function of gender, ethnicity, I.Q., total instructional time (classroom instructional time and time on the computer)
and instructional organization. The results of the analysis of the data regarding this statement are revealed in Tables VI, VII, VIII, and IX.

Tables VI and VII reveal that gender, instructional organization, computer time, classroom reading time and total instructional time made no significant unique contribution to the predictability of achievement gain in grade three. However, both I.Q. and ethnicity made a significant unique contribution to predictability at less than the .01 level. It is important to note that the adjusted R square which gives the percentage of the variance that can be accounted for by all the variables entered was .56. This would leave approximately 44 percent of the variance still unaccounted for in grade three.
TABLE VI

CONTRIBUTION OF VARIABLES TO ACHIEVEMENT GAIN IN GRADE THREE USING CLASSROOM TIME AND COMPUTER TIME

<table>
<thead>
<tr>
<th>Variable</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>F</th>
<th>Sig. F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.Q.</td>
<td>1</td>
<td>39.55620</td>
<td>68.99403</td>
<td>.0001***</td>
</tr>
<tr>
<td>Gender</td>
<td>1</td>
<td>.58142</td>
<td>1.01411</td>
<td>.3142</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>4</td>
<td>9.60689</td>
<td>2.09854</td>
<td>.0023**</td>
</tr>
<tr>
<td>Computer</td>
<td>1</td>
<td>.73886</td>
<td>1.28871</td>
<td>.2566</td>
</tr>
<tr>
<td>Time*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom</td>
<td>1</td>
<td>.02772</td>
<td>.04835</td>
<td>.8260</td>
</tr>
<tr>
<td>Time*</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instruct.</td>
<td>1</td>
<td>1.20315</td>
<td>2.09854</td>
<td>.1478</td>
</tr>
<tr>
<td>Organ.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R Square          .56

Adjusted R Square .56 Significant F Change .0001***

* Total time is a combination of these variables.
** P < .01
*** P < .001
TABLE VII

CONTRIBUTION OF VARIABLES TO ACHIEVEMENT GAIN IN GRADE THREE USING TOTAL INSTRUCTIONAL TIME

<table>
<thead>
<tr>
<th>Variable</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>F</th>
<th>Sig. F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.Q.</td>
<td>1</td>
<td>39.92334</td>
<td>69.61562</td>
<td>.0001*</td>
</tr>
<tr>
<td>Gender</td>
<td>1</td>
<td>.61253</td>
<td>1.06810</td>
<td>.3016</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>4</td>
<td>9.44735</td>
<td>4.11841</td>
<td>.0026**</td>
</tr>
<tr>
<td>Total Time***</td>
<td>1</td>
<td>.01264</td>
<td>.02204</td>
<td>.8820</td>
</tr>
<tr>
<td>Instruct. Organ.</td>
<td>1</td>
<td>1.00387</td>
<td>1.75049</td>
<td>.1861</td>
</tr>
</tbody>
</table>

R Square .56

Adjusted R Square .56 Significant F Change .0001*

* P < .001
** P < .05
*** Represents a combination of classroom and computer time in reading instruction.

A review of the data for grade five can be found in Tables VIII and IX. This data revealed that instructional organization, ethnicity, computer time, classroom time and total time made no significant contribution to the predictability of achievement gain in grade five. However, gender and I.Q. did make a significant contribution to
predicting achievement gain. The adjusted R square was .65
which would suggest that only 35 percent of the variance in
achievement gain in grade five is still unaccounted for.

TABLE VIII
CONTRIBUTION OF VARIABLES TO ACHIEVEMENT GAIN IN GRADE
FIVE USING CLASSROOM TIME AND COMPUTER TIME

<table>
<thead>
<tr>
<th>Variable</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>F</th>
<th>Sig. F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.Q.</td>
<td>1</td>
<td>52.38798</td>
<td>71.14450</td>
<td>.0001*</td>
</tr>
<tr>
<td>Gender</td>
<td>1</td>
<td>3.01933</td>
<td>4.40035</td>
<td>.0432**</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>4</td>
<td>6.09961</td>
<td>2.07086</td>
<td>.0827</td>
</tr>
<tr>
<td>Computer Time***</td>
<td>1</td>
<td>.64311</td>
<td>.87336</td>
<td>.3503</td>
</tr>
<tr>
<td>Classroom Time***</td>
<td>1</td>
<td>.16970</td>
<td>.23045</td>
<td>.6313</td>
</tr>
<tr>
<td>Instruct. Organ.</td>
<td>1</td>
<td>.27970</td>
<td>.37984</td>
<td>.5378</td>
</tr>
</tbody>
</table>

R Square .65
Adjusted R Square .65
Significant F Change .0001*

* P < .001
** P < .05
*** Total time is a combination of these variables.
TABLE IX
CONTRIBUTION OF VARIABLES TO ACHIEVEMENT GAIN
IN GRADE FIVE USING TOTAL TIME

<table>
<thead>
<tr>
<th>Variable</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>F</th>
<th>Sig. F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.Q.</td>
<td>1</td>
<td>53.01974</td>
<td>72.02110</td>
<td>.0001*</td>
</tr>
<tr>
<td>Gender</td>
<td>1</td>
<td>2.81390</td>
<td>3.82235</td>
<td>.0509**</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>4</td>
<td>6.07768</td>
<td>2.06395</td>
<td>.0836</td>
</tr>
<tr>
<td>Total Time***</td>
<td>1</td>
<td>.18391</td>
<td>.24982</td>
<td>.6173</td>
</tr>
<tr>
<td>Instruct. Organ.</td>
<td>1</td>
<td>.15132</td>
<td>.20555</td>
<td>.6504</td>
</tr>
</tbody>
</table>

R Square .65
Adjusted R Square .65 Significant F Change .0001*

* P < .001
** P = .05
*** Represents a combination of computer and classroom time.

When the interactions listed in Table V were entered into the full model using classroom time and computer time in grade three, classroom time and computer time became significant at less than .01 levels. The interactions of computer time with classroom time and computer time with ethnicity were significant at the less than .01 levels. The results of this analysis can be seen in Table X.
TABLE X
FULL MODEL WITH INTERACTIONS USING COMPUTER TIME AND CLASSROOM TIME - GRADE THREE

<table>
<thead>
<tr>
<th>Variable</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom Time</td>
<td>9.034</td>
<td>.0027*</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>4.189</td>
<td>.0023*</td>
</tr>
<tr>
<td>Gender</td>
<td>.489</td>
<td>.4845</td>
</tr>
<tr>
<td>Computer Time</td>
<td>8.974</td>
<td>.0028*</td>
</tr>
<tr>
<td>I.Q.</td>
<td>66.516</td>
<td>.0001**</td>
</tr>
<tr>
<td>Instructional Organization</td>
<td>3.130</td>
<td>.0772</td>
</tr>
<tr>
<td>Classroom Time and Computer Time</td>
<td>11.695</td>
<td>.0007**</td>
</tr>
<tr>
<td>Computer Time and I.Q.</td>
<td>7.107</td>
<td>.0078*</td>
</tr>
</tbody>
</table>

* P < .01  
** P < .001

When the interactions were entered into the full model for grade three using total instructional time, there were no changes in significance for the variables nor did any of the interactions show significance.

When the interactions were entered into the full model for grade five using computer time and classroom time, I.Q.
and gender remained significant but computer time became significant at less than .05 level. Moreover, the interactions of I.Q. and instructional organization, I.Q. and computer time and computer time and ethnicity became significant at less than .05 levels as well. The results of this analysis can be seen in Table XI.

