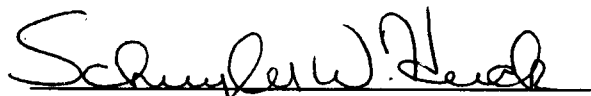
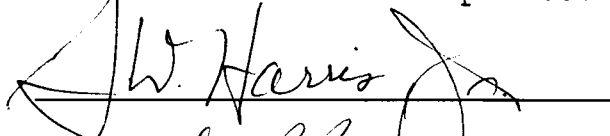
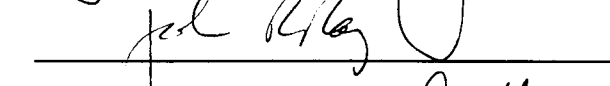
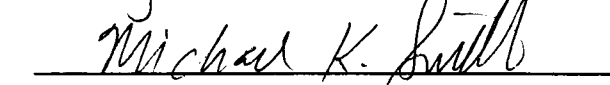


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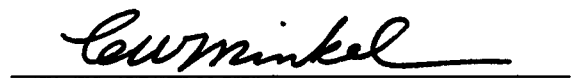
I am submitting herewith a dissertation written by Teresa Ann Garland entitled "Computer Applications and Student Achievement." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.


Schuyler Huck, Major Professor

We have read this dissertation
and recommend its acceptance:

Accepted for the Council:


Associate Vice Chancellor and
Dean of The Graduate School

Computer Applications and Student Achievement
in a Model Technology School

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Teresa Ann Garland
December 1995

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DEDICATION

For God
with whom all things are possible.

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ABSTRACT

The primary purpose of this investigation was to examine the relationships between time spent in minutes on different computer applications and student achievement in reading and language arts. Further, this study considered that relationships differed for male and female students. In addition, differences in computer usage between students of different grade levels and of different genders were reported.

Data were collected from two hundred forty-eight students in grades one, two, and three at an elementary school in East Tennessee. Scores from the 1993 spring administration of the Comprehensive Test of Basic Skills (CTBS) portion of the Tennessee Comprehensive Assessment Program (TCAP) were obtained in vocabulary, reading comprehension, total reading, language expression, language mechanics, and total language. In addition, computer records were collected for these students which contained information concerning the time spent on different computer activities. Activities were categorized according to the computer application they represented. Pearson Product-Moment Correlation Coefficients were computed to determine the relationships between variables.

No significant relationships were found between time spent on tutorial applications and achievement test scores of

primary grade students. Tutorial applications include both drill and practice and tutorial activities. Significant relationships were found for female students in grades one and two between time on techniques applications and achievement scores in reading and language arts. Techniques applications consisted of word processing, desktop publishing, and writing cartoon captions. Significant relationships were also found for female first and second graders between total time on reading and language arts activities and achievement test scores. Total time on reading and language arts activities was the combined time spent on tutorial and techniques applications.

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CHAPTER I

INTRODUCTION

American schools are steadily purchasing computers for instructional purposes and the use of technology will continue to flourish (Office of Technology Assessment, 1989). Technologies are both a catalyst and a tool in the transformation of education (Mann, 1994). If used properly, computer technology can be a valuable teaching aid for teachers. In their report summarizing the research on the effectiveness of computer assisted instruction (CAI) in schools, Rappaport and Savard (1980) recommend that CAI be promoted and expanded in the schools. But how do educators determine the best ways to promote and expand computer instruction? Shroeder (1994) writes that it is important to confirm the computers' impact on learning. Becker (1986) suggests that we examine studies that compare the achievement of students using computers with those who have not used computers. Becker (1986) writes,

Small school and classroom-based programs have been started throughout the country. Not only do studies contribute to the field...they are essential if we are to make progress in establishing the usefulness of new computer-based methods and materials (108).

Educators want to know how computers can best be used to improve instruction. In determining how to use

computers, several questions must be asked. How well do computers work to increase student learning? In what subject areas are computers most effective? What type of computer applications work best to teach students? And which students benefit most from computer instruction? These are all questions that must be answered if educators are to implement technology effectively.

Many Americans are calling for changes in the focus of today's educational system. One proposed change is for education to embrace technological advances and train workers for the jobs of the future. This change has the support of leaders of business and industry who believe education is already behind in producing technologically literate students. Damian (1982) agrees, predicting that the higher-order skills often used for computer programming today will be the basic skills of tomorrow.

Parents, business leaders, students, and educators agree that contemporary instruction must prepare students for a technological world (Bangert-Drowns, 1989; Lund & Wild, 1993; National Commission Excellence in Education, 1983). Millions of people use computers at home and work, and the lives of people in every segment of the population eventually will be touched by technology. Because of the increasing interest in technology, the use of computers is starting to be seen as the mark of a school's adequacy. Kulik and Bangert-Drowns (1984)

contend that education is now being transformed by a technological revolution focused on the uses of computers for instruction. School administrators must be prepared for these changes and become informed about computers in order to effectively and efficiently implement computers in schools and reap the most benefit. They must learn how to make decisions related to computer use, calculate the cost of computer implementation, evaluate the cultural values presented by computers and computer software, gauge the educational demands of the community, increase the availability of adequate computer software, and determine the uses and effectiveness of computers.

Computers have had an irrevocable impact on education in the United States. The projected result of this influx of technology into public schools is a more effective education for students. Suppes (1983) suggests it is important to recognize the influences of technology and organize instruction around the educational needs of today's students. Partridge (1991) contends that technology can enhance the instructional effectiveness of schools and help them move toward the goal of a quality education for all children.

As the growth of technology continues, government officials will face many policy decisions (Education Turnkey Systems, Inc., 1985). Five strategies are

suggested for addressing these issues that could be of use to local school officials:

1. Encouraging the effective use of computers.

This can be done by disseminating research findings and exemplary practices and by targeting specific populations.

2. Ensuring the availability of good software.

Such software should be interesting to a variety of students and free from racism, sexism, and bias.

3. Addressing the problems of equal access to computers.

This can best be done by studying imbalances that exist such as gender, ability, socioeconomic factors, and planning interventions.

4. Expanding staff development and training.

5. Fostering debate on the importance of computer knowledge.

Educators are examining how computers can be used to improve instruction more now than ever before. The cost of computers has decreased over the years, and using computers to facilitate instruction has become

increasingly attractive (Rappaport & Savard, 1980). Some researchers have found computers to be a cost-effective way to deliver instruction to students (Niemiec & Walberg, 1989). Kulik and Kulik (1991) suggest that further study is needed on the cost effectiveness of computer instruction. Roblyer (1989) writes:

As educational decision-makers face the fiscal challenges of maintaining and expanding the instructional computing movement, they need current information about the past and potential impact of computer applications to help them invest their resources wisely (1).

Fultz (1993) recommends that values, not just value, must be considered in evaluating educational technologies. He states that one of educators' primary concerns when buying technology is whether they are getting value for their money. This includes a good price and a service contract. But he goes on to say that the values promulgated by the technology should be a concern as well. Educators should, for instance, determine if equitable representation is given to females and minorities as main non-stereotyped characters in computer software stories, examples and so on (Fultz, 1993).

The values and opinions of the community should also be considered in the decision to implement use in the schools. Some communities emphasize fundamental or lower-order skills. An example might be basic skills in

reading, writing, and arithmetic. Schools in these communities might choose to implement computer applications that build the recall of factual information. Typically, this is done with computers via drill and practice applications. Other communities emphasize development of critical and creative thinking capabilities. The schools in these communities might choose to implement computer applications that build higher-order thinking and problem-solving skills (Snelbecker, 1981). For these schools, one of the goals might be for students to learn to manage information by accessing, organizing, and presenting it (Mann, 1994).

Cohen (1984) writes that educators must become better users and consumers of computer software. They must be made aware of a particular software's strengths and weaknesses, its quality, and how it can best be utilized to increase student achievement. In attaining and implementing this information, educators can positively influence the quality of software produced in the computer market.

The future use of computers in schools depends on the initiatives taken by school decision makers to use such technologies effectively. Most experts agree that those initiatives with the greatest potential are:

Active Planning: Implementation must be systematically planned.

Comprehensive Staff Training: Teachers and administrators need thorough, continuing computer training that covers a broad spectrum of issues.

Centralized Control: This means that control of all computer operations, including telecommunications is housed at a central location.

Institutional Reform: Administrators should implement educational reforms such as staff incentives, flexible scheduling, and revised staff certifications. These reforms would serve to increase the use of computers (ETSI, 1985).

An analysis of research pertaining to the use of technology in education revealed a variety of computer applications used in schools. The results of the 1983 survey of the Center for Social Organization of Schools (Collis & Muir, 1984) revealed that computers were being used for: learning about computers, learning with computers, using them as tools, and using them with special student groups. Learning about computers included computer history, vocabulary, operating skills, uses and abuses, and programming. Learning with

computers related to drill and practice experiences, generally in mathematics and language arts. Computers as educational tools involved using software in teaching. The use of computers with special student groups related to the implementation of computers with various subgroups of students, such as the handicapped, female students, and students from lower socioeconomic groups.

Research indicates that different learners may be successful with each of these different applications of technology. Students with different styles of learning benefit from different kinds of software programming. However, current use of the computer in some elementary schools appears to be limited to a narrow spectrum of applications.

A recent survey of elementary school teachers (National Institute of Education, 1988) found that the computer was used by 54 percent of those questioned for drill and practice activities. Forty-three percent of these teachers taught computer literacy and programming. Learning games were used to facilitate instruction by 46 percent of those surveyed. None of the teachers reported using the computer for applications or word processing. Results from this study indicate that 40 percent of all computer time is spent practicing math facts, learning facts, spelling drills, and other memorization tasks.

More computer time was used for drills and remedial activities than for any other computer activity.

Other studies have reached similar conclusions. A 1989 Department of Education study reported that computers are rarely used to introduce concepts or skills to students. Teachers in this study viewed drill and practice to reinforce instruction as the most productive use of the computer.

Recently, educational research has pointed to microcomputers and other educational technologies as having a beneficial effect on student achievement. Chiou (1992) believes that educational research related to instruction should be "product-oriented" (10). This means looking at methods of instruction and determining if outcomes reflect gains in learning. A measure of learning used often is standardized achievement test scores. Achievement test scores have been considered a good way to assess student learning (Anessi & Trollip, 1991). Walberg (1992) agrees writing, achievement tests have the advantages of educational and psychological plausibility, accuracy, and validity in risk assessment, and they avoid the expense, time, unreliability, misclassification, and harm of other means of risk assessment. They also provide measures of accomplishment and diagnosis, and concentrate attention on the tangible and reasonably agreed-upon ends of schooling (7).

Importance of the Study

Literature is replete with claims of the effectiveness of various methods of computer-assisted instruction (CAI). However, after nearly 25 years of computer usage in public education, the impact of computer applications on traditional measures of educational effectiveness (student achievement, attitudes, dropout rate, and learning time) remains largely unknown (Roblyer, Castine & King, 1988).

Definitive research relative to the instructional effectiveness of CAI was elusive in 1980s, but how definitive are the data in the 1990s? Many educators would agree that information about the effectiveness of computers remains elusive and that more studies are needed concerning the impact of computers on teaching and learning (Roblyer, 1989; Becker, 1986; Clark, 1985; Gillingham & Guthrie, 1987; Burns & Bozeman, 1981; Kulik & Kulik, 1991; King & Roblyer, 1984). Studies are needed in a broad range of areas: instructional effectiveness (Burns & Bozeman, 1981); design and delivery of instruction (Clark, 1985); effectiveness of different types of computers (Kulik & Kulik, 1991); computer tools that increase student achievement (Gillingham & Guthrie, 1987); and how time on computers can best be allocated (Becker, 1986).

Every day American public school administrators are making decisions related to computer implementation. These policy decisions concern how, where, and by whom computers will be used. Often these decisions are not based on complete information, for instance, the effectiveness of computers in different subject areas (Okey, 1985). Becker (1986) agrees, concluding that we need to know in what subjects and for what students computers are a helpful learning tool. Additionally, he continues, we need to know what software provides the learning experiences needed to meet curricular goals. Becker (1986) concluded that the evidence of computer effectiveness was scanty and provided little information to help educators decide how to best use computers for instruction. He predicts that educators will become disillusioned with computers if objective evidence does not accumulate that illustrates the effectiveness of computers.

King and Roblyer (1984) propose school and classroom-based computer programs need to be studied in order to contribute information to the field. They think these studies are essential in establishing the usefulness of new computer methods and materials. This information is critical in the selection and implementation of computers. Becker (1986) writes that educators have great interest in knowing the ways that

"allocating computer time would produce the greatest improvements in student academic performance" (108). He believes research studies can "provide school districts with valuable information relevant to their current investment policy for instruction-related technology" and can provide information about "making their computer investments pay off in the best ways" (108).