TABLE XI
ANALYSIS OF THE FULL MODEL WITH INTERACTIONS USING COMPUTER TIME AND CLASSROOM TIME - GRADE FIVE

<table>
<thead>
<tr>
<th>Variable</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Time</td>
<td>5.268</td>
<td>.0219*</td>
</tr>
<tr>
<td>Gender</td>
<td>4.268</td>
<td>.0391*</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>2.071</td>
<td>.0827</td>
</tr>
<tr>
<td>Classroom Time</td>
<td>.180</td>
<td>.6719</td>
</tr>
<tr>
<td>Instructional Organization</td>
<td>4.057</td>
<td>.0443*</td>
</tr>
<tr>
<td>I.Q.</td>
<td>5.629</td>
<td>.0179*</td>
</tr>
<tr>
<td>I.Q. and Computer Time</td>
<td>4.232</td>
<td>.0400*</td>
</tr>
<tr>
<td>I.Q. and Instructional Organization</td>
<td>4.408</td>
<td>.0360*</td>
</tr>
<tr>
<td>Computer Time and Ethnicity</td>
<td>4.499</td>
<td>.0342*</td>
</tr>
</tbody>
</table>

* P < .05
When the interactions were entered into the full model for grade five using total time, I.Q. and gender lost their significance. Instructional organization and the interaction of I.Q. and instructional organization became significant at less than the .05 level. The results of this analysis can be seen in Table XIII.

**TABLE XII**

ANALYSIS OF FULL MODEL WITH INTERACTIONS USING TOTAL TIME - GRADE FIVE

<table>
<thead>
<tr>
<th>Variable</th>
<th>F</th>
<th>Significance of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>3.537</td>
<td>.0603</td>
</tr>
<tr>
<td>Total Time</td>
<td>.130</td>
<td>.7188</td>
</tr>
<tr>
<td>Ethnicity</td>
<td>2.064</td>
<td>.0836</td>
</tr>
<tr>
<td>Instructional Organization</td>
<td>5.892</td>
<td>.0154*</td>
</tr>
<tr>
<td>I.Q.</td>
<td>2.455</td>
<td>.1175</td>
</tr>
<tr>
<td>I.Q. and Organization</td>
<td>6.330</td>
<td>.0120*</td>
</tr>
</tbody>
</table>

* P < .05
When a shift in the significance of some of the research variables was observed and significance was found for some of the interactions further analysis was undertaken.

High, average and low parameters for all continuous variables (I.Q., total time, classroom reading time, computer time, fall score and spring score) were established using the following formulas.

- **High** = \((\text{mean} + 1 \text{ standard deviation})\) to highest score
- **Average** = \((\text{mean} - 1 \text{ standard deviation})\) to the \((\text{mean} + 1 \text{ standard deviation})\)
- **Low** = Low to the \((\text{mean} - 1 \text{ standard deviation})\) with the lower limit being inclusive

In order to test the significance of the differences between the means, multivariate analysis of variance (MANOVA) was used. Because of the nature of the SPSSX statistical package, the combined adjusted means for the achievement scores were used rather than the residual (gain) scores. Statistically they can be equated. The analysis of covariance controlled for the initial differences in the student scores which might have been present and the adjusted scores were used for the analyses. MANOVA was chosen because it allows for the specification of the models to be tested. The dependent variable was the spring score on the ITBS and the covariate was the fall score on the ITBS. The analysis of covariance adjusted the spring score means.
on the basis of the fall score means and compared these adjusted spring score means to see if they were significantly different from one another. The adjusted scores are in grade level equivalents and a score of 4.37 should be interpreted as approximately fourth grade, fourth month.

In order to simplify interpretation, the following data is presented by grade level.

Grade Three

Achievement was grouped by high, average and low I.Q. levels using the formulas described. The adjusted scores of third graders when grouped by I.Q. levels revealed that achievement levels increased as I.Q. levels increased. Multivariate analysis of variance showed the differences between the means to be significant at less than a .01 level. The data are described in Tables XIII and XIV.

### TABLE XIII

<table>
<thead>
<tr>
<th>Level</th>
<th>Mean</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>4.19</td>
<td>164</td>
</tr>
<tr>
<td>Average</td>
<td>4.58</td>
<td>666</td>
</tr>
<tr>
<td>High</td>
<td>4.90</td>
<td>170</td>
</tr>
</tbody>
</table>
Achievement was also grouped by ethnic categories. The highest scores were achieved by those in the American Indian category. Scores for those in the Other, Oriental, Black and Hispanic categories followed in descending order. A test for the differences between the means showed significance at less than a .01 level. These data are found in Tables XV and XVI.
### TABLE XV

**ADJUSTED ACHIEVEMENT SCORES BY ETHNIC GROUPS - THIRD GRADE**

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Mean</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Indian</td>
<td>5.42</td>
<td>6</td>
</tr>
<tr>
<td>Oriental</td>
<td>4.15</td>
<td>44</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4.03</td>
<td>110</td>
</tr>
<tr>
<td>Black</td>
<td>4.11</td>
<td>55</td>
</tr>
<tr>
<td>Other</td>
<td>4.70</td>
<td>785</td>
</tr>
</tbody>
</table>

### TABLE XVI

**TEST OF SIGNIFICANCE FOR DIFFERENCES BETWEEN THE ADJUSTED MEANS OF ACHIEVEMENT SCORES FOR ETHNIC CATEGORIES - GRADE THREE**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within cells</td>
<td>610.75</td>
<td>994</td>
<td>.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ethnicity</td>
<td>14.92</td>
<td>4</td>
<td>3.55</td>
<td>5.77</td>
<td>.001*</td>
</tr>
</tbody>
</table>

* P < .001
Since classroom instructional time, computer time and the interaction of classroom time and computer time became significant when entered into the full model, each of these was explored further. The data revealed that the greatest achievement occurred when classroom instructional time was highest and the least achievement when classroom time was average. The differences between the means for levels of classroom instructional time were found to be significant at less than the .05 level. This data can be found in Tables XVII, XVIII, XIX, and XX.

**TABLE XVII**

*ADJUSTED ACHIEVEMENT SCORES AND CLASSROOM INSTRUCTIONAL TIME — THIRD GRADE*

<table>
<thead>
<tr>
<th>Classroom Time</th>
<th>Mean</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>4.67</td>
<td>140</td>
</tr>
<tr>
<td>Average</td>
<td>4.52</td>
<td>762</td>
</tr>
<tr>
<td>High</td>
<td>4.82</td>
<td>98</td>
</tr>
</tbody>
</table>
TABLE XVIII

TEST SIGNIFICANCE OF DIFFERENCES BETWEEN THE ADJUSTED MEANS OF ACHIEVEMENT SCORES FOR LEVELS OF CLASSROOM TIME - GRADE THREE

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within cells</td>
<td>562.06</td>
<td>996</td>
<td>.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classroom Time</td>
<td>4.09</td>
<td>2</td>
<td>2.05</td>
<td>3.28</td>
<td>.03*</td>
</tr>
</tbody>
</table>

* P < .05

When the adjusted mean scores by computer time were tested, no significant differences were found.

TABLE XIX

ADJUSTED ACHIEVEMENT SCORES AND COMPUTER TIME - THIRD GRADE

<table>
<thead>
<tr>
<th>Computer Time</th>
<th>Mean</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>4.61</td>
<td>205</td>
</tr>
<tr>
<td>Average</td>
<td>4.67</td>
<td>644</td>
</tr>
<tr>
<td>High</td>
<td>4.73</td>
<td>171</td>
</tr>
</tbody>
</table>
### TABLE XX

**TEST OF SIGNIFICANCE FOR DIFFERENCES BETWEEN THE ADJUSTED MEANS OF ACHIEVEMENT SCORES FOR LEVELS OF COMPUTER TIME - GRADE THREE**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within cells</td>
<td>624.88</td>
<td>996</td>
<td>.63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Time</td>
<td>.06</td>
<td>2</td>
<td>.03</td>
<td>.05</td>
<td>.95</td>
</tr>
</tbody>
</table>

The data regarding the interaction of computer time and classroom instructional time can be seen in Tables XXI and XXII. The data revealed that when time on the computer was average or high, achievement was highest when classroom instructional time was also high. When time on the computer was low, the greatest achievement occurred when classroom instructional time was also low. The difference between the means for the high classroom time category was significant at less than the .05 level. No significance was found for other classroom time categories. Significance was found between the means at the .01 level for the average and low categories of computer time.
### TABLE XXI

**COMBINED ADJUSTED MEANS FOR CLASSROOM INSTRUCTIONAL TIME BY COMPUTER TIME - THIRD GRADE**

<table>
<thead>
<tr>
<th>Classroom Time:</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Time:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>4.84</td>
<td>4.45</td>
<td>4.55</td>
</tr>
<tr>
<td>Average</td>
<td>4.54</td>
<td>4.55</td>
<td>4.93</td>
</tr>
<tr>
<td>High</td>
<td>4.62</td>
<td>4.57</td>
<td>4.99</td>
</tr>
</tbody>
</table>
TABLE XXII

TEST OF SIGNIFICANCE FOR DIFFERENCES BETWEEN THE ADJUSTED MEANS OF ACHIEVEMENT SCORES FOR LEVELS OF COMPUTER TIME BY LEVELS OF CLASSROOM TIME - GRADE THREE

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within cells</td>
<td>613.45</td>
<td>990</td>
<td>.62</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class time by</td>
<td>6.79</td>
<td>4</td>
<td>1.70</td>
<td>2.74</td>
<td>.03*</td>
</tr>
<tr>
<td>Computer Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer within</td>
<td>2.77</td>
<td>2</td>
<td>1.39</td>
<td>2.24</td>
<td>.11</td>
</tr>
<tr>
<td>Class - Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer within</td>
<td>.89</td>
<td>2</td>
<td>.44</td>
<td>.72</td>
<td>.49</td>
</tr>
<tr>
<td>Class - Average</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer within</td>
<td>3.77</td>
<td>2</td>
<td>1.88</td>
<td>3.04</td>
<td>.05*</td>
</tr>
<tr>
<td>Class - High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class within</td>
<td>5.10</td>
<td>2</td>
<td>2.55</td>
<td>4.12</td>
<td>.02*</td>
</tr>
<tr>
<td>Computer - Low</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class within</td>
<td>5.48</td>
<td>2</td>
<td>2.74</td>
<td>4.42</td>
<td>.01**</td>
</tr>
<tr>
<td>Computer - Ave.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class within</td>
<td>.87</td>
<td>2</td>
<td>.44</td>
<td>.70</td>
<td>.50</td>
</tr>
<tr>
<td>Computer - High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* P ≤ .05
** P = .01
The interaction of computer time and I.Q. was also found to be significant when entered into the full model. The differences between the means for students in the low I.Q. category were significant at the .05 level. They made significantly higher scores when computer time was also high. Neither of the other I.Q. categories showed significant differences between the means. The means of the I.Q. categories within the computer time categories were significant at less than .001 levels. Students in the high I.Q. category made higher scores than students in either of the other categories. The data relating to this interaction can be found in Tables XXIII and XXIV.

TABLE XXIII

COMBINED ADJUSTED MEANS FOR ACHIEVEMENT SCORES FOR LEVELS OF I.Q. AND LEVELS OF COMPUTER TIME - THIRD GRADE

<table>
<thead>
<tr>
<th>I.Q.</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Time:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>3.93</td>
<td>4.66</td>
<td>4.85</td>
</tr>
<tr>
<td>Average</td>
<td>4.28</td>
<td>4.58</td>
<td>4.82</td>
</tr>
<tr>
<td>High</td>
<td>4.36</td>
<td>4.50</td>
<td>5.04</td>
</tr>
</tbody>
</table>
TABLE XXIV

TEST OF SIGNIFICANCE FOR DIFFERENCES BETWEEN THE ADJUSTED MEANS OF ACHIEVEMENT SCORES FOR LEVELS OF I.Q. BY LEVELS OF COMPUTER TIME - GRADE THREE

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within cells</td>
<td>595.45</td>
<td>990</td>
<td>.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.Q. by Computer Time</td>
<td>6.39</td>
<td>4</td>
<td>1.60</td>
<td>2.66</td>
<td>.03**</td>
</tr>
<tr>
<td>Computer within Class - Low</td>
<td>16.58</td>
<td>2</td>
<td>8.29</td>
<td>13.78</td>
<td>.001*</td>
</tr>
<tr>
<td>Computer within Class - Average</td>
<td>11.50</td>
<td>2</td>
<td>5.75</td>
<td>9.56</td>
<td>.001*</td>
</tr>
<tr>
<td>Computer within Class - High</td>
<td>7.90</td>
<td>2</td>
<td>3.95</td>
<td>6.57</td>
<td>.001*</td>
</tr>
<tr>
<td>Class within Computer - Low</td>
<td>3.56</td>
<td>2</td>
<td>2.96</td>
<td>2.96</td>
<td>.05**</td>
</tr>
<tr>
<td>Class within Computer - Ave.</td>
<td>1.62</td>
<td>2</td>
<td>.84</td>
<td>1.35</td>
<td>.26</td>
</tr>
<tr>
<td>Class within Computer - High</td>
<td>1.22</td>
<td>2</td>
<td>.61</td>
<td>1.01</td>
<td>.36</td>
</tr>
</tbody>
</table>

* P = .001
**P ≤ .05

Grade Five

When I.Q. was found to make a significant unique contribution to achievement in the fifth grade at less than the .001 level, the adjusted achievement scores were broken down
by I.Q. levels. Students in the high I.Q. category made the highest scores with those in the average and low categories achieving in their respective orders. When the difference between the means was tested, significance was found at less than the .001 level. The data are contained in Tables XXV and XXVI.