Roblyer (1989) concurs and believes now is the time for computer research, writing:

Findings indicate that computer applications have an important role to play in the future of education, but the exact nature of that role has only begun to be explored. Opportunities for using technology to make an impact on education have never been greater, and neither have opportunities for research (10).

Purpose of the Study

The current status of CAI is problematic in several areas of particular interest in this study. Of primary concern is that the evidence regarding the effectiveness of CAI is far from substantial. This is especially true when effectiveness is defined by a traditional measure of performance-achievement test scores. Although computers have become more and more visible in schools, test results have continued to decrease or remain constant. It appears that technology has failed to live up to many

educators' expectations in improving learning as defined by specific outcome measures.

To determine which application category is most suited for improving achievement test scores, an objective method of comparison is necessary. However, a review of related literature failed to produce such a method. Lack of information makes it difficult to decide which computer applications are the most effective and efficient. Unfortunately, much of the belief in the effectiveness of CAI in increasing test scores is a matter of faith rather than fact.

The purpose of this study was to investigate the relationships between individual reading and language arts scores as measured by the vocabulary, reading comprehension, total reading, language expression, language mechanics, and total language scores on the Comprehensive Test of Basic Skills (CTBS) portion of the Tennessee Comprehensive Assessment Program (TCAP) and time spent on computer applications. An additional purpose was to examine differences in time spent on computer applications between students of different grades. Further, gender differences in time spent on computer applications were explored. The subjects for this study were all first, second, and third grade students at Ingleside Elementary School who participated in 1994 spring achievement testing.

Assumptions

- Tennessee Comprehensive Assessment Program (TCAP) and/or the Comprehensive Test of Basic Skills (CTBS) measure what they are designed to measure in each subtest.

Limitations

- No attempt was made to control for extraneous variables such as socioeconomic status, IQ, age, ability level, or by quality of instruction received of students taking the test.
- The study is limited to the computer applications currently in use at Ingleside Elementary School.
- Findings cannot be generalized to populations that differ from the one used in this study.

Delimitations

- The study is delimited to the use of Ingleside Elementary School students.

- The study is delimited to students' reading and language TCAP/CTBS test scores.
- The population includes grades one, two, and three because of the school population (K-3).
- This study is delimited to those students taking the TCAP/CTBS spring 1994 test.

Organization of the Study

This study is organized into five chapters. Chapter I includes the introduction and a brief description of the study. Chapter II presents a summary of pertinent information found in the review of books, professional journals, and unpublished doctoral dissertations and master's theses. Databases searched for the review of literature were: Dissertation Abstracts and Educational Resources Information Center (ERIC). Other studies were retrieved by branching from bibliographies located through the computer searches. Contacts were made with educators in the field for unpublished works and interviews. Chapter III discusses the methods and procedures that were used in the collection and analysis of the study data. Chapter IV presents the findings of the study; and Chapter V is a

summary of the study, conclusions derived from the findings, and recommendations for further study.

CHAPTER II

LITERATURE REVIEW

The majority of literature pertinent to this study suggests that, when properly implemented, computer instruction can have a positive impact on student achievement. What constitutes appropriate implementation is arguable, but a few major themes emerge. Selection of appropriate computer technologies is a very important and complex theme. It requires considering the needs of the students, the school climate, and expected outcomes.

The number of computers available for staff and students, including how this relates to the amount of time students can spend on computer activities, is a central issue. The training of teachers is another concern. Training should be thorough and continuing. Having a computer consultant as a resource person is considered to be helpful.

Computer activities should cover both lower-order and higher-order skills, providing a wide range of experiences for students. Software selections should be appropriate, interesting, and reflect equity. Females and minorities should be adequately represented in non-stereotypical ways.

Another equity issue that must be addressed involves the availability of computers. Female students, minority

students, and students of all ability levels should be guaranteed adequate time on all types of computer applications.

Well-implemented computer programs generally produce achievement gains. Positive effects are seen when the proper setting and scheduling have been implemented, including flexible scheduling, effective teacher training, administrative support, and individualized pacing. Beasley (1985) believes it important to select software that focuses on educational goals and can be integrated throughout the curriculum. Continuing evaluation of computer instruction is recommended. Studies are needed that answer questions about who benefits most from different types of computer applications.

The best use of computers depends on the situation in which they are used. The decisions about which technologies to implement must be made by school administrators who have given consideration to the values, philosophies and goals of the school system, and the needs of the user (Marsh, 1993).

According to Snelbecker (1981), the climate of the school influences the type of computer applications used. Teacher-controlled programs would be more compatible with drill and practice, while school programs in which students are responsible for their learning may be more

compatible with other types of activities. Snelbecker (1981) goes on to say,

In a sense, such innovations can serve as extensions of the teacher and should be viewed as such when selecting among possible alternatives and planning their use in the education of young children. They can aid in providing personalized educational experiences for each student and in giving students guidance about their progress on an individual basis in a timely fashion (53).

In choosing software, educators must select technologies that meet the needs, interests, and learning styles of students. These technologies should have equal representations of men and women, and minorities. Students should be able to use the software cooperatively when working in small groups.

How can administrators decide what type or types of computer applications are appropriate for their schools? First, they need to collect some information about particular computer applications. Some questions they need to answer are:

- What educational objectives are attainable by using this particular application?
- What evidence supports that these objectives are attainable (research)?
- With what type of student has this application proved effective?
- In what kind of school and with what kinds of teachers and students has this type of application been used?

- What are the limitations of this application?
 - What kinds of problems can be anticipated in using this application?
 - Has the application been effective over time?
- (Snelbecker, 1981).

Some of the most frequently used applications are drill and practice, tutorial, word processing, communications, and information technologies.

Tutorial and Drill and Practice Applications

Drill and practice activities generally describe situations where the concept is presented in class and reinforced using the computer. Tutorial applications typically introduce a concept on the computer and follow-up with activities to reinforce the concept (Suppes, 1968). Marsh (1993) recommends drill for students who need to overlearn content and in subject areas where overlearning is essential. Tutorial, Marsh (1993) writes, is useful in mastering concepts because the computer helps the learner, adjusts content to the appropriate level, and provides assessment.

Spence and Hively (1993) would agree that practice can be beneficial for many students. They write that students are often pushed to higher levels long before the tool skills are mastered. Vockell (1990) writes that

computers can help students overlearn skills so that they become automatic. Some students who benefit from overlearning are low-ability students (Burns & Bozeman, 1981; Carnoy, Daley & Loop, 1987; Swan, Guerrero, Mitrani & Schoener, 1990). For low-ability students, drill and practice was more effective than tutorial applications in increasing achievement (Carnoy et al., 1987). CAI has been shown to work with behavior-disordered students as well. Cheney (1990) found that students who used computers spent more time on task and were less disruptive. Kulik and Bangert-Drowns (1984) believe the patience of drill and practice applications in tutoring students and the immediate feedback it can give may contribute to achievement gains for students.

Kulik (1983) and Ragosta (1983) agree that drill and practice is important in students' learning and can lead to measurable increases in test scores. Other researchers have produced findings that support this opinion. In his 1985 meta-analysis of computer studies, Bangert-Drowns found that CAI with tutoring and drill and practice was effective in raising achievement test scores.

Burns and Bozeman (1981) found that when CAI was used for small amounts of time in elementary schools it led to achievement increases. They reported that slower students showed larger increases, but the higher-ability

students also had gains when using drill and practice. For elementary and secondary students, they found that tutorial applications produced slightly greater gains than drill and practice applications. CAI was found to be effective in increasing math achievement for both high-achieving and low-achieving students. No significant increases were found for average students.

Kulik and Kulik (1983) found moderate achievement gains in their meta-analysis of computer studies involving drill and practice, tutorials, computer-managed teaching, simulations, and programming. Gains were similar to an increase from the 50th percentile to the 63rd percentile. In 48 of the 51 studies they evaluated, computer users had better scores than control subjects.

Visonhaler and Bass (1972) reviewed ten computer studies. They reported that elementary students who received drill and practice generally demonstrated performance gains from one to eight months greater than students who received only traditional instruction.

Anastasio and Wilder (1984) conducted a longitudinal study of CAI. This study focused on CAI in compensatory education in elementary grades. Achievement test scores on the Iowa Test of Basic Skills showed the greatest improvement in mathematics. Reading and language arts scores showed improvement, but to a lesser degree.

Carnine (1987) summarizes eight research studies related to CAI's use with mildly handicapped secondary school students. Findings indicate that drill and practice, tutorial, and simulations used as a supplement to teacher instruction could help these students increase skills in doing math word problems.

Hartley's (1977) meta-analysis revealed improvement in elementary and secondary math scores. Gains were similar to a move from the 50th to the 66th percentile. Niemiec and Walberg (1985) found similar results when elementary school students used CAI for mathematics instruction. Suydam (1986) concluded that drill and practice and tutorial forms of CAI are effective in developing math skills of students. Carnoy et al. (1987) write that the increases in mathematics achievement as a result of CAI are more often statistically significant and of greater magnitude than in other subject areas. Roblyer (1989) and Resta and Rost (1986) would concur. They found achievement gains made in mathematics were greater than those in reading. Mys and Petrie (1988) found the WICAT program to be effective in producing greater gains in mathematics.

Some authors, however, view drill and practice as poor use of computer time. O'Brien (1987) believes that the repetition of drill and practice is mind killing. Papert (1993) agrees that these applications are poor

selections for educators and that computer time could be better spent using other computer applications. Other researchers have not found positive results using drill and practice. Suydam (1986) in his study of CAI in mathematics found that it did not necessarily increase achievement levels. Carnoy et al. (1987) could make no conclusion about the influence of CAI on increases in math and reading test scores. In a 1985 study evaluating the Dolphin CAI program in Chapter I in District of Columbia Schools, Harris and Lipinsky found no statistically significant differences in reading and math gains between students using CAI and those who did not use it. Hativa, in a 1988 case study of an elementary girl's use of the computer, found that drill and practice did not improve mathematics scores. In fact, the student performed worse on the computer than on paper. Swan, Guerrero, Mitrani, and Shoener (1990) found CAI was as effective in reading as in math. No researcher found CAI more effective in improving reading than math achievement.

A 1985 study of the uses of computers in education found that drill and practice was the most often used computer application in schools (Education Turnkey Systems, Inc., 1985). Becker (1986) concurs, writing that drill and practice dominates computer usage, particularly in the primary grades. He reports that most

computer time is spent in math and language arts areas. He blames this on a lack of equipment and the unsystematic planning of computer implementation at this grade level.

Edwards, Norton, Taylor, Van Dusseldorn, and Weiss (1974) concluded that drill and practice was the most consistently effective computer application. Their conclusions could be biased due to an overemphasis of research on drill and practice. Most computer studies involve the use of drill and practice applications used for practice in mathematics and science (Okey, 1985). Drill and practice reflects a lower-order instructional process, but its purpose is skill development, which is an important step in developing higher-order cognitive skills. Hativa, Shapira and Navon (1990) propose that teachers use drill and practice because they believe it benefits students. Research appears to support this belief, but some studies have not produced such astounding effects.

Carnoy et al. (1987) write that CAI does improve student achievement, but there is no clear indication of which aspect of CAI contributes most directly to these gains, i.e., software design, intensity of contact, external reinforcements of CAI material, and so on. They go on to say that this does not mean school systems should immediately rush to buy drill and practice

software. They suggest more research should be conducted with both drill and practice and problem-solving software.

Swan, Guerrero, Mitrani, and Schoener (1990) concluded that tutorial and drill and practice activities are effective in developing skills and diagnosing skill deficiencies. They warn, however, that

the problem-solving skills inherent in higher-level reading and mathematics may not be so easily developed, nor the lack of such skills so simply diagnosed by instructional models of this sort (400).

These studies of drill and practice and tutorial applications are important, but studies of other computer applications are needed as well. Okey (1985) reports that computer studies are expanding to look at simulations and problem solving as well as drill and practice and tutorial applications. Suydam (1986) agrees, writing that, although drill and practice in mathematics has been the predominate use of computers, word processing is increasing.

Techniques Applications

Drill and practice and tutorial activities are still the most often used computer applications in schools (Becker, 1991), but word processing is gaining ground. Shroeder (1994) writes,

Despite the continued prevalence of drill and practice techniques, the selection of interactive software and recognition of word processing's usefulness are improving rapidly (2).

Morton, Lindsay, and Rocke (1989) predict word processing may prove to be one of the most important computer applications. They also write that its use with elementary-age students looks very promising. Also promising is desktop publishing. Desktop publishing was developed to work with word processing and graphics programs (Marsh, 1993). Students can use desktop publishing to produce works that include both text and art. This allows the writer to use words and pictures to tell a story.

Spreadsheets perform mathematical operations such as addition, subtraction multiplication, division, and squaring on numbers. Using spreadsheets requires thought and planning on the part of the student (Marsh, 1993). Techniques applications include such technologies as spreadsheets, desktop publishing, and word processing.

In 1986, Becker reported that students used word processing applications about 15 percent of their computer time (Becker, 1986). In a 1991 article, he discusses a survey of 54,000 public school educators. The survey results indicated that the time spent teaching keyboarding and word processing had increased, surpassing the time spent teaching computer programming.

Keyboarding is the foundation of word processing (Marsh, 1993). Students need knowledge of and skills in keyboarding to make computer use faster and more efficient. In some studies, lack of keyboarding skills confounded the results (Gardner, Morrison & Jarman, 1993).

Russell (1989) writes that word processing, along with telecommunications, databases, and spreadsheets, is one of the workhorses of the computer. Word processing helps students get around writing problems; helps them focus on their strengths; helps them communicate more effectively; and helps students with special needs (Russell, 1989). Other authors agree. Hornbeck (1990) writes that word processing assists students in writing. He proposes that students write more material and that what they write is more structurally complex. In a 1989 report by the Office of Technology Assessment, word processing contributed to significant improvements in writing. Mann (1994) concurs, writing, "Through word processing applications students learn to focus their thoughts, collaborate, revise and produce quality work" (172).

Word processing is seen as beneficial in other areas well. Shroeder (1994) claims word processing can aid poor readers in improving reading skills. Yet another author, Collins (1991), found that word processing

enhanced language skills such as composing, editing, grammar, spelling, punctuation, and proofreading. In another study, Hall and Rhodes (1986) found that word processing encouraged cooperation and collaboration, describing students writing, talking, reading, and exploring together in the learning environment. Beasley (1985) foresees these attributes as particularly beneficial for gifted students.

However, other studies have produced less positive findings. Roblyer (1989) could draw no conclusions about the effectiveness of word processing in improving writing skills, but did conclude that it had a positive effect on student attitude. MacArthur and Graham (1984) looked at the impact of word processing on the writing ability of learning disabled, elementary school students and found that it did not have a major impact.

Word processing appears to help some students improve their writing skills. It has also been shown to improve standardized reading scores. Kindergarten and first grade students who used IBM's Writing to Read program progressed faster than other students on standardized reading tests (Arzt, 1987).

Many authors believe in the ability of word processing to improve students' higher-order thinking skills as well (Roblyer, 1989; Shroeder, 1994; Hornbeck, 1990). According to Roblyer (1989), the use of word

processing seems to be promising in enhancing creativity and problem-solving skills. Hornbeck (1990) believes that writing is the skill most closely linked to thinking and that word processing can help students improve their writing. Word processing allows students to interact with the text and use higher-order thinking skills (Schroeder, 1994).

Whether or not word processing is effective in building certain skills, teachers perceive it to be. In his 1986 survey of teachers, Becker uncovered some interesting teacher perceptions concerning computer uses. Teachers in schools that used mostly drill and practice activities felt computer time was more beneficial for lower-ability students. Teachers in schools that emphasized word processing reported computer time more beneficial for above-average students. Computer programming, teachers reported, made no contributions to learning outcomes.

In their study, Gardner, Morrison, and Jarman (1993) found that teachers reported students wrote longer pieces, redrafted, and edited their work using word processing. This, teachers believed, had a positive impact on the quality of writing of primary school students. In a similar study, teachers attributed improvements in their students' sentence structure and mechanics to word processing (Arzt, 1987).

Time continues to be a factor in the use of computer applications. Word processing requires longer amounts of time than are now available to most students using computers. This need for increased time is especially apparent when discussing learning disabled or other physically challenged students (Morton, Lindsay & Rocke, 1989).

Artz (1987) recommends more descriptive studies of word processing. He suggests the need to know the effects of a sequential, long-range word processing program, particularly the implementation strategies used. In addition, the effects of technological enhancements such as word processing, multi-user networks, electronic news wires, and so on should be scrutinized (Artz, 1987).

Telecommunications

Papert (1993) writes that electronic communication provides new contexts for learning. Telecommunications provides access to information and correspondence via telephone lines anywhere in the world (Collins, 1991). It allows students to communicate with students in other classrooms in the building, the district, the state, the country, and even internationally (Marsh, 1993).

Telecommunications can be divided into two forms: telelearning and electronic mail. Telelearning may

involve audio and video conferencing, exchange networks, videotapes, electronic bulletin boards, and so on. Whatever its forms, telelearning links people who are geographically distant. One of its current uses is to provide classes for students in remote areas. Electronic mail, or e-mail, refers to communication between people using computer modems to access telephone lines. Students can be linked to pen pals virtually anywhere in the world (Mann, 1994).

Telecommunications does seem to be a medium that can have many educational benefits (Fishman & Pea, 1994; Harasim, 1990). There are drawbacks, however. At this time the huge cost of implementing these technologies in schools seems to outweigh the benefits (Roblyer, 1992).

Exploratory/Problem-Solving Applications

Databases are a collection of information stored on the computer. Databases work like a filing cabinet where information can be organized and searched (Marsh, 1993). On-line databases, data retrieval from libraries, and correspondence can be accessed through electronic mail.

Compact disks with read-only memory, better known as CD-ROM, can contain entire encyclopedias with pictures, graphics, data, videos, and sound (Mann, 1994; Barker & Tucker, 1990). The primary function of the CD-ROM is the

storing of information and published products (Marsh, 1993).

Simulations generate models that replicate real-world situations and allow students to problem solve without dangerous consequences (Collins, 1991; Marsh, 1993; Allessi & Trollip, 1991). Games and simulations help illustrate concepts and principles. Both encourage the development of logical thinking and problem-solving abilities, which reflect higher-order skills. Exploratory/Problem-Solving applications include such technologies as databases, CD-ROMS, simulations, and games.

Computer Effectiveness

What is the effectiveness of various types of computer applications? Probably there is not one best method of computer instruction. Each type of application has its own strengths and weaknesses. Cohen (1983) writes that, when looking at increasing student achievement with computers, one must consider the type of application being used.

When computers are used to supplement traditional instruction, elementary students have improved achievement scores. Especially for disadvantaged

students. Other research has supported this finding. Rapaport and Saverd (1980) and Walberg (1991) found that CAI as a supplement to traditional instruction proved to be effective.

Roblyer (1989) found effects were slightly higher for tutorial applications in reading, but no conclusions about the superiority of one type of application over another could be supported. Roblyer (1989) points to trends in his research and suggests further study of drill and practice and tutorial applications and their effects on low-level and higher-level skills. Many authors suggest continued research on a variety of computer applications (Roblyer, 1989; Okey, 1985).

Are computer applications more effective with certain types of content? Gillingham and Guthrie (1987) report that experts disagree on what topics should be taught and which computers tools are most suitable for increasing achievement. Gillingham and Guthrie (1987) write that descriptive studies are necessary to determine which components of instruction can be effectively provided by computers. Some areas of interest are: subjects, grade level, learner maturity, and ability level. In 1985, computers were used most frequently in mathematics in elementary schools. This was followed by use in language arts, reading, computer programming, social studies, science, and art. CAI has been most

effective in science, foreign language, mathematics, reading, and language arts (ETSI, 1985). Other researchers have found CAI to be more effective in increasing mathematics achievement than in reading achievement (Bennett & Maher, 1984). Perkins (1987) suggests computer studies need to be done in other subject areas. Collins asserts that the ability to incorporate computer instruction into all subject areas is currently available within most school systems. When CAI is integrated fully into the curriculum it is more effective.

Many authors believe computer instruction can be used to improve reading skills. Schroeder (1994) believes CAI improves reading by improving affect, fluency, comprehension, and writing skills. The Office of Technology Assessment (1989) reports that reading comprehension can be improved with computer-assisted reading programs that focus on whole text and comprehension. Cronin, Meadows, and Sinatra (1990) used computers to increase reading and writing scores of eleventh grade students.

The preponderance of computer studies are in mathematics content areas, where it has been demonstrated to be effective. Perkins (1987) writes that computers are worth the time and that skills in math improved when elementary students used computers. Drucker, McBride,

and Wilbur (1987) studied third grade students in mathematics. Using the computer to analyze errors helped these students improve subtraction skills. Coates and Stephens (1990) found a strong relationship between computer science aptitude and mathematics achievement among junior high students. Way (1984) looked at the scores of eight grade students attending CAI labs on the Iowa Test of Basic Skills. Students attending the lab had higher math scores than non-computer-using eighth graders.

Other studies have produced less positive results. Gardner, Morrison, and Jarman (1993) concluded that high levels of technological usage may not impact student scores in mathematics during a one-year span. They found no difference in overall performance between experimental and control groups. There was a positive result in science, but it was not significant.

Studies looking at the effectiveness of computers in improving reading and math skills have produced mixed results. Swan Mitrani, Guerrero, Cheung, and Schoener (1990) found that computer-based programs, of which WICAT was one, increased scores in reading and math for the educationally disadvantaged. Swan, Mitrani, Guerrero, Cheung, and Schoener (1990) studied computer-using students in grades three through twelve. They were able to link program participation to performance. Reading

gains and math gains were similar in this study. Computer-using elementary children achieved gains of one to eight months greater than non-computer-using peers (OTA, 1989). Baker, Gearhart, and Herman (1990), in their evaluation study of Apple Classrooms of Tomorrow (ACOT), found little difference in achievement test scores of ACOT students compared to other students. Writing had shown some improvement, but the differences were attributed to pre-existing differences. A 1987 study conducted by the Office of Education Assessment evaluated the gains in achievement by a sample of Chapter I students. Scores had improved, but this gain was not statistically significant. Carnoy et al., (1987) caution that the findings being reviewed are not descriptive of what is actually occurring in school classrooms, but indicate the gains that could occur in specific situations with specific technologies.

The number of computers needed in a system often depends not only on the type of implementation, but also on the number of students and the amount of time students need to spend on computers. Time is a complex issue in the implementation of computers in instruction.

In a four-year California study, Anastasio and Wilder (1984) found time spent on CAI to be a factor influencing achievement test scores. In reading and language arts, students showed gains with ten minutes per

day on the computer. In mathematics they found that while students using CAI for ten minutes showed gains, students using CAI for twenty minutes had double the gains of the ten-minute users. The experimental group in this Educational Testing Service study were at the 64th percentile in math after the first year, 71st percentile the second, and 76th percentile the third. The experimental group showed steady increases over time. Results were similar in reading and language arts (Ragosta, 1983).

Carnoy et al. (1987) uncovered similar results in their review of studies. They found that primary school students who used drill and practice for limited durations over an extended period of time did show increases in reading and math scores. In another review of studies, Suydam (1986) reported at least one study where achievement was linked to the amount of time spent on the computer. Burns and Bozeman (1981) are other researchers who suggest there may be a relationship between achievement gains and the number of CAI sessions a student receives.

High-risk students appear to benefit from time on CAI as well. Dowdney (1987) found that high-risk secondary students improved in reading and math after using the computer one hour per week. Papert (1993) agrees writing that CAI will raise the test scores of low

achieving students. Okolo (1992) suggests that using computers helps these students spend more time on task.

Other researchers have produced conflicting results. In a study of students in grades one through five who used WICAT, Bliss (1991) found that students in the experimental group showed no greater gains than expected when compared to control group students. Experimental subjects used the computer 30 minutes per day for supplemental instruction in reading, language arts, writing, and mathematics. Becker (1987) found no evidence that school-wide test scores were affected by CAI in most elementary school settings. He reports that computers have only a limited impact on student learning.

One study found that the typical elementary school student spent 20 minutes per week on the computer and attributed this lack of use to be a result of poor teacher training (ETSI, 1985). Becker (1987) found elementary students who use computers average about 35 minutes per week on them. He breaks this time down even further, reporting that over 75 percent of computer time is spent on mathematics, language arts, spelling, and reading activities. Fifty percent of this is with drill and practice and tutorial activities. The other half of computer time is divided between such activities as: computer programming, keyboarding, problem-solving, word processing, and so on.

The relationship between time spent on the computer and gains in achievement remains unclear. The studies previously mentioned may reflect more time on computers than the typical student receives.

Most studies that looked at time in relation to computer use focused on the time saved by using computers. These studies reported that students typically learned concepts much faster when taught and reinforced on the computer. (Kulik & Kulik, 1983; Kulik & Kulik, 1991; Marsh, 1993; Edwards et al., 1974; Kulik, et al., 1987; ETSI, 1985; Burns and Bozeman, 1981; Kulik Bangert-Drowns, 1983-1984; Bracey, 1992; Thomas, 1979). Students generally spent 20 to 40 percent less time learning the concepts. Increasing the amount of time students spend at school has been a recommendation of some educators (NCEE, 1983; Walberg, 1992). If the same concept can be learned on the computer more quickly, computer learning might be a more effective use instructional time.