TABLE XXV

ADJUSTED ACHIEVEMENT SCORES BY I.Q. LEVELS – GRADE FIVE

<table>
<thead>
<tr>
<th>I.Q. Level</th>
<th>Mean</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>5.99</td>
<td>124</td>
</tr>
<tr>
<td>Average</td>
<td>6.53</td>
<td>661</td>
</tr>
<tr>
<td>High</td>
<td>6.82</td>
<td>141</td>
</tr>
</tbody>
</table>
TABLE XXVI

TEST OF SIGNIFICANCE FOR DIFFERENCES BETWEEN THE
ADJUSTED MEANS OF ACHIEVEMENT SCORES
BY LEVELS OF I.Q. - GRADE FIVE

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within cells</td>
<td>703.24</td>
<td>992</td>
<td>.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.Q.</td>
<td>35.60</td>
<td>2</td>
<td>17.80</td>
<td>23.26</td>
<td>.001*</td>
</tr>
</tbody>
</table>

*P ≤ .001

Gender made a significant contribution to achievement at less than the .05 level (Table VIII). The data revealed that the females achieved higher scores than the males. The difference between the means was not significant. The data pertinent to this variable can be found in Tables XXVII and XXVIII.
TABLE XXVII

ADJUSTED ACHIEVEMENT SCORES FOR GENDER - GRADE FIVE

<table>
<thead>
<tr>
<th>Gender</th>
<th>Mean</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>4.48</td>
<td>463</td>
</tr>
<tr>
<td>Female</td>
<td>4.67</td>
<td>463</td>
</tr>
</tbody>
</table>

TABLE XXVIII

TEST OF SIGNIFICANCE FOR DIFFERENCES BETWEEN THE ADJUSTED MEANS OF ACHIEVEMENT SCORES FOR GENDER CATEGORIES - GRADE FIVE

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within cells</td>
<td>703.24</td>
<td>923</td>
<td>.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>2.48</td>
<td>1</td>
<td>2.48</td>
<td>3.10</td>
<td>.08</td>
</tr>
</tbody>
</table>

Several changes were noted when the interactions were entered into the full model with computer time and classroom time. Computer time and instructional organization became significant as did the interactions of I.Q. with computer time, computer time with ethnicity, and I.Q. with instructional organization (see Table XI).
Computer time was broken down into high, average and low categories using the prescribed formulas. Students who had low time on the computer made the highest scores. Students in the high time category achieved at higher levels than those in the average category. The differences between the means did not achieve significance. The resulting data can be seen in Tables XXIX and XXX.

TABLE XXIX

ADJUSTED ACHIEVEMENT SCORES BY LEVELS OF COMPUTER TIME - GRADE FIVE

<table>
<thead>
<tr>
<th>Computer Time</th>
<th>Mean</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>6.66</td>
<td>171</td>
</tr>
<tr>
<td>Average</td>
<td>6.64</td>
<td>650</td>
</tr>
<tr>
<td>High</td>
<td>7.63</td>
<td>105</td>
</tr>
</tbody>
</table>
TABLE XXX

TEST OF SIGNIFICANCE FOR DIFFERENCES BETWEEN ADJUSTED MEANS OF ACHIEVEMENT SCORES FOR LEVELS OF COMPUTER TIME - GRADE FIVE

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within cells</td>
<td>739.00</td>
<td>922</td>
<td>.79</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Time</td>
<td>1.83</td>
<td>2</td>
<td>.91</td>
<td>1.14</td>
<td>.32</td>
</tr>
</tbody>
</table>

The interaction of computer time and I.Q. achieved significance at less than a .05 level when entered into the full model using computer time and reading time (see Table XI). The differences between the means for the time on the computer categories within each of the I.Q. categories were not significant. However, I.Q. level within the computer time categories was significant at the less than the .001 level. Students in the low I.Q. category achieved higher scores when time on the computer was average. Their achievement scores were lowest when time on the computer was highest. Students in the average I.Q. category achieved higher scores when time on the computer was also least. Students in the high I.Q. category made the highest scores when computer time was low. The lowest scores for this
group were made when computer time was highest. The data pertinent to this interaction are contained in Tables XXXI and XXII.

TABLE XXXI

ADJUSTED ACHIEVEMENT SCORES FOR LEVELS OF I.Q. AND LEVELS OF TIME ON THE COMPUTER - GRADE FIVE

<table>
<thead>
<tr>
<th>I.Q.:</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Time:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>6.06</td>
<td>6.46</td>
<td>7.18</td>
</tr>
<tr>
<td>Average</td>
<td>6.21</td>
<td>6.58</td>
<td>7.04</td>
</tr>
<tr>
<td>High</td>
<td>5.77</td>
<td>6.55</td>
<td>7.01</td>
</tr>
</tbody>
</table>
XXXII

TEST OF SIGNIFICANCE FOR DIFFERENCES BETWEEN THE ADJUSTED MEANS OF ACHIEVEMENT SCORES FOR LEVELS OF COMPUTER TIME BY LEVELS OF I.Q. - GRADE FIVE

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within cells</td>
<td>700.86</td>
<td>916</td>
<td>.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I.Q. by Computer Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer within I.Q. - Low</td>
<td>3.32</td>
<td>4</td>
<td>.83</td>
<td>1.09</td>
<td>.36</td>
</tr>
<tr>
<td>Computer within I.Q. - Average</td>
<td>2.76</td>
<td>2</td>
<td>1.38</td>
<td>.38</td>
<td>.17</td>
</tr>
<tr>
<td>Computer within I.Q. - High</td>
<td>1.36</td>
<td>2</td>
<td>.38</td>
<td>.89</td>
<td>.41</td>
</tr>
<tr>
<td>I.Q. within Computer - Low</td>
<td>16.78</td>
<td>2</td>
<td>8.39</td>
<td>10.97</td>
<td>.001*</td>
</tr>
<tr>
<td>I.Q. within Computer - Ave.</td>
<td>21.27</td>
<td>2</td>
<td>10.64</td>
<td>13.90</td>
<td>.001*</td>
</tr>
<tr>
<td>I.Q. within Computer - High</td>
<td>13.36</td>
<td>2</td>
<td>6.68</td>
<td>8.73</td>
<td>.001*</td>
</tr>
</tbody>
</table>

*P < .001

When instructional organization showed significance after the interactions were added to the full model when either computer time and classroom time or total time were used, it was explored further (see Table XI). Students in contained classrooms scored lower than the students in
non-self contained classrooms but the difference between the means was not significant. The data for this variable are contained in Tables XXXIII and XXXIV.

**TABLE XXXIII**

**ADJUSTED ACHIEVEMENT SCORES BY INSTRUCTIONAL ORGANIZATION - GRADE FIVE**

<table>
<thead>
<tr>
<th>Instructional Organization</th>
<th>Mean</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contained</td>
<td>6.51</td>
<td>380</td>
</tr>
<tr>
<td>Non-contained</td>
<td>6.62</td>
<td>546</td>
</tr>
</tbody>
</table>

**TABLE XXXIV**

**TEST OF SIGNIFICANCE FOR ADJUSTED MEANS OF ACHIEVEMENT SCORES FOR CATEGORIES OF INSTRUCTIONAL ORGANIZATION - GRADE FIVE**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within cells</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructional Organization</td>
<td>1.60</td>
<td>1</td>
<td>1.60</td>
<td>2.00</td>
<td>.16</td>
</tr>
</tbody>
</table>
The interaction of I.Q. and instructional organization achieved significance when entered into the full model when a combination of classroom time and computer time was used and when total time was used (see Tables XI and XII). Students in all I.Q. categories made higher scores when the instructional organization was non-contained although significance between the means was not established. I.Q. level did achieve significance at less than .001 within the levels of instructional organization. Students in the high I.Q. category made the highest scores in both organizational structures. The data pertinent to the interaction can be found in Tables XXXV and XXXVI.

TABLE XXXV

ADJUSTED ACHIEVEMENT SCORES FOR LEVELS OF I.Q. AND INSTRUCTIONAL ORGANIZATION - GRADE FIVE

<table>
<thead>
<tr>
<th>I.Q.:</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Organization:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contained</td>
<td>6.07</td>
<td>6.53</td>
<td>6.96</td>
</tr>
<tr>
<td>Non-contained</td>
<td>6.18</td>
<td>6.57</td>
<td>7.11</td>
</tr>
</tbody>
</table>
TABLE XXXVI

TEST OF SIGNIFICANCE FOR DIFFERENCES BETWEEN THE ADJUSTED MEANS OF ACHIEVEMENT SCORES FOR LEVELS OF I.Q. BY CATEGORIES OF INSTRUCTIONAL ORGANIZATION - GRADE FIVE

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within cells</td>
<td>701.20</td>
<td>919</td>
<td>.77</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Org. within I.Q. - Low</td>
<td>422</td>
<td>2</td>
<td>.21</td>
<td>.21</td>
<td>.76</td>
</tr>
<tr>
<td>Org. within I.Q. - Average</td>
<td>.37</td>
<td>1</td>
<td>.37</td>
<td>.48</td>
<td>.49</td>
</tr>
<tr>
<td>Org. within I.Q. - High</td>
<td>.25</td>
<td>1</td>
<td>.25</td>
<td>.33</td>
<td>.57</td>
</tr>
<tr>
<td>I.Q. within Org. Contain.</td>
<td>18.43</td>
<td>2</td>
<td>9.22</td>
<td>12.03</td>
<td>.001*</td>
</tr>
<tr>
<td>I.Q. within Org. Non-Cont.</td>
<td>25.44</td>
<td>2</td>
<td>12.72</td>
<td>16.60</td>
<td>.001*</td>
</tr>
</tbody>
</table>

*P < .001

When computer time and classroom time were part of the full model and the interactions were entered into the equation, ethnicity and time on the computer became significant at less than the .05 level. The differences between the means for students in the low time category showed significance at the less than a .001 level for the
American Indian and less than the .05 level for the Black. The other ethnic categories showed no significant differences between the means. Students in the American Indian category made higher scores when computer time was also higher. Students in the Black category showed a similar pattern. The data are contained in Tables XXXVII and XXXVIII.

**TABLE XXXVII**

ADJUSTED ACHIEVEMENT SCORES FOR LEVELS OF COMPUTER TIME AND ETHNICITY CATEGORIES – GRADE FIVE

<table>
<thead>
<tr>
<th>Computer Time:</th>
<th>Low</th>
<th>Average</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>American Indian</td>
<td>4.06</td>
<td>6.47</td>
<td>7.77</td>
</tr>
<tr>
<td>Oriental</td>
<td>6.32</td>
<td>6.61</td>
<td>6.51</td>
</tr>
<tr>
<td>Hispanic</td>
<td>6.37</td>
<td>6.52</td>
<td>6.00</td>
</tr>
<tr>
<td>Black</td>
<td>5.61</td>
<td>6.37</td>
<td>6.49</td>
</tr>
<tr>
<td>Other</td>
<td>6.62</td>
<td>6.64</td>
<td>6.55</td>
</tr>
</tbody>
</table>
TABLE XXXVIII

TEST OF SIGNIFICANCE FOR DIFFERENCES BETWEEN ADJUSTED MEANS OF ACHIEVEMENT SCORES FOR LEVELS OF COMPUTER TIME BY CATEGORIES OF ETHNICITY - GRADE FIVE

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
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* P ≤ .01  
** P ≤ .05  
*** P ≤ .001
Summary

I.Q. and ethnicity made a significant unique contribution to the predictability of achievement gain in grade three at less than .01 levels. When the interactions of the variables were entered into the full model and each restricted model compared to the full model, significance was found for classroom time and computer time at less than .01 levels. The interaction of computer time with classroom time and computer time with I.Q. were also found to be significant at less than .01 levels.

I.Q. and gender made a significant unique contribution to the predictability of achievement gain in grade five at the .001 and .05 levels respectively. When the interactions of the variables were entered into the full model using classroom time and computer time with each restricted model, computer time and instructional organization assumed significance at less than the .05 levels. The interactions of I.Q. with instructional organization and computer time with ethnicity became significant at less than .05 levels. When the interactions of the variables were entered into the full model using total time and compared with each restricted model, the only variable that achieved significance was instructional organization and that was at less than a .05 level. The interaction of I.Q. and instructional organization also achieved significance at less than a .05 level.
CHAPTER V

SUMMARY, FINDINGS, INTERPRETATIONS, CONCLUSIONS, RECOMMENDATIONS

The focus of this study was to determine the unique contribution of selected variables to the predictability of gain in reading achievement in a computer-assisted instructional setting. I.Q., gender, instructional organization, time on the computer, classroom instructional time, total time (a combination of classroom and computer time), and ethnicity were explored as well as the interactions of each with one another. Grade levels three and five were used for the study. The sample consisted of 500 boys and 500 girls in the third grade and 463 boys and 463 girls in the fifth grade from a large suburban school district in the Dallas-Fort Worth area. The number of contained and non self-contained classrooms was kept proportional to those of the district for each grade level. The students were given the Iowa Test of Basic Skills, Primary Battery, grades 3 - 9, subset Reading Comprehension during the fall of 1984 and the spring of 1985. The Cognitive Abilities Test was also given during the fall of 1984. Students were introduced to the WICAT program for reading comprehension gradually during the month of December, 1984. After the spring
administration of the ITBS in late April, 1984, the data were collected and analyzed.

Discussion of the results of the data analysis will include findings, interpretations and conclusions. Recommendations for further research will also be given.

Findings

Findings and interpretations regarding each of the research variables follow.

I.Q.

Results of the analysis of variance for I.Q. showed that I.Q. made a unique and significant contribution to the predictability of achievement gain in reading at less than the .01 level. Differences between the means for levels of I.Q. were also found to be significant at less than the .01 level. Students in the highest I.Q. category made the greatest gains with students in the average and low categories following in respective order. This held true for both grade levels. When the interactions of the variables with one another were entered into the full model for predictability, significance did not change in grade three. In grade five the interaction of I.Q. and instructional organization did achieve significance at less than the .05 level. This held true for both equations—
computer time and classroom time and total time. I.Q., by itself, did not retain its significance when the equation included total time rather than computer time and classroom time. The interaction of I.Q. and computer time was also significant at less than the .05 level. A discussion of the interactions can be found later in the chapter.

**Gender**

No significance was found for gender in terms of its unique contribution to predictability in reading achievement gain in grade three. This was not true in grade five. Gender reached significance at less than the .05 level for grade five. Females achieved greater gains than males but no significant difference between the means of the males and females was noted. When the interactions of the variables with one another were entered into the full model for predictability, gender lost significance.

**Ethnicity**

Ethnicity achieved significance at less than the .01 level in grade three. A comparison of the means revealed that the greatest gains were made by students in the American Indian category followed by students in the Other, Oriental, Black and Hispanic categories respectively. The differences between the means of the ethnic groups were significant at less than the .05 level.
Ethnicity, by itself, did not achieve significance in grade five. However, the interaction of ethnicity and computer time was significant at less than the .05 level. This finding will be discussed later in the chapter.

**Instructional Organization**

The unique contribution of instructional organization to the predictability of achievement gain was not significant in grade three or in grade five. When the interactions of the research variables were entered into the full model for predictability, instructional organization became significant at less than the .05 level for grade five in favor of the non self-contained category. The interaction of I.Q. and instructional organization also became significant at less than the .05 level. A discussion of this finding can be found later in the chapter.