It is predicted that time usage patterns will increase and become considerably different from those currently in operation (ETSI, 1985). Because it is generally accepted that more practice leads to greater mastery of skills, the amount of time students spend using CAI may have considerable impact on the benefits received. More research is needed that provides

information about meaningful units of time in relation to the computer (Becker, 1986).

After administrators learn about computers, computer applications, the effectiveness of computers on achievement, and the number of computers needed, they must determine what types of applications would fit best with the school climate and goals of the system. Becker (1986) writes that the more computers a school had, the more educators in that school perceived them to have an effect. What this effect was perceived to be depended to a large degree on the climate of the school. Snelbecker (1981), for instance, proposes that teacher-controlled school programs are more compatible with computer applications using drill and practice than are programs in which students have major responsibilities for their own learning. Becker (1986), in his survey of educators, found that school teachers and administrators in schools that emphasized drill and practice thought below average and gifted students benefitted from computer instruction, but that it was not very helpful for average students. In addition to school climate, the gender of the teacher played a role as well.

In his 1985 study of computer-using teachers, Becker found differences in strategies and outcomes between male and female teachers. Female computer-using teachers used computers more for programming and less for drill and

practice than their male counterparts. At the elementary school level, female teachers used computers longer and with more positive outcomes.

Integrating computers into schools will cause change. Successful change, Collins (1991) writes, must be well-planned, comprehensive, include staff development, and be long term. Most importantly, it requires the support of teachers. As with most educational reforms, the impact of computers on students and the educational environment depends to a large degree on teachers. For this reason it is extremely important that teachers learn how computers work and how they can be used in schools (Shelbecker, 1981). Many authors concur that teachers continuing educational training and growth is essential to the healthy educational growth of students and that this is particularly true in relation to computers (Zajonc, 1992; Collins, 1991; Fullan, 1982; Borchers, Shroyer & Enochs, 1992; Mayshark, 1995; Snelbecker, 1981; Parker, 1985).

What creates a supportive environment for teachers to learn about and use computers? Borchers, Shroyer, and Enochs (1992) state it most succinctly, writing that teachers in rural settings used computer-teaching strategies after adequate training, continuous support, and implementation assistance. The authors found computer consultants were a critical factor because these

consultants provided on-site expertise. Implementation also required administrative support in the form of funding, time, flexible scheduling, continuing computer training, and encouragement.

This teacher training, Fullan (1992) suggests, must result in changes in practice in the classroom. For this change to occur, Borchers, Shroyer, and Enochs (1992) write that teachers must believe computers have the capability to enhance learning. This might be accomplished by presenting teachers with research results that illustrate the computers capability to increase achievement scores. Clariana (1992) believes the process is a little more simple, writing that, if teachers know the content areas covered by achievement tests and the content of material covered by the computer, then teachers will adjust instruction accordingly. However, teachers must have some knowledge of computers before they can use them as a teaching tool.

With the advent of technology in the classroom, teachers are being asked to accommodate a changing classroom culture and changing patterns of control (Levinson, Doyle & Benjamin, 1993; Turkle, 1984; Weir, 1989). Mann (1994) concurs, writing, "Technology-rich learning environments are changing ideas about learning as they reshape the roles of teachers and students" (176). These roles become blurred as teachers and

students learn together and teach one another. This arrangement can empower students in the learning process, helping them to feel they have more control over learning (Mann, 1994). Swan, Mitrani, Guerrero, Cheung, and Schoener, in their 1990 report on computer-based classroom environments, found that teachers who used computers were more facilitators of learning and that learning in their classrooms was more individualized and instruction more student centered and cooperative.

Before any of these benefits can occur, teachers must be sold on the idea that computers can aid in instruction. Administrators should make teacher training a central part of their implementation strategy. Without teacher support, few educational reforms survive. Fullen (1991) states it most powerfully when he writes, "Educational change depends on what teachers do and think; it's as simple and as complex as that" (117).

Luckily, many teachers believe computers are an effective tool in instruction. In his study of teachers' beliefs about computers, Higgins (1990) found that 91 percent of computer-using teachers believed reading and writing skills were improved with computer use. Bliss (1991) reports similar findings. She found that a majority of teachers and administrators in a school using WICAT perceived it to be effective in developing reading and math skills. Some educators perceive computers to be

particularly helpful with low-ability students (Becker, 1986). Burns and Bozeman (1981) write that educators are interested in computer technology applied to education and that use will probably continue to grow.

Computers appear to give students a feeling of control over their own learning as well. Students using computers reported feeling more autonomous in their learning, especially high-risk students (Hornbeck, 1990). Swan, Mitrani, Guerrero, Cheung, and Schoener (1990) surveyed students who used computers. Sixty-three percent of these students believed that they were more in control of their own learning.

O'Brien (1987) believes the main goal of education should be the development of complex thinking and that the computer can facilitate this process. Becker (1987) found that educators in his survey saw computers to be beneficial in developing higher-order thinking skills. Teachers in the study predicted that high-ability students would benefit most from the computer in improving higher-order thinking. These beliefs translated into practice in Black's (1993) study that found differences in the learning experiences of low-ability and high-ability students. Black (1993) found that low-ability students received instruction in lower-order cognitive processes, while high-ability students

spend more time on higher-order processes such as analyzing, synthesizing, and evaluating.

Computer studies involving the use of simulations and problem-solving tasks to improve higher-order thinking skills have produced mixed results (Becker, 1987). Niemiec and Walberg (1985) did find positive results in using CAI to improve mathematical reasoning. Most computer studies have focused on mathematics. Perkins (1987) suggests CAI should be examined across a wide spectrum of subject areas at the same time and postulates that CAI across the curriculum might lead to the development of problem-solving strategies in students.

Beasley (1985) recommends educational software that provides activities at a variety of mental levels and that emphasize the higher levels of Bloom's Taxonomy. Becker (1987) describes computer activities that require students to problem-solve and make independent decisions. According to Olsen (1987), the WICAT curriculum teaches students many of the advised skills: how to draw inferences, reach conclusions, make predictions based on information and evidence, and summarize available information.

Becker (1991) and Bracey (1989) continue to see the focus on lower-order skills such as the recall of facts and algorithms as problematic to computer instruction.

Becker (1991) implies that more emphasis should be placed on higher-order thinking and problem solving. Hornbeck (1990) agrees, writing that computers should be thought of as tools to teach students to think critically or analytically to solve problems and draw inferences. This emphasis on higher-order skills would be a change in education. Making critical thinking normative for the masses has never been done historically in education, but it is becoming essential if American students are going to compete in international markets (Hornbeck, 1990).

Technology provides excellent opportunities for research (Okolo, 1992). Unfortunately, studies involving computers have been somewhat limited in scope. Kulik and Kulik (1991) write that studies need to look at computers as something other than drill and practice tools. The concept of the computer is more than just an efficient drill and practice machine. Other authors have given suggestions as well. Grayson (1970) suggests that more CAI studies should be done with large numbers of students for longer periods of time. Carnoy, et al., (1987) suggest looking at studies with more than 100 students. Roblyer (1989) wants more studies to explore the effectiveness of computer applications at different grade levels. Much of the past research has been in controlled environments. The more important question, the one that researchers have avoided asking, is whether an approach

to instruction is generally successful in typical implementations and settings (Becker, 1986).

Gender

With increased computer use now in schools, are all students receiving the same opportunities to learn on computers, or are some students denied equal access? If students are not receiving equal opportunities, what are some of the consequences? Mehan (1985) foresees societal divisions based on access to information technology. He postulates that "if only a few people learn to control computers. . . while most can only react passively to them," (12) the result will be an even greater societal division than those caused by economics or culture. Society will be polarized into groups that control information and groups that simply receive the information. Differential access to information is already appearing, but Mehan (1985) believes that schools can combat this by providing equal access to information technology. It was predicted that by 1990 equity disparities in computer use would be more qualitative than quantitative (ETSI, 1985). Unfortunately, both types of inequality continue.

Who is being shortchanged in this access to information? Several subgroups have been studied; some

of these are lower socioeconomic groups, low-ability groups, minority groups, and female students. One of the more consistent patterns in computer usage is the differential access between male and female students.

More male than female students are learning to use computers (Demetrulias, 1985; Campbell, 1984; Kreinberg, Alper & Joseph, 1985; Sanders, 1985; Koch, 1994; Nelson & Watson, 1991; Becker, 1986; Fetler, 1985). Sanders (1985) states that the more students use computers the greater the chance they will continue to use them. Conversely, girls who avoid using computers will continue to do so later in life. This can have serious consequences to the choices and opportunities available to women in the future job market. It is expected that up to 75 percent of future jobs will require some computer skills. Sanders (1985) writes, "Ignorance of computers will be a serious handicap in the job market in the years to come" (38). Kreinberg, Alper and Joseph (1985) concur, stating,

If our daughters don't become as comfortable and knowledgeable about computers as our sons, they won't be able to participate in fields of study and work that increasingly rely on computer use (13).

The need for students, both male and female, to learn computer skills necessary for participation in certain college programs and in future job markets is fairly obvious, but are there more immediate concerns

about disparities in computer use? Niemic and Walberg (1985) would say yes. The results of their meta-analysis of the effects of computer-assisted instruction in K-12 students revealed that boys saw increases in their academic achievement in mathematics that was twice that of the girls using computers in the study. They write, "Boys appeared to achieve more than girls" (Niemic & Walberg, 1985). Coates and Stevens (1990) found no difference in computer science aptitude between male and female junior high students. But, according to Nelson and Watson (1991), males continue to receive higher achievement scores in computer technology in schools and in their careers. They believe this disparity is an outcome of inequitable opportunity to acquire technological skills. Fetler (1985) concurs. He writes, "If girls exhibit lower levels of achievement about computers than boys, one reason may be less opportunity to interact with the technology" (188). Girls appear to lose interest in computers by third or fourth grade (Nelson and Watson, 1991), and apathy seems to grow through the adolescent years when girls seem to lose interest in science and math as well (Mehan, 1985). Nelson and Watson (1991) believe that more time on computers would lead to improved attitudes toward computers by female students. Having access to computers does not insure that students learn appropriate uses;

however, access is a necessary, but not a sufficient, condition for learning to use computers.

Why do males and females differ in their interest in computers, and why do males seem to benefit more academically from their interactions with computers? Many reasons are cited for these inequalities. Some of them are: lack of computer equipment; male-oriented computer software; greater experience using computers by males inside and outside the school environment; teachers' inexperience with computers and software; the predominance of male computer teachers; a lack of awareness of equity disparities in computer usage by educators; feelings of anxiety associated with computer use by females and a predominating societal and educational view that technology is a male domain.

Kreinberg, Alper, and Joseph (1985), Becker (1986), Ontiveros (1988), Demetrulias (1985), and Campbell (1984) consider lack of equipment to be a problem in delivering computer education to students. The shortage of equipment may, in effect, cause some students to receive less computer instruction than other students. Becker (1986) predicts that when demand exceeds supply, computer time will be allocated unequally. Who is being left out? Demetrulias (1985) believes that when the number of computers is small more aggressive male students typically win the competition for computer time.

In a three-month study, she found that males in grades K-12 averaged eight minutes more on the computer than their female counterparts. This was not a significant difference, but in addition to this result she found that her subject pool contained more male students. Therefore, more males were using computers than females. She suggests that the low number of computers in the school contributed to the limited amount of time available to students to use the computer and to more usage by males (Demetrulias, 1985). Campbell (1984) concurs, writing:

The small number of computers available for a large number of students may be the strongest influence limiting computer use. When the demand is greater than the supply, the more aggressive tend to usurp the limited supply, and thanks at least in part to our socialization, boys are more aggressive than girls (5).

If computer time is given based on a first-come, first-served basis, males may capture more of the learning opportunities (Sanders, 1985). Lipinski, et al. (1986) found that when there are few computers, about 20 to 1, aggressive social behavior determines who uses them, and most of the time boys win out. Even if there are adequate numbers of computers, boys still capture the "best" computers. Volman (1995) found that "if there are different computers, the boys usually have the better ones" (9): the ones with color screens, faster operations, and so on.

Even when female students manage to get time on good computers, there may be a shortage of computer activities they enjoy. Most computer software is designed by males for males (Campbell, 1984). Nelson and Watson (1991) report that most software marketed and purchased by families and schools have male themes. Educators and parents may attribute lack of involvement as disinterest rather than lack of opportunity or uninteresting activities (Dubois & Schubert, 1986). Koch (1994) believes that the gender bias in computer software contributes to girls' lack of interest and inhibits their access to technology. The majority of computer games are competitive; require strong hand-eye coordination; contain gender-stereotyped characters; are based on win/lose, conflict situations; and often contain violence (Koch, 1994; Sanders, 1985 Sadker & Sadker, 1994). Boys tend to prefer this type of game. Girls often find these activities pointless and a waste of time. Girls prefer purposeful activities that are practical, involve problem-solving, have strong female characters, are collaborative, and give a sense of completion (Koch 1994; Sanders, 1985; Nelson & Watson, 1991). The available software is not sufficient to meet the needs of computer education (Kreinberg, Alper, & Joseph, 1985).