**Time on the Computer**

Time on the computer failed to achieve significance in either grade three or grade five in the initial model. When the interactions were entered into the full model for predictability, computer time became significant at the less than the .01 level in grade three and less than the .05 level in grade five. In grade three, students who had the greatest amount of time on the computer made the greatest gains. The other time categories followed in order. The
same did not hold true for grade five. While students in
the highest time category made the greatest gains, students
in the low time category had higher scores than students in
the average time category. The differences between the
means were not significant.

The interaction of computer time with classroom time,
computer time with I.Q. and computer time with ethnicity
will be discussed later in the chapter.

### Classroom Instructional Time

Results showed that classroom time was not a significant
factor in the predictability of achievement gain in reading
grade three or five when the interactions of the research
variables with one another were not taken into account.
When the interactions were entered into the full model,
classroom time did become significant at less than the .01
level for grade three but not for grade five. Students in
grade three who were in the highest classroom time category
made the greatest gains. Student in the average time
category made the least gains. Students in the low time
category made average gains. The differences between the
means were significant at less than the .05 level. The
interaction of classroom time with the variables of computer
time and I.Q. was significant at less than .01 levels for
grade three. In grade five, no significance was found.
These findings will be discussed later in the chapter.
Total Time

The variable of total time did not achieve significance in either grade three or grade five. When the interactions of the variables with one another were entered into the full model for predictability, total time was still not significant.

I.Q. and Computer Time

The interaction of I.Q. and computer time became significant in grades three and five at less than .01 and .05 levels respectively. For both grades, the differences between the means for I.Q. levels within levels of computer time were significant at less than .01 levels. An analysis of the data for grade three showed that students in the low I.Q. category did best when computer time was high. The differences between the means of the low I.Q. students within the computer time category showed significance at the .05 level. Average and high I.Q. categories did not reveal any significant differences although it appeared that students in the high I.Q. category made the greatest gains when computer time was high. The same results did not occur in the fifth grade. The differences between the means for time on the computer within each of the I.Q. categories did not achieve significance although students in the low and average I.Q. categories made greater gains when computer
time was average and students in the high I.Q. category made greater gains when computer time was low.

**Computer Time and Classroom Time**

When the interactions were entered into the full model for predictability, computer time by classroom time showed significance at less than the .01 level for grade three. The greatest gains in achievement were made when classroom time and computer time were both high. High classroom time and average computer time or low classroom time and low computer time followed in close order. The difference between the means for high class time category was significant at less than the .05 level but none of the other categories achieved significance. Classroom time within the levels of computer time was significant in both the low and average categories at less than .05 and .01 levels respectively. When computer time was low, the greatest gains were made when classroom time was also low. When computer time was average, the greatest gains were made when classroom time was high. No significance was found for the interaction of computer time and classroom time in grade five.

**I.Q. and Instructional Organization**

The interaction of I.Q. and instructional organization was found to be significant at less than the .05 level in grade five. Further analysis revealed that students in the
high I.Q. category made the greatest gains in both categories of instructional organization and the significance of I.Q. level within instructional organization was less than .01. Students in all levels of I.Q. made greater gains in the non self-contained environment but significance for the difference between the means was not established.

**Computer Time and Ethnicity**

The interaction of computer time and ethnicity became significant at less than the .05 level in grade five and entered into the full model using computer time and reading time. The differences between the means for all ethnic categories in the low computer time level were significant at less than the .01 level. Students in the Other category made the greatest gains followed by Hispanics, Orientals, Blacks and American Indians in descending order. Computer time within each ethnic category achieved significance at less than the .01 level for American Indians and at less than the .05 level for Blacks. Students in the American Indian and the Black categories made the highest scores when computer time was also high. None of the other ethnic groups showed a significant difference between the means. Their pattern of achievement also differed from that of the American Indian and the Black. In the Oriental, Hispanic and Other categories, the greatest gains were made in the average time category.
Table XXXIX illustrates the findings for the main research variables and interactions for grades three and five. The following legend should be used for interpretation:

- Full Model with Computer/Classroom Time ............ FMCCT
- Full Model with Total Time .......................... FMTT
- Full Model with Computer/Classroom Time and Interactions ................ FMCCTI
- Full Model with Total Time and Interactions .... FMTTI
- I.Q. ................................................. I.Q.
- Gender ................................................ Gen.
- Instructional Organization ........................ In. Org.
- Computer Time ...................................... Com.
- Classroom Instructional Time ......................... Cl.
- Total Time .......................................... Tot.
- Ethnicity .......................................... Eth.
- Total Time and I.Q. .................................. T1
- Total Time and Instructional Organization ........ T2
- Total Time and Ethnicity ............................. T3
- Gender and I.Q. ...................................... T4
- Gender and Instructional Organization ............. T5
- Gender and Computer Time ............................ T6
- Gender and Classroom Time ........................... T7
- Gender and Ethnicity ................................ T8
- Gender and Total Time ............................... T9
- I.Q. and Instructional Organization ................ T10
- I.Q. and Computer Time .............................. T11
- I.Q. and Classroom Time ............................. T12
- I.Q. and Ethnicity .................................... T13
- Instructional Organization and Computer Time ... T14
- Instructional Organization and Classroom Time .. T15
- Instructional Organization and Ethnicity .......... T16
- Computer Time and Classroom Time .................. T17
- Computer Time and Ethnicity ........................ T18
- Classroom Time and Ethnicity ........................ T19
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* NS = No Significance
** P \( \leq \) .01
*** P \( \leq \) .05
Interpretation

I.Q. and Achievement

Research regarding I.Q. and its relationship to achievement suggests that there is a positive correlation of about .60 between I.Q. test score and school performance (30). This study supports this notion. I.Q. was found to have a significant unique contribution to the predictability of achievement gain at less than .01 level in both grade three and grade five. While I.Q. lost some of its power in the fifth grade when the interactions of the variables were entered into the full model, the interactions that achieved significance at less than the .05 levels included I.Q. as one of the related variables. It may be that the power of I.Q. becomes even stronger when it is in combination with other variables.

Gender and Achievement

Gentile (17) reported that girls have a decided advantage over boys in reading achievement at the elementary years. Other researchers have supported this finding citing many reasons for why it occurs (5, 7, 8, 16, 25, 31, 32). The findings of this study also lend support to this conclusion. Girls made higher scores than boys in both grade three and grade five. A significant difference between the means was not established for grade three. In grade five, significance was reached at less than the .05
level. When the interactions of the variables with one another were entered into the full model for prediction using reading time and computer time, gender remained significant at less than the .05 level. When the interactions were entered using total time, gender was no longer significant. There may be a relationship between gender and computer time or classroom time that, although it does not show significance, does affect achievement.

**Ethnicity and Achievement**

Ethnicity was found to be a significant contributor to the prediction of achievement gain in grade three at less than the .01 level. The greatest gains were made by students in the American Indian category. The categories of Other, Oriental, Black and Hispanic followed in respective order. Other studies have suggested that minority students make greater gains in a computer-assisted setting than in a traditional setting (4, 20, 22, 24, 28). This study did not compare traditional instruction with computer-assisted instruction so no conclusions regarding this can be made.

Ortman (27), in studying the effectiveness of a computer-assisted reading program for students in grades four through six, concluded that after one year of supplementary computer-assisted instruction, low-achieving
Hispanics made greater gains in reading than low-achieving Anglos. This study does not lend support to this finding. When achievement gain as broken down by low, average, and high I.Q. levels within ethnic categories, the low achieving American Indians and the low achieving Others (which would include the Anglo population) made greater gains than the low-achieving Hispanics, Orientals or Blacks. The extremely small size of the American Indian population may have affected the results for that particular population. However, the number of students in the cells for the other ethnic populations was large enough to assure the validity of the conclusion.