In addition to a preponderance of male-oriented software, or perhaps as a result of it, males are more

likely to come to school with computer experience (Campbell, 1984; Koch, 1994). Kreinberg, Alper, and Joseph (1985) cite a 1982 statistic that indicated females purchase far fewer computers than men. If this condition continues to exist, it may help to explain why an overwhelming number of computer "hackers" are male. Computer hackers are people who spend much of their free time working and playing with computers (Campbell, 1984). Other conditions may contribute to this high male ratio. Koch (1994) and Kreinberg, Alper and Joseph (1985) found that more males than females attend computer camps and summer computer courses. Koch (1994) states that parents, in addition to sending their sons to computer classes more often than their daughters, tend to place computers in their sons' rooms rather than placing them in a central, equally accessible location in the home. Girls see their fathers making most of the decisions related to computers and using the computer more often than their mothers (Giacquinta, Bauer & Levin, 1993).

Unfortunately, this discrepancy in computer experience is rarely made up in schools. Demetrulias (1985) and Sanders (1985) believe that this inequality continues in the school environment with more males studying computer programming. This finding is not surprising in light of work done by Koch (1994), which found that girls prefer using computer applications to

computer programming. She postulates that girls are turned off by the rigidity of programming. One of the applications that girls seem to enjoy is word processing. Unfortunately, Beynon (1993) considers the use of word processing to be a "ghetto" for girls. These applications make girls only users instead of managers of a technology. Sherry Turkle agrees. In a 1986 interview, she comments that girls need to learn computer programming (Rhodes, 1986). Mehan (1985) observed that girls and boys used computers the same in labs, but that boys used computers more than girls in their spare time. Not surprisingly in their 1986 study of computers in primary schools, Hall and Rhodes found that the students who emerged as computer experts were all boys.

Another problem in computer education is inadequate computer training for teachers. Many teachers lack knowledge of and experience with computers. Kreinberg, Alper, and Joseph (1985) agree that teachers need time to operate computers, to review a wide range of software in a wide variety of subject areas, to have resource support, and to be provided with adequate and continuing staff development. Without experience with computers and computer applications, teachers can feel that computers are a burden. When this happens, teachers may choose to ignore computers out of fear, resentment, or indifference. Nelson and Watson (1991) theorize that

teachers who are untrained on computers may perceive their students to have more skill than themselves and resist the computer. In either situation the result is the same: negative attitudes are communicated to students. These attitudes appear to have significant effects on female students, perhaps because most teachers are female. When teachers are not involved in their students' learning opportunities, students get the message that it is not important (Clariana, 1992). Parker (1985) proposes that the best way to insure that computers are put into good use is through appropriate teacher training—teaching teachers how computers can work for them. Charles (1993) agrees that faculty training and commitment are essential for the Integrated Learning System (ILS) to be effective in the classroom. Teachers who used the ILS as an educational tool had students who performed better on measures of achievement (Clariana, 1992). Teachers must learn to teach with computers, not simply learn about them. In addition, teachers must understand the changes in classroom culture and patterns of control that are associated with computer implementation. Computers will serve education only to the extent that teachers gain control over them (Weir, 1989).

Currently, most of the teachers demonstrating their knowledge of and comfort with computers are male. There

is a lack of computer-using female role models in our schools for girls to emulate. Becker (1985) studied the effects of male and female teachers who use computers and concluded that schools needed large numbers of female teachers using computers to act as role models for female students to improve technological skills.

In addition to not seeing female teachers in computer classes, teenage girls may not see their female friends there either. According to Sanders (1985), girls may stay away from computers because they do not see other girls using them. Adolescent girls in particular may need social interaction with their peers and may avoid the isolation caused by the traditional arrangement of one student per computer. Computers do not have to lead to isolation. Rupe (1986) found that computers did not adversely affect socialization in the classroom. In fact, McMahon (1990) observed children working with computers and noted that, given the option, students naturally form groups when working on computers, increasing discussion and interaction. Vockell (1990) and Black (1993) point out that many students learn better in cooperative or collaborative learning environments. Cooperative learning occurs when one student helps the entire group be successful. Collaborative learning is not competitive and occurs when students learn together from one another. Both can be

achieved via the computer. Bracey (1982) writes that computers can actually increase collaboration and cooperation among students when CAI is being used to solve problems. Fultz (1993) predicts greater productivity when individuals work in congenial groups. Students of both sexes who share computer terminals have been found to learn as much or more than those students learning individually (Thomas, 1979; Valke, 1988; Bracey, 1988). Valke (1988) goes so far as to recommend three students per group as the ideal, but cautions that as expertise is gained students may prefer to work individually.

Once in computer classes, girls may receive messages that cause them discomfort. Educators may send clear, nonverbal messages that computers are for boys. Males may be asked to help the teacher more often than girls. Teachers allow boys to carry in the computer and demonstrate computer uses. When asked to select their best computer students, males are chosen more often than females (Campbell, 1984). Teachers may even tell boys how to solve computer problems while they solve the problems themselves for female students. These things dissuade girls from using the computer and may lead girls to view the computer as a boy's domain.

Another obstacle to overcome is the deep and abiding association of computers with science and math, already

considered to be bastions of male dominance (Sanders, 1985; Campbell, 1984). When computers first came onto the educational scene, they were often housed in the math or science departments. Many are still housed there. The same forces that inhibit women from participating in math and science inhibit them from enrolling in computer science (Fiber, 1985). Females need to know that computers are not just for math and science, but can be used in a variety of ways in a variety of subject areas.

The media also perpetuate the stereotype of the computer as a male domain. Most audio, video, and print advertisements portray males using computers (Campbell, 1984) or men as experts in technology (Koch, 1994). Beer (1994) cites examples of print advertising in computer magazines that accentuated stereotypical masculinity associated with computers. These advertisements are obviously focused on the male audience of potential buyers. The message for females cannot be more clear: technology is a male domain.

In light of the many obstacles to equal opportunity for females in computer education, can there be solutions? Many authors say yes and describe a plethora of interventions to overcome disparities and increase the opportunities for females to use computers (Dubois and Schubert, 1986; Sanders, 1993; Campbell, 1984; Koch, 1994). The key to closing this gender gap, according to

Sanders (1985), Dubois and Schubert (1986), and Koch (1994), is to become aware that it exists. Koch (1994) states that educators must make gender and technology a priority in order to make a difference. Demetrulias (1985) believes this can best be done by establishing sex equity goals for computer education. She believes educators should intervene to assure that students have equal access to computers. Teachers must be aware of the possibility that males might dominate the computers and take action to prevent this from happening (Demetrulias, (1985). Kreinberg, Alper and Joseph (1985) agree, stating, "Teachers need to find ways to enable each student to have equal access and quality time on the computer" (13).

Kreinberg, Alper and Joseph (1985) believe that teachers themselves need greater access to computers. They write that teachers need computer experiences that provide them a chance to operate the equipment and explore a variety of software. Mathinos and Woodward (1988) surveyed a group of teachers concerning the use of computers. One respondent suggested that teachers be allowed more time to learn about the computer before it is implemented in the classroom. In addition to time with computers, they need continuing staff development and resource support and need to feel comfortable about using computers (Becker, 1994). Teachers can use this

knowledge to integrate computers across the curriculum—not just for math and science—and in a variety of applications, such as electronic mail, networks, and word processing. These are activities that girls tend to enjoy. Teachers can even make unappealing activities more appealing by stressing the aspects of the activity that girls find most interesting. For example, programming can be made more enjoyable for girls by introducing it as a creative, problem-solving process (Krienberg, Alper & Joseph, 1985).

Campbell (1984) writes that stereotyped software is not acceptable in the classroom. Having experience with programs allows teachers to screen them for content that gives equal treatment to both sexes, visuals that are free from stereotype, and topics that are of interest to both males and females. Teachers can also use this opportunity to evaluate programs as to their appeal to male and female students. Students can be included in the program-selection process by allowing them to explore new programs prior to purchase and obtaining their comments and observations about the activities. Another source of information may be state district and local education agencies that provide software recommendations. The goal should be to provide a wide range of computer experiences for all students (Dubois & Schubert, 1986).

In addition to awareness of computer equity issues, improving the computer training teachers receive, and improving the computer programs available to students, educators must also try to make computer classes a comfortable place and computing an enjoyable experience for girls. Girls need more exposure to computers at all levels, but particularly during the middle-school years. Girls prefer collaboration to individual work. Allowing females to work on the computer in small groups would most probably increase their enjoyment (Koch, 1994). Teachers and parents can change the computer environment by encouraging students to attend after-school computer classes and computer camps or even by assigning students to single-sex classes. Once girls are in the computer class, teachers should allow girls to solve problems for themselves, instead of doing it for them. Successful problem solving can increase the comfort and confidence girls feel in using technology (Koch, 1994). In addition to being a role model themselves, it is especially important for computer teachers to provide female role models who use computers. This can be accomplished by studying women currently working in the computer industry, observing female teachers who use computers, or having local businesswomen discuss their computer experiences with the class. Girls need to know women who have been successful in computer-related fields.

Teachers may use some or all of these strategies to increase computer participation among female students.

In order to be full participants in the computer education process, girls must be encouraged to participate. Campbell (1984) writes that "with appropriate encouragement, girls will use computers as much as boys--and perform as well or better" (6). Sanders (1993) suggests that educators should insist girls learn to use electronic equipment, should design activities girls are interested in, emphasize the usefulness of technology, and eliminate biased practices. Coates and Stephens (1990) summarize the ideas in this way: "Success for women in computer science depends on the development of positive attitudes and interest in the area" (163).

Computers provide a unique opportunity and challenge for educators. This technology is a relatively new educational tool that as of yet has no clearly defined role. Educators should take the opportunity to observe this new instrument of teaching and learning. In addition, teachers should evaluate what has been done well and what has been done poorly with computers, learn from these evaluations, and implement strategies to correct some of the mistakes that have previously occurred. All students should be able to reap the educational benefits of computers. This can best be

achieved by providing equal access for students and providing software that is free of racism, sexism, and bias (Campbell, 1984).

CHAPTER III

METHOD OF THE STUDY

More research is needed concerning computers and instruction (Beynon, 1993; Bracey, 1987). Comparisons of effectiveness of different CAI approaches should be done (Levin & Woo, 1979). Bracey (1987) writes that research should ask "whether there were differences among outcomes when CAI was used for drill and practice, tutorials or simulations and so forth" (22). A variety of research methods should be employed (Campbell, 1988), but this can be a costly process. Correlational studies can be done with little expense and "can provide a preliminary survey of hypotheses, and those which survive this can be checked through more expensive experimental manipulation" (Campbell and Stanley, 1963, 64).

The purpose of the study was to investigate the relationship between the use of computer-assisted instruction and measurable academic ability. The data for the study were secured through the Institute for Educational Technologies. The Institute conducted a three-year research project at Ingleside Elementary School concerning the integration and impact of technologies on school climate (Smith, 1992; 1993; 1995).

This chapter discusses the method and procedure used in the study. The chapter is organized in the following

manner: definition of terms, description of the school, description of the computer system, identification of the population, description of the instrument, data collection, and data analysis.

Definition of Terms

Tutorial

These computer technologies provide individualized instruction for students in certain aspects of the curriculum. Instruction includes the use of drill and practice (Smith 1993).

Communications

These technologies allow students, teachers, administrators, and parents to connect with each other and with geographically distant learning resources through the computer. Some examples of these technologies are: electronic mail, bulletin boards, and the Internet (Smith 1992).

Exploratory/Problem Solving

These are technologies that enable users to electronically access large amounts of information, organize it, evaluate it, and use the information to solve a problem. These technologies would function as a

learning resource and include multi-media encyclopedias on CD-ROM and databases accessed through communication lines (Smith 1993).

Application/Techniques

These technologies enable the learner to develop skills or techniques that facilitate higher-order thinking processes, including critical thinking, communicative skills, or problem-solving skills. Some examples of these technologies are: desktop publishing, spreadsheets, database manipulation, statistical analysis, and word processing (Smith 1993). Hereafter this technology will be referred to as techniques.

Integrated Learning System (ILS)

An ILS is a computer-based learning experience. Most systems have multiple computers connected to a central network; collect records of student performance; can display printed reports; and can assign lessons based on each student's progress (Sherry, 1990).

World Institute for Computer-Assisted Teaching (WICAT)

WICAT is one of the companies that develop Integrated Learning System products for schools.

Tennessee Comprehensive Assessment Program (TCAP)

The Tennessee Comprehensive Assessment Program (TCAP) refers to the K-12 testing program in Tennessee. The TCAP elementary achievement tests consist of a norm-referenced and a criterion-referenced portion. For the purpose of this study, TCAP will refer specifically to the norm-referenced portion of the achievement test. The Comprehensive Test of Basic Skills (CTBS) is the norm-referenced portion of the test.

Reading Comprehension

The reading comprehension subtest of the TCAP contains items designed to measure the ability of students to construct and expand meaning (CTBS, 1993).

Vocabulary

The vocabulary subtest of the TCAP contains items that measure various avenues to constructing and expressing meaning (CTBS, 1993).

Total Reading

Total reading scores are derived from the TCAP reading comprehension and vocabulary subtest scores. The total reading score is used to calculate total battery scores. Reading passages are presented to students followed by test items that address the central

meaning rather than the surface details of the text. This emphasis on whole meaning requires students to employ complex thinking skills (CTBS, 1993).

Language Expression

The language expression subtest of the TCAP measures such skills as subject-verb agreement, sentence formation, sentence combining, and paragraph-writing skills that rely on the connection between form and meaning and require the student to make judgments about the effectiveness of one sentence over another. This subtest requires the student to demonstrate writing strategies using "complex thinking" and "critical comprehension" (CTBS, 1993).

Language Mechanics

The language mechanics subtest of the TCAP contains items that are intended to measure the student's knowledge of writing conventions and strategies that enhance meaning (CTBS, 1993).

Total Language

Total language scores are derived from the language expression and language mechanics subtest scores on the TCAP. The total language score is used to calculate total battery scores. The test items require students to

use complex thinking and critical comprehension to demonstrate knowledge of language and writing strategies (CTBS, 1993).

Description of the School

Ingleside Elementary is a K-3 school located in Athens, Tennessee, and is part of the Athens City School System. From 1986 to 1991, the school received both state and national recognition. Ingleside was recognized by the U.S. Department of Education as one the best elementary schools in the nation; by Tennessee as one of the top ten elementary schools in the state; and by *Child Magazine* as one of the best schools in America. In 1991 Ingleside became a Model Technology School through a cooperative effort of the Tennessee Valley Authority, Athens City School Board of Education, the State of Tennessee, and the Institute for Educational Technologies. The goal of the project was for all types of technologies to be employed in a systematic way that would become an integral part of the school's education program. The vision of the project was a complete system of computer instruction operating in a single school (Smith, 1992).

During the 1992-1993 school year, Ingleside transitioned from a K-6 school to a K-3 school. This

transition presented some difficulties, including the transfer of teachers into and out of the school. These new teachers entered an environment where technologies existed and in which they were untrained. The addition of a school-level technology coordinator helped to overcome this problem. The coordinator provided instruction to both students and teachers and acted as a resource for teachers (Smith, 1993).

Plans for the 1993-1994 school year included the addition of an interactive videodisc, CD-ROM, and connection to the Internet. However, a series of technical problems prohibited their addition to the central network for the 1993-1994 school year.

Description of the Computer System

Hativa (1988) suggests that any report on computer research should give a good description of the computer system used.

All first through third grade classrooms at Ingleside Elementary School have four computers. In addition, the school's computer lab houses fifteen more computers. All of these computers are connected to a central network. In 1991 an Integrated Learning System (ILS) from WICAT was installed on the network (Smith, 1992). Networked computers eliminate the need for disk

handling and can provide considerable management of computer activities. This can result in an increase in the communication and educational uses of the school's computers (Marsh, 1993).

Computer-Assisted Instruction (CAI) is where students interact directly with the computer through drill and practice, tutorials, simulations and problem-solving. (ETSI, 1985; Dowdney, 1987, Steinberg, 1991; Fletcher, 1992; Papert, 1993). Bell (1983) described the drill and practice portion of CAI as flash card type exercises presented by the computer which help students become familiar with content. Tutorial applications, Bell (1983) continues, guide the student through a program of learning, setting the program to the student's pace. Willett and Yamashita (1983) propose that the use of appropriate remediation and immediate feedback makes CAI an effective learning experience. CAI affects achievement through improving the quality, quantity, and clarity of student interaction with content material (Carnoy, et al. 1987).

Computer-Managed Instruction (CMI) contains all the elements of CAI, but the computer does more by evaluating student test performance, guiding students to the appropriate instructional resources, and keeping records of student progress (Kulik & Kulik, 1991). Bliss (1991) recommends a computer manager that is proficient in

running the system. This manager is able to help place students at the appropriate level in each subject area; advise teachers on using the system and benefitting the most from it; assist students; produce teacher reports; and act as a liaison between the school and the service company. Cohen (1983) agrees and writes that a good software program assesses student performance, provides immediate feedback, uses remediation, correctly places the student, and produces written reports for teachers. WICAT is a networked computer that can perform all these tasks.

Unfortunately, little research of integrated learning systems has been done to date (Bracey, 1992). More research of the ILS should be done and, according to Bender (1991), the ultimate goal of this research would be to "determine if an ILS system can promote academic achievement in elementary schools" (20). If ILS systems prove effective in improving achievement, school administrators and parents will give it consideration — despite the cost.

A benefit of the WICAT ILS is that it covers approximately 95 percent of the objectives on standardized tests (Clariana, 1992). This type of instruction has been found to produce significant achievement gains. Swan, Guerrero, Mitrani, and Schoener (1989) concluded WICAT to be a good vehicle for

delivering a remedial instruction to elementary students in reading and math.

The WICAT Primary Reading Curriculum is used with students in kindergarten through third grade to improve reading skills with units on reading, writing, and language. Some of the skills taught in the curriculum are: letter identification, consonant sounds, sight words, sound patterns, word meanings, and comprehension. Audio and graphics are used to enhance the reading instruction. The Reading Curriculum contains over 1000 interactive activities (Olsen, 1986). This program can track when students log on the computer, the activity used, and the time spent on each activity.

Most teachers in grades one, two, and three at Ingleside spend the majority of computer time on classroom computers and use the computer lab for special projects. Typically, students are scheduled for some computer time at least once a day.

Identification of the Population

The population from which the participants were selected for the study consisted of students enrolled in first through third grade at Ingleside Elementary School for the 1993-1994 school year. During 1993-1994, Ingleside had approximately 400 students and 18 classroom

teachers in grades K-3. Only students who completed the TCAP testing in spring 1994 at Ingleside Elementary were chosen to participate. No sampling technique was employed since the study included all students who met the criteria. Eighty-one first graders, 95 second graders, and 72 third graders met the study criteria for a total of 248 students.

Description of the Instrument

The Tennessee Comprehensive Assessment Program Achievement Test (TCAP) is a combination of a criterion-referenced test and a norm-referenced test. For the norm-referenced test portion, students were given the Comprehensive Test of Basic Skills (CTBS). The CTBS Technical Report (1988) indicates that the Comprehensive Test of Basic Skills "is intended to measure students' understanding of the broad concepts developed by all curricula as opposed to being content specific to any particular instructional program" (9). The more broadly based items were intended to probe a greater depth of content and require application of more complex thinking processes—features that correspond with the philosophy that underlies much of modern educational theory and practice. Test publishers write,

The development of CTBS focused on an integrative approach resulting in the move toward teaching strategies, rather than isolated skills, and in the integration of thinking skills within the various domains (CTBS, 1988, 10).

The content of the CTBS requires students to apply a full range of thinking skills. Specifically, the CTBS classifies items into six of the eight major thinking skills described by Rankin and Hughes. The six thinking skills are: gathering information, organizing information, analyzing information, generating ideas, synthesizing elements, and evaluating outcomes. Gathering information involves observations through the senses, recall of knowledge, and questioning. Organizing information requires representing, comparing, and classifying information into cohesive, manageable units. Analyzing information is based on the ability to recognize relationships and patterns, to determine the accuracy and adequacy of information, and to identify the attributes and components of an object or situation. Generating ideas involves restructuring problems, predicting events or consequences, and making inferences from available information. Synthesizing elements requires the student to summarize information and integrate it into a meaningful whole. Evaluating outcomes is based on the ability to set standards for quality for and judging outcomes (Hannafin & Sullivan, 1995).

At the first, second, and third grade levels, the CTBS/TCAP contains the following subtests: word analysis, reading vocabulary, reading comprehension, language mechanics, language expression, mathematics computation, mathematics concepts and applications, science, and social studies. In addition, second and third grade students have a spelling subtest. Students receive scores in each of the subtests as well as scores in total reading, total language, total mathematics, and total battery. This study used reading and language subtest scale scores as well as total reading and total language scale scores. The total reading score is derived from the reading vocabulary and reading comprehension subtests. The total language score is calculated from the language mechanics and language expression subtests.

Data Collection

The Institute of Educational Technologies provided computer records containing the number of minutes each student spent on reading and language arts computer activities; TCAP subtest scale scores in vocabulary, reading comprehension, total reading, language expression, language mechanics, and total language; and demographic data on grade level and gender. Scale scores are appropriate for this study because they are linear

standard scores. Such scores can be treated mathematically, whereas other types of test scores cannot. Lyman (1986) reports that linear standard scores tell us the location of a student's raw score in relation to the group mean and standard deviation. In normal and non-normal distributions, raw scores can be converted to linear standard score equivalents without changing the shape of the original distribution. Lyman (1986) writes, "Because of these properties, we can average these scores exactly as we can raw scores (20). The Institute obtained 1994 TCAP score reports and demographic data from the principal of Ingleside Elementary School shortly after the test results were returned from the State of Tennessee. WICAT computer records for each student were obtained from the school technology coordinator at the end of the 1993-1994 school year. The ILS is capable of tracking student activities in all four computer applications categories: tutorial, communications, exploratory/problem solving, and techniques. Unfortunately, no communications and exploratory/problem activities were represented because the networked CD-ROM and Internet were not operational during the school year. Decisions on which of the remaining two categories each activity represented were made by the consensus of the school technology coordinator and two graduate researchers assigned to the Model Technology School

Project by the Institute for Educational Technologies. Activities related to reading and/or language arts were grouped into either the tutorial or the techniques application categories. The time each student spent using each of the computer applications was tabulated. The time students spent using tutorial applications can be best described as the number of minutes students used drill and practice and tutorial activities on the computer. The time students spent using techniques applications is the number of minutes students used technologies that facilitated higher-order thinking and problem-solving skills. In this study, that translates into time spent on word processing, desktop publishing, and cartoon captioning. From this information, the total time in minutes each student spent using reading and language arts computer activities was calculated.

(see Appendix) Names were replaced with numbers to ensure confidentiality. Finally, test and computer data for each student in grades one through three were entered into a database. Students who had not participated in the spring 1994 TCAP testing were removed from the data analysis.

Data Analysis

Data were plotted using a graph and a box plot to produce a visual representation of the data set. The box plot revealed several extreme scores. An extreme score for this study was defined as over three interquartile ranges from the 75th percentile (SAS, 1990; Tukey, 1977). Extreme scores were removed from databases of independent variables related to time spent on computer applications (Glass, 1984).

When extreme scores in time spent on computer applications were removed from the data set, these eleven scores were reviewed for similarity. In all cases scores were omitted because of extreme amounts of time spent on techniques applications. Four males and seven females had obtained extreme scores in this area. In grade one, extreme scores were obtained by three students who came from three different classrooms. In grade two, only one female student had a score considered to be extreme. Seven students, four males and three females, from two third grade classrooms had extreme scores. The removal of three female students in first grade for extreme scores in time spent on techniques applications could lower the mean of this group. Still, the removal of extreme scores provides a more accurate measure of what

is actually happening in computer use among first grade girls.

Data were separated into groups based on grade level. Means and standard deviations were computed for time on tutorial applications, time on techniques applications, activities, and total time spent on reading and language arts activities. An Analysis of Variance (ANOVA) procedure was performed to determine if the means for time spent on tutorial applications, techniques applications, and total time spent on reading and language arts computer applications were significantly different at any grade level: one, two, or three. Post hoc analyses were used to determine where differences occurred. Scheffe's multiple comparison procedure was selected because it is not seriously affected by unequal variances (Neter, Wasserman & Kutner, 1990).

Correlation matrices were developed to determine the intercorrelations between achievement test scale scores on the TCAP in vocabulary, reading comprehension, total reading, language mechanics, language expression, and total language and student scores in time spent on tutorial applications, time spent on techniques applications, and total time spent on reading and language arts activities in grades one, two, and three. Pearson Product-Moment Correlation Coefficients were used because they are robust to violations of assumptions

(Thorndike, 1978). The level of significance was lowered to the one-percent level (Younger, Personal Communication August 29, 1995) to control for Type I error. All statistical analyses were done using the Statistical Analysis System (SAS) computer package.