Ethnicity did not achieve significance in grade five. This may be due to the fact that by the fifth grade, some of the cultural and socio-economic differences have been remediated through special programs for minority groups and therefore ethnicity no longer plays the same role.

When the interactions were entered into the full model for prediction using computer time and classroom time, ethnicity remained significant in the third grade but still lacked significance in the fifth grade. The relationship between ethnicity and time on the computer became significant at less than .05 level for grade five. This phenomenon will be discussed later in the chapter.
Total Time and Achievement

Frederick and Walberg (15) concluded that time was only a very modest predictor of achievement. The results of this study support their finding. Total time never achieved significance in grade three or grade five despite the fact that the difference between the low time and the high time was as much as 5,000 minutes for the third grade and 3,000 minutes for the fifth grade over the five months the study was conducted. This finding becomes enormously important in light of the recent pressure in educational circles to increase achievement scores by giving students more time on task in the particular subject area.

Time on task has been difficult to document (18). This study relied on the data received from the classroom teacher and the computer clock for the time on task statistics. There is no way of knowing whether or not the time that was said to be spent on reading instruction was truly the amount of time spent. A different method for defining the time on task data might be appropriate.

Time on the Computer and Achievement

Computer time failed to achieve significance in grade three or grade five in the full model without the interactions. When the interactions were entered into the full model, computer time became significant at less than the .01
level for grade three and at less than the .05 level for grade five.

Anelli (2) found no appreciable differences in reading achievement gain using different levels of computer time for third and fourth grades. This study does not support this finding.

In grade three, high computer time resulted in the greatest gains with the other time categories following in order. The WICAT program in reading uses a tutorial and drill and practice approach. It may be that third graders find working with the computer a new and exciting learning tool. In the kindergarten, first and second grades exposure to the computer is somewhat more limited due in part to the fact that students lack the necessary facility in reading.

In grade five, students in the lowest time category made the greatest gains and students in the highest time category achieved higher scores than the students in the average time category but the differences between the means for the time categories was not significant. The findings for the fifth grade lend support to the conclusions drawn by Anelli (2).

Fanning (12) suggested that there were sex-related differences for levels of time on the computer. The interaction of gender with levels of computer time did not achieve significance in this study and no support for Fanning's conclusion was found.
It is important to note that this study looked at computer time in a computer-assisted instructional setting. There are many other ways computers can be used in an educational setting including simulations, programming, word processing, games and graphics. It may be that the relationship between computer time and achievement is different in these settings. Research in these areas has not yet been conducted.

**Classroom Instructional Time and Achievement**

Classroom time became significant at less than the .01 level when the interactions were entered into the full model for prediction in grade three. The highest time category resulted in the greatest gains which would appear to lend support to the conclusions of Bloom (9), Samuels and Tenure (28), Stallings and Kaskowitz (33), Anderson (1), Arlin and Roth (3), Cooley and Leinhardt (11) and Fisher, et al. (14) that more time spent in reading instruction leads to higher achievement. The means of the low and average categories of time did not reflect this postulation. Students in the lowest time category made higher achievement scores than the students in the average time category. Karweit and Slavin (19) suggested that there is a "time-needed-for-learning factor" that appears to affect the relationship between time and achievement. It may be that this has contributed to the change in the pattern for the low and average time categories.
I.Q. and Computer Time

The interaction of I.Q. and computer time became significant at less than the .01 level in grade three and at less than the .05 level in grade five. Studies by Chambers and Sprecher (10) and Peurzieg et al. (13) found that low I.Q. and low-achieving students made greater gains in a computer-assisted setting than in a traditional setting. Litman (21) and Lysiak (23) suggested that computer-assisted instruction was beneficial to low-achieving students. Molnar (24) concluded that low level students require more time on the computer than average and above average students. This study lends support to these conclusions. An analysis of the data for this study revealed that students in the low I.Q. category in third grade made their greatest gains when computer time was high and these gains were significant at the .05 level in comparison to the gains of the students in the other I.Q. categories. I.Q. level did play an important role within each time category and students in the high I.Q. category made greater gains than students in the low and average categories irregardless of the time level. Significance was found at the .01 level. This further supported the findings of Sattler (30) concerning the correlation between I. Q. and performance and Molnar (24) concerning the need for more time on the computer for low-achieving students.
The findings for the fifth grade did not coincide with the findings for the third grade. Students in the low and average I.Q. categories made greater gains when the computer time was average rather than high. High I.Q. students made the greatest gains when computer time was low. It may be that by the time students reach the fifth grade computers no longer hold the mystery and excitement they did in the third grade. Students at high I.Q. levels may be bored with drill and practice and tutorials on the computer and need the stimulation of programming and/or other types of computer activities.

**I.Q. and Instructional Organization**

The interaction of I.Q. and instructional organization was not significant in grade three. Significance was achieved in grade five at less than the .05 level in favor of the students in the high I.Q. category for both organizational structures. Knowing the correlation between achievement and I.Q. is about .60, (30), this is not surprising. The fact that the significance for the differences between the means for I.Q. categories was less than .01 lends further credibility to Sattler's (30) conclusion.

Students in all I.Q. categories made higher scores when in a non self-contained environment. This finding does not support the conclusions drawn by Beckerman and Good (6) and Veldman and Sanford (34) which suggested that pupils
with less ability can profit from their exposure to students with greater ability since students in non self-contained classrooms were often grouped according to their ability level. However, this was not always the case in this study.

Another factor that should be taken into account when viewing this finding is that many of the non self-contained classrooms were found to be higher socio-economic areas. Students from these areas tend to have a broader background of experiences and this may have had an impact on their scores. Another explanation for this finding is perhaps children in non-self contained classrooms are more adept at working in a variety of instructional settings.

**Computer Time and Classroom Time**

The interaction of computer time with classroom time was significant at less than the .01 level for grade three but showed no significance for grade five. Significance of the differences between the means for levels of computer time within classroom time categories for grade three was achieved for the high time category only at the .05 level. Students made higher scores when time on the computer and time in the classroom were highest. The relationship of classroom time within computer time categories was quite different. When computer time was low and classroom time was low, students achieved higher scores. When computer
time was average, the greatest gains were made when classroom time was high. Karweit and Slavin (19) have suggested that there is a "time-for-learning factor" that is different for each student. This may account for the curious differences that exist in the relationship between levels of computer time and levels of classroom instructional time.

Computer Time and Ethnicity

Significance for the interaction between computer time and ethnicity was reached at less than the .05 level for grade five. At the time of this study, there was no literature available on the relationship of time on the computer between ethnic groups.

The analysis of computer time categories between the groups showed that within the time categories there were significant differences. In the low computer time category, the Others (including the Caucasian population) achieved the highest scores followed by the students in the Hispanic, Oriental, Black and American Indian categories respectively. In the average time category, students designated as Other continued to achieve the highest scores but the order for the other ethnic groups changed. In this time category, Orientals followed the Others in achievement with the Hispanics, American Indians and Blacks coming in descending
order. In the high computer time category, the order of achievement shifted once again. Students in the American Indian category made the greatest gains in comparison to the other ethnic groups. The categories of Other, Oriental, Black and Hispanic followed respectively.