Gay (1990) states that computing correlation coefficients separately for certain defined subgroups can be beneficial. Gay (1990) recommends sample sizes of thirty or more for calculating correlations. Inadequate sample sizes prohibited separate evaluations by ethnicity or special education classification. A separate subgroup evaluation was done for gender. Means and standard deviations were calculated at each grade level by gender. Several t-tests were performed to determine if the mean scores of males differed from the mean scores of females in time spent on tutorial applications, time on techniques applications, and total time on reading and language arts applications at each grade. Finally, Pearson Product-Moment Correlation Coefficients were calculated between TCAP subtest scores and time spent on computer applications for both male and female students at each grade level.

Hypotheses

The purpose of this study was to investigate the relationships between use of computer-assisted instruction applications and achievement scores in reading and language arts as measured by the CTBS portion of the TCAP. Hypotheses were tested to determine if time spent on the computer and gender were related to achievement. The following null hypotheses were tested:

H₁: No significant differences in time spent on tutorial applications exist between grades.

H₂: No significant differences in time spent on techniques applications exist between grades.

H₃: No significant differences in total time spent on reading and language arts activities exist between grades.

H₄: No significant relationship exists between time spent on tutorial applications and scores on the TCAP at any grade level.

- H₅: No significant relationship exists between time spent on techniques applications and scores on the TCAP at any grade level.
- H₆: No significant relationship exists between total time spent on reading and language arts programs and scores on the TCAP at any grade level.
- H₇: No significant differences in time spent on tutorial applications exist between males and females at any grade level.
- H₈: No significant differences in time spent on techniques applications exist between males and females at any grade level.
- H₉: No significant differences in total time spent on reading and language arts activities exist between males and females at any grade level.
- H₁₀: No significant relationship exists between total time spent on tutorial applications and scores on the TCAP for males at any grade level.

- H₁₁: No significant relationship exists between total time spent on techniques applications and scores on the TCAP for males at any grade level.
- H₁₂: No significant relationship exists between total time spent on reading and language arts programs and scores on the TCAP for males at any grade level.
- H₁₃: No significant relationship exists between total time spent on tutorial applications and scores on the TCAP for females at any grade level.
- H₁₄: No significant relationship exists between total time spent on techniques applications and scores on the TCAP for females at any grade level.
- H₁₅: No significant relationship exists between total time spent on reading and language arts programs and scores on the TCAP for females at any grade level.

CHAPTER IV

RESULTS

Data on primary students' reading and language arts test scores and time spent on different computer applications were analyzed. Roblyer (1985) stresses the importance of including descriptive statistics for both the whole group and specified subgroups under study. Table 1 presents the averages on TCAP tests for students at Ingleside Elementary School and statewide averages for Tennessee. First graders at Ingleside scored very near statewide averages on all six test areas. Ingleside scores were slightly higher than state averages for second and third grades for all tests. As a school Ingleside performed at or above state levels (Smith, 1995).

Table 1

Spring 1993 TCAP Scores for Ingleside Elementary School and the State of Tennessee

TCAP Test	Vocab.	Reading Comp.	Total Reading	Lang. Mech.	Lang. Exp.	Total Lang.
<u>Grade I</u>						
Ingleside	575	569	572	627	601	614
Tennessee	577	566	572	618	615	617
<u>Grade II</u>						
Ingleside	684	704	694	705	699	702
Tennessee	643	654	644	673	671	672
<u>Grade III</u>						
Ingleside	703	723	714	727	734	731
Tennessee	676	690	683	687	706	697

The mean and standard deviation scores for time spent on tutorial and techniques applications and total time spent on reading and language arts computer activities are shown in Table 2. Results show that on average students in first grade spent more time on the computer in all three areas than did students in grades two and three. First graders averaged 530 minutes on tutorial applications; second graders were slightly lower at 492 minutes; and third graders spent 361 minutes on these applications. The use of techniques applications was lowest in second grade with an average of 231 minutes. Third graders averaged 325 minutes, and first graders used techniques applications for 382 minutes.

Table 2

The Means and Standard Deviations of Time Spent in Minutes on Computer Applications for Students at Ingleside Elementary School

	Tutorial			Techniques			Total Time		
	Applications			Applications					
	$\bar{X}$	SD	n	$\bar{X}$	SD	n	$\bar{X}$	SD	n
Grade 1	530	254	81	382	373	78	927	534	79
Grade 2	492	191	95	231	204	74	734	309	75
Grade 3	361	339	72	325	228	65	779	469	70

The mean for first graders on total time on reading and language arts activities was 927 minutes. Second graders averaged 734 minutes, and third graders 779 minutes on these computer activities. An Analysis of Variance (ANOVA) procedure was used to compare the means of time on tutorial and techniques applications and total time on reading and language arts activities between grades.

Hypothesis #1: No significant differences in time spent on tutorial applications exist between grades.

ANOVA results revealed significant differences between grades for tutorial applications ($F=8.74$, $df=2/245$, $p < .01$). Scheffe's multiple comparison procedure was performed to determine where the differences between grades occurred at the five percent level of significance. On tutorial applications no difference existed between grades one and two. The means for grades two and three were significantly different. Students in grade three used tutorial applications an average of 361 minutes, fewer than second graders who averaged 492 minutes. Comparisons revealed a significant difference between the means on tutorial applications of grades one and three. First graders spent an average of 530 minutes on tutorial applications while third graders averaged 361 minutes. Third grade students averaged significantly less time on tutorial applications than did

either first or second grade students. The hypothesis was rejected.

Hypothesis #2: No significant differences in time spent on techniques applications exist between grades.

ANOVA results revealed significant differences between grades for techniques applications ($F=5.50$, $df=2/214$, $p < .01$). Scheffe's Test revealed significant differences on time spent on techniques applications occurred between grades one and two. No significant differences existed between the means of grade one and grade three or between grades two and three. Second grade students spent less time on techniques applications, 231 minutes, than did first graders at 382 minutes. Third graders averaged 325 minutes on techniques applications. The hypothesis was rejected.

Hypothesis #3: No significant differences in total time spent on reading and language arts activities exist between grades.

ANOVA results revealed that no significant difference existed between grades of mean time spent on reading and language arts activities ($F=3.92$, $df=2/221$, $p=.02$). The null hypothesis was not rejected.

Hypothesis #4: No significant relationship exists between the time spent on tutorial applications and scores on the TCAP at any grade level.

Gay (1990) states that, in studies designed to explore or test hypothesized relationships, correlation coefficients should be interpreted by their statistical significance. Statistical significance implies that the correlation coefficient is different from zero and reflects a true relationship instead of a chance relationship. Gay (1990) goes on to warn that, no matter how statistically significant a correlation is, a low correlation coefficient still represents a low relationship between the variables.

This hypothesis was tested by tabulating correlation coefficients. Correlation matrices were developed to show the relationships of time spent on computer applications and achievement test scores at each grade level. In examining the correlation matrices for tutorial, techniques, and total time on reading and language arts applications at each grade level, it was noted that several significant intercorrelations existed between achievement test variables and time on computer variables. None of these significant correlations, however, was in the area of tutorial applications. Pearson Product Moment Correlation Coefficients reflecting the relationships between tutorial

applications and achievement subtest scores and p values are shown in Table 3. These coefficients range from $-.082$ to $.138$ and suggest little relationship between the variables. No significant relationships existed between tutorial applications and scores on any achievement test at any grade level. The null hypothesis was not rejected.

Table 3

Pearson Correlation Coefficients Between Time in Minutes on Tutorial Applications and Achievement Test Scores for Students at Ingleside Elementary School

	Grade 1			Grade 2			Grade 3		
	r	p	n	r	p	n	r	p	n
Vocabulary	.138	.22	81	.142	.17	95	-.086	.47	72
Reading Comprehension	.068	.55	81	.138	.18	95	-.060	.62	71
Total Reading	.107	.34	81	.151	.14	95	-.079	.51	71
Language Expression	-.012	.92	81	.096	.35	95	-.060	.62	72
Language Mechanics	.133	.24	81	.044	.67	95	-.082	.49	72
Total Language	.044	.70	81	.081	.43	95	-.077	.52	72

Hypothesis #5: No significant relationship exists between time spent on techniques applications and scores on the TCAP at any grade level.

The relationships between techniques applications and achievement test scores are reflected in the correlation coefficients in Table 4. First grade correlations revealed several significant relationships between time on techniques applications and test scores. In reading subtests the coefficients ranged from .234 (NS) in reading comprehension and .279 (NS) in total reading to .291 ($p < .01$) in vocabulary. In language subtests the range was from .224 to .366, all reflective of weak relationships. The strongest correlation coefficient from first grade was .366 ($p < .01$) in language mechanics. This was followed by .294 ($p < .01$) in total language and .224 (NS) in language expression. Correlation coefficients in grade two ranged from .256 to .544, indicating low to moderate relationships. Correlation coefficients of 0 to .3 are considered low, .3 to .7 moderate, and .7 to 1.0 strong.

The strongest correlation in second grade was .544 ($p < .01$) between time on techniques applications and achievement test scores on the language mechanics subtest. A correlation coefficient of .440 ($p < .01$) in total language and .292 (NS) in the language expression subtest. Coefficients for second grade reading were .256

Table 4

Pearson Correlation Coefficients Between Time in Minutes on Techniques Applications and Achievement Test Scores for Students at Ingleside Elementary School

	Grade 1			Grade 2			Grade 3		
	r	p	n	r	p	n	r	p	n
Vocabulary	.291*	.01	78	.322*	.01	74	-.060	.64	65
Reading Comprehension	.234	.04	78	.256	.03	74	.041	.75	64
Total Reading	.279	.01	78	.303*	.01	74	.048	.70	64
Language Expression	.224	.05	78	.292	.01	74	.170	.18	65
Language Mechanics	.366*	.00	78	.544*	.00	74	.165	.19	65
Total Language	.294*	.01	78	.440*	.00	74	.183	.14	65

* $p < .01$

(NS) in reading comprehension, .322 ($p < .01$) in vocabulary, and .303 ($p < .01$) in total reading. Correlation coefficients for grade three ranged from -.060 in vocabulary to .183 in total language. No significant relationships between the variables existed at grade three. Significant relationships existed between time on techniques applications and test scores in grades one and two. The null hypothesis was rejected.

Hypothesis #6: No significant relationship exists between total time spent on reading and language arts programs and scores on the TCAP at any grade level.

This hypothesis was tested using Pearson Product-Moment Correlation Coefficients. Table 5 contains the correlation coefficients between total time spent on reading and language arts activities and achievement subtest scores. These calculations resulted in no significant correlations in grade three. Correlation coefficients ranged from .087 in the vocabulary subtest to .174 in language expression. These scores indicated

Table 5

Pearson Correlation Coefficients Between Total Time in Minutes on Reading and Language Arts Activities and Achievement Test Scores for Students at Ingleside Elementary School

	Grade 1			Grade 2			Grade 3		
	r	p	n	r	p	n	r	p	n
Vocabulary Reading	.319*	.00	79	.330*	.00	75	.087	.48	70
Comprehension	.259	.02	79	.233	.04	75	.098	.42	69
Total Reading	.305*	.01	79	.293	.01	75	.103	.40	69
Language Expression	.201	.08	79	.333*	.00	75	.174	.15	70
Language Mechanics	.341*	.00	79	.468*	.00	75	.106	.38	70
Total Language	.268	.02	79	.431*	.00	75	.154	.20	70

* p < .01

no practical relationship between the dependent and independent variables in grade three. Second grade results again indicated significant relationships in vocabulary .330 ($p < .01$), language expression .353 ($p < .01$), language mechanics .468 ($p < .01$) and total language .431 ($p < .01$). Correlations in reading comprehension .233 and total reading .293 were not significant at the one percent level. These numbers indicated weak to moderate relationships between the variables. Correlation coefficients for first grade were vocabulary .319 ($p < .01$), reading comprehension .259 (NS), total reading .305 ($p < .01$), language mechanics .341 ($p < .01$), language expression .201 (NS), and total language .268 (NS). Significant relationships between total time on reading and language arts activities and TCAP test scores existed in grades one and two. The null hypothesis was rejected.

Gay (1990) writes that it is sometimes beneficial to examine relationships of certain defined subgroups separately from the total group so that, when all scores are lumped together, some relationships may be obscured and the relationships between two subgroup variables may be very different.