Within each ethnic group changes were also noted. Students in the American Indian category scored best when computer time was high and the difference between their scores was significant at less than the .01 level. Students in the Oriental, Other and Hispanic categories made their greatest gains when computer time was average. Students in the Black category scored highest when computer time was also highest. The differences between the means for the Blacks was significant at less than the .05 level.

High computer time seems to be most effective for American Indians and Blacks. Average computer time seems to be the most beneficial for students in all other ethnic categories.

Conclusions

Based on the findings of this study, several meaningful conclusions can be made regarding the research variables.

1. According to the findings I.Q. was positively related to achievement across instructional organization, total time, gender and ethnicity. However, the role of I.Q. in relationship to achievement in reading was qualified by
its relationship to computer time and grade level. This study found that in grade three, students in high I.Q. designations and low I.Q. designations made greater gains when computer time was high. Students in the average I.Q. designation made greater gains when computer time was low. In contrast to these findings, fifth grade students in the high I.Q. category achieved more when computer time was low. Students in the low and average I.Q. categories achieved higher scores when time was average.

The findings seem to suggest that in the third grade, the students who benefit most from high time in a computer-assisted instructional setting are those students with low or high I.Q. designations. Therefore, it is these students who should be given preference when contemplating a computer-assisted instructional environment. Their peers in the average I.Q. category may benefit more from other types of instructional approaches or computer experiences.

In the fifth grade, students with low or average I.Q. designations did not benefit from high time in the computer-assisted instructional setting. Rather, they did best when time on the computer was kept at a moderate level. Students in the high I.Q. category did best when computer time was kept at a minimum. These findings suggest that computer-assisted instruction may not be the best instructional approach for high I.Q. students in the fifth grade.
Therefore, other instructional approaches and uses for the computer with this group would seem to be indicated.

2. Ethnicity played an important role in the predictability of achievement in grade three with American Indians making the greatest gains and Others, Orientals, Blacks and Hispanics following in respective order. It did not play a significant role in grade five except in combination with computer time. American Indians and Blacks made higher scores when computer time was high. Hispanics made the lowest scores when computer time for them was highest. All other ethnic groups made higher scores when computer time was average.

These findings seem to suggest that at the fifth grade level reading achievement might be increased if American Indians and Blacks were allowed more time in a computer-assisted instructional setting. For Hispanics, more time in the computer-assisted instructional setting would not seem to be the most effective instructional approach. Other instructional strategies and computer experiences would seem to be indicated for this group of students.

3. Gender made a significant contribution to achievement in grade five. Females achieved at higher levels than males in reading. However, there was not a significant relationship between time and gender in either grade, suggesting that perhaps boys and girls benefit
equally from the computer-assisted instructional setting in reading.

4. Instructional organization made a significant contribution to achievement gains in reading in grade five when in combination with I.Q. Students in non self-contained classrooms achieved at higher levels than those in self-contained classrooms. Perhaps more non self-contained classroom environments should be considered when districts are planning to use computer-assisted instruction in reading.

5. Total time spent in reading instruction does not appear to have a significant role in reading achievement in either grade three or grade five contrary to prior assumptions that time on task was highly related to achievement. This finding suggests that perhaps increasing time on task is not the most appropriate approach for raising achievement levels in reading particularly in a computer-assisted instructional setting.

6. Classroom instructional time had an effect on achievement gain when in combination with computer time in grade three. The correlation between the two was positive with high computer time and high classroom time giving the greatest gains. When classroom time was low, the greatest gains were made when computer time was low as well.
Based on this finding, it appears that although computer-assisted instruction compliments classroom instruction, one is not a substitute for the other. Therefore, when classroom time is low, increasing computer-assisted time is not effective compensation. Other instructional approaches should be considered.

7. The differing results found for grades three and five suggest that there are grade level differences in the variables that should be used for predicting achievement gain.

Perhaps school districts should take into account I.Q., ethnicity, classroom instructional time and computer time before placing students in the third grade in computer-assisted instructional programs in reading. In grade five, I.Q., gender, instructional organization, computer time and ethnicity should be considered.

Recommendations for Future Research

The following recommendations are based on the findings and conclusions of this study and the review of related literature.

1. This study should be replicated with the following changes: a) a different procedure for determining the time on task data, b) a full school year in the computer-assisted instructional program, and c) a different software package.
2. Further study should be conducted on relationship of computer time and ethnicity. These studies should focus on larger sample sizes within each ethnic group.

3. Studies which look at academic content areas beyond reading such as math and science should be conducted. The question of whether the variables used in this study are appropriate in other subject areas is an important one.

4. Further study of the relationship between computer time and classroom time and computer time and I.Q. should be undertaken for different grade levels. The differing results found between grades three and five suggest there are grade level differences in terms of the interaction of these variables.

5. The relationship of total time spent in reading instruction and achievement should be explored further. An instrument which measures time on task accurately should be developed before this study is undertaken.

6. Research should be undertaken to explore the relationship of computer time and achievement in other than computer-assisted instructional settings (i.e. drill and practice and tutorials). These settings might include: a) graphics experiences, b) simulations, c) games, d) word processing, and e) programming.

7. This study suggests that there may be a relationship between gender and computer time. Since the relationship
approached significance, it is important that further study be done to determine the extent of the relationship between these two variables.
CHAPTER BIBLIOGRAPHY


12. Fanning, J. M. An analysis and comparison of the results of 'time on task' of a title 1 remedial reading project for students receiving five periods of instruction a week vs. a group of students receiving three periods of instruction a week. (Doctoral Dissertation, Temple University, 1983). Dissertation Abstracts International, 44/04-A, 1332, University Microfilms (Order No. AAD83-21258).


27. Ortmann, L. N. The effectiveness of supplementary computer-assisted instruction in reading at the 4 - 6 grade level (four-six). (Doctoral Dissertation, University of the Pacific, 1983), Dissertation Abstracts International, 45/01-A, 140, University Microfilms (Order No. AAD84-10506).


BIBLIOGRAPHY

Books


Articles


Gallagher, J. R. Can't spell, can't read. Atlantic Monthly, June 1948, 81, 35-39.


Reports


Publications of Learned Organizations

Good, T. L. Classroom research: what we know and what we need to know. Austin, Texas: Research and Development Center for Teacher Education, The University of Texas at Austin, 1982.


Unpublished Materials


Du Plessis, G. The influence of computer-assisted instruction on the achievement and attitude towards mathematics amongst black pupils. (Master's Thesis, University of Pretoria, 1980), Master's Abstracts, 20/01, 90, University Microfilms (Order No. AAD80-26342).


Fanning, J. M. An analysis and comparison of the results of 'time on task' of a Title I remedial reading project for students receiving five periods of instruction a week vs. a group of students receiving three periods of instruction a week. (Doctoral Dissertation, Temple University, 1983). Dissertation Abstracts International, 44/04-A, 1332, University Microfilms (Order No. AAD83-21258).


Merritt, R. L. Achievement with and without computer-assisted instruction in the middle school. (Doctoral Dissertation, University of Southern Mississippi, 1982). Dissertation Abstracts International, 44/01A, 34), University Microfilms (Order No. AAD83-11071).


Ortmann, L. N. The effectiveness of supplementary computer-assisted instruction in reading at the 4 - 6 grade level (four-six). (Doctoral Dissertation, University of the Pacific, 1983), Dissertation Abstracts International, 45/01-A, 140, University Microfilms (Order No. AAD84-10506).