Table 6 shows the mean time that male and female students at each grade level spent on tutorial and techniques applications and total time spent on reading and language arts activities. Males in grade one averaged more time on the computer in all three areas. Males spent an average of 978 minutes on reading and language arts activities while females averaged 880 minutes. In techniques applications, females averaged 359 minutes while their male counterparts averaged 406 minutes. First grade males, on average, spent 572

Table 6

Means and Standard Deviations for Male and Female Students at Ingleside Elementary School on Time Spent Using Computer Applications

	Tutorial			Techniques			Total		
	$\bar{X}$	SD	n	$\bar{X}$	SD	n	$\bar{X}$	SD	n
<u>Grade 1</u>									
Males	572	271	38	406	407	38	978	506	38
Females	494	234	43	359	342	40	880	561	41
<u>Grade 2</u>									
Males	486	196	41	194	167	31	683	258	31
Females	496	189	54	258	225	43	769	339	44
<u>Grade 3</u>									
Males	378	361	35	294	211	31	763	485	33
Females	345	320	37	353	241	34	792	461	37

minutes on tutorial computer applications, and females spent 494 minutes. For second graders this trend of slightly more use of the computer by males had disappeared. Second grade males spent slightly less time on tutorial applications, 486 minutes to 496 minutes. Second grade females spent more time on techniques applications 258 minutes to 194 minutes. In total time spent of reading and language arts activities, the second grade girls edged out the boys. The girls averaged 769 minutes on these activities, and the boys averaged 683. This pattern continued in the third grade. Third grade boys used tutorial activities for 378 minutes while the girls spent 345 minutes on these applications. Girls averaged 353 minutes in techniques applications, and the boys averaged only 294 minutes. Girls spent more time on reading and language arts activities than boys in third grade. The girls used the computer an average of 792 minutes, and the boys averaged 763 minutes.

Hypothesis #7: No significant differences in time spent on tutorial applications exist between males and females at any grade level.

Hypothesis #8: No significant differences in time spent on techniques applications exist between males and females at any grade level.

Hypothesis #9: No significant differences in the total time spent on reading and language arts activities exist between males and females at any grade level.

Several t-tests were used to determine if there were differences in the means of males and females on the time spent on tutorial and techniques application and total time spent on reading and language arts activities in each grade level. These test results, shown in Table 7, show probabilities ranging from .16 to .80. Means for males and females are not significantly different for any computer application at any grade level. Null hypotheses 7, 8, and 9 were not rejected.

Table 7

Results of t-test for Male and Female Students on Computer Applications at Each Grade Level

	Variances	t	Degrees of Freedom	Probability
<u>Grade 1</u>				
Tutorial	Equal	1.39	74	.17
Techniques	Equal	0.55	76	.58
Total	Equal	0.81	77	.42
<u>Grade 2</u>				
Tutorial	Equal	-0.26	93	.80
Techniques	Unequal	-1.40	72	.16
Total	Equal	-1.19	73	.24
<u>Grade 3</u>				
Tutorial	Equal	0.40	70	.69
Techniques	Equal	-1.04	63	.30
Total	Equal	-0.25	68	.80

*p < .05

The previous statistical tests indicated no significant differences between the times males and females used different computer applications. Following Gay's (1990) suggestion, Pearson Product-Moment Correlation Coefficients were calculated between time spent on different computer applications and TCAP achievement test scores for both males and females.

Hypothesis #10: No significant relationship exists between time spent on tutorial applications and scores on the TCAP for males at any grade level.

Hypothesis #11: No significant relationship exists between time spent on techniques applications and scores on the TCAP for males at any grade level.

Hypothesis #12: No significant relationship exists between time spent on reading and language arts programs and scores on the TCAP for males at any grade level.

Table 8 shows the results of the analyses for males. No significant correlations between time on computer applications and test scores existed at any grade level. Hypotheses 10, 11, and 12 were not rejected.

Table 8

Pearson Correlation Coefficients Between Time in Minutes on
Computer Applications and Achievement Test Scores for Male Students
at Ingleside Elementary School

	Tutorial			Techniques			Total		
	r	p	n	r	p	n	r	P	n
<u>Grade 1</u>									
Vocabulary	-.010	.95	38	.108	.52	38	.081	.63	38
Reading Comprehension	-.064	.70	38	.182	.27	38	.112	.50	38
Total Reading	-.040	.81	38	.156	.35	38	.104	.53	38
Language Expression	-.023	.89	38	.153	.36	38	.111	.51	38
Language Mechanics	.008	.96	38	.306	.06	38	.250	.13	38
Total Language	-.013	.94	38	.222	.18	38	.172	.30	38
<u>Grade 2</u>									
Vocabulary	.053	.74	41	.177	.34	31	.140	.45	31
Reading Comprehension	.026	.87	41	.174	.35	31	.029	.88	31
Total Reading	.041	.80	41	.187	.31	31	.084	.65	31
Language Expression	-.052	.75	41	.330	.07	31	.182	.33	31
Language Mechanics	-.010	.95	41	.419	.02	31	.357	.05	31
Total Language	-.039	.81	41	.402	.03	31	.272	.14	31
<u>Grade 3</u>									
Vocabulary	.049	.78	35	.080	.67	31	.135	.45	33
Reading Comprehension	.032	.86	34	-.194	.31	30	.180	.32	32
Total Reading	.055	.76	34	-.084	.66	30	.180	.32	32
Language Expression	.092	.60	35	-.165	.37	31	.271	.13	33
Language Mechanics	.013	.94	35	.090	.63	31	.137	.45	33
Total Language	.057	.74	35	.138	.46	31	.223	.21	33

* $p < .01$

Hypothesis #13: No significant relationship exists between time spent on tutorial applications and scores on the TCAP for females at any grade level.

Hypothesis #14: No significant relationship exists between time spent on techniques applications and scores on the TCAP for females at any grade level.

Hypothesis #15: No significant relationship exists between time spent on reading and language arts programs and scores on the TCAP for females at any grade level.

Table 9 shows the Pearson Product-Moment Correlations between time on computer applications and achievement test scores for females at each grade level. Results for grade 3 revealed no significant differences between tutorial and techniques applications and total time on reading and language arts activities and TCAP test scores. Significant differences did occur in grade two.

No significant relationships existed between time on tutorial applications and test scores for second grade girls. Significant correlations for techniques applications were .416 in vocabulary, .587 in language mechanics, and .454 in total language. Five tests had

Table 9

Pearson Correlation Coefficients Between Time in Minutes on Computer Applications and Achievement Test Scores for Female Students at Ingleside Elementary School

	Tutorial			Techniques			Total		
	r	p	n	r	p	n	r	p	n
<u>Grade 1</u>									
Vocabulary	.370	.01	43	.580*	.00	40	.599*	.00	41
Reading Comprehension	.286	.06	43	.343	.03	40	.401*	.00	41
Total Reading	.335	.03	43	.475*	.00	40	.534*	.00	41
Language Expression	.089	.57	43	.361	.02	40	.342	.03	41
Language Mechanics	.341	.03	43	.480*	.00	40	.470*	.00	41
Total Language	.197	.20	43	.437*	.00	40	.418*	.01	41
<u>Grade 2</u>									
Vocabulary	.223	.11	54	.416*	.01	43	.458*	.00	44
Reading Comprehension	.248	.07	54	.266	.08	43	.326	.03	44
Total Reading	.260	.06	54	.353	.02	43	.410*	.01	44
Language Expression	.259	.06	54	.263	.09	43	.440*	.00	44
Language Mechanics	.082	.56	54	.587*	.00	43	.502*	.00	44
Total Language	.191	.17	54	.454*	.00	43	.513*	.00	44
<u>Grade 3</u>									
Vocabulary	-.208	.22	37	.041	.82	34	.046	.79	37
Reading Comprehension	-.139	.41	37	.171	.33	34	.036	.83	37
Total Reading	-.192	.26	37	.126	.48	34	.046	.79	37
Language Expression	-.203	.23	37	.138	.44	34	.092	.59	37
Language Mechanics	-.166	.33	37	.176	.32	34	.071	.68	37
Total Language	-.205	.22	37	.173	.33	34	.090	.60	37

* p < .01

significant relationships with total time on reading and language arts activities in second grade: vocabulary .458, total reading .410, language mechanics .502, language expression .440, and total language .513.

For first grade girls, no significant relationship existed in tutorial applications. Significant relationships existed for vocabulary .580, total reading .475, language mechanics .480, and total language .437 in techniques applications. Similar relationships were found in total time on reading and language arts activities: vocabulary .599, reading comprehension .401, total reading .534, language mechanics .470, and total language .418, all significant at the one-percent level.

Hypothesis 13 was not rejected. No significant relationships existed between time spent on tutorial applications and scores on the TCAP for first, second, or third grade girls. Hypotheses 14 and 15 were rejected. Significant relationships existed in grades one and two between total time and time on techniques applications and TCAP scores.

Summary of Results

The results from the study are summarized below:

1. Significant differences between time spent on tutorial applications were found. Third grade students spent less time on tutorial applications.
2. Significant differences between time spent on techniques applications were found. First graders spent more time on techniques applications than second graders.
3. No significant differences in total time spent on reading and language arts activities were found between grades.
4. No statistically significant relationships were found between time spent on tutorial applications and scores on the TCAP in grades one, two, or three.
5. No statistically significant relationships were found between time spent on techniques applications and scores on the TCAP in grade three.
6. For second grade students, time on techniques applications correlated positively with achievement test scores in vocabulary, total reading, language mechanics, and total language.
7. For first grade students, time on techniques applications correlated positively with achievement test scores in vocabulary, language mechanics, and total language on the 1994 TCAP.

8. No statistically significant relationships were found between total time spent on reading and language arts activities and scores on the TCAP in grade three.

9. For second grade students, total time on reading and language arts activities correlated positively with TCAP achievement test scores in vocabulary, language expression, language mechanics, and total language.

10. For first grade students, positive correlations between total time on reading and language arts activities and TCAP achievement scores were found on three subtests: vocabulary, total reading, and language mechanics.

11. No statistically significant differences were found between males and females on time spent on tutorial applications, techniques applications, and reading and language arts activities at any grade level.

12. No statistically significant relationships existed for males between time on tutorial applications and achievement test scores at any grade level.

13. No statistically significant relationships were found between time on techniques applications and TCAP test scores for male students at any grade level.

14. No statistically significant relationships existed between total time on reading and language arts activities and test scores for male students at any grade level.

15. No statistically significant relationships existed between TCAP scores and time on tutorial applications, techniques applications, or total time on reading and language arts activities for female third grade students.
16. For female first graders, no significant relationships were found between time on tutorial applications and TCAP scores.
17. For female first graders, time on techniques applications correlated positively with TCAP subtest scores in vocabulary, total reading, language mechanics, and total language.
18. For female first graders, total time on reading and language arts activities correlated positively with TCAP subtest scores in vocabulary, reading comprehension, total reading, language mechanics, and total language.
19. For female second graders, time on tutorial applications were not significantly correlated with TCAP scores.
20. For female second graders, time on techniques applications correlated positively with TCAP scores on vocabulary, language mechanics, and total language.
21. For female second graders, total time spent on reading and language arts activities correlated positively with five TCAP test scores: vocabulary, reading comprehension, total reading, language mechanics, and total language.

CHAPTER V

DISCUSSION

The intent of this study was to statistically analyze the relationship between individuals' reading and language arts scores as measured by the vocabulary, reading comprehension, total reading, language expression, language mechanics, and total language scores on the Comprehensive Test of Basic Skills (CTBS) and the time they spent using tutorial and techniques computer applications. Further, the purpose was to analyze the correlation between these variables with regarding the gender and grade level of the participants.

Summary of the Study

Two hundred forty-eight students stratified by grade level from Ingleside Elementary School participated in the study. The results of the data were derived from three analytical procedures: Pearson Product-Moment Correlation Coefficient Tests, Scheffe's Test, and Analyses of Variance. The probability level of one percent was selected to test for statistical significance. The results of this study can be summarized in this way:

1. Third graders spent less time on tutorial applications than did first or second graders.
2. First graders spent more time on techniques applications than second graders.
3. No significant relationships existed between time spent on the computer and reading and language arts achievement test scores for third graders. Neither male third graders nor female third graders had significant relationships between the variables.
4. No significant relationships existed between time spent on computer tutorial applications for first or second grade students and achievement test scores. This was true regardless of gender.
5. Significant relationships existed between time spent on techniques applications and reading and language arts achievement scores for first and second graders. When these relationships were analyzed by gender, it was found that first and second grade boys had no significant relationships. All relationships determined to be significant were influenced by the scores of female students.
6. This trend was true for total time spent on reading and language arts activities as well. Significant relationships were influenced by the scores of female students in grades one and two. In addition, the total time variable was derived from the tutorial and

techniques application variables. In most cases significant relationships in total time reflected significant relationships in time spent on techniques applications. No significant differences were found in time spent on computer applications between boys and girls.

Questions and Speculations

From these results several questions emerge: Why do third graders spend less time on tutorial applications? Why do first graders spend more time on techniques applications? What are the implications of no difference in time usage for males and females? Why are significant relationships found only for female students? Why are results significant in only first and second grade? Are female students who have higher achievement scores in reading and language more likely to use the computer, or does using the computer facilitate achievement for female students by improving reading and language achievement? Why isn't computer usage predicting TCAP scores?

Why do third graders spend less time on tutorial applications?

The WICAT Primary Reading Curriculum is used with students in kindergarten through third grade to improve

reading, writing, and language. Many of the basic skills taught in this curriculum could have been mastered by third grade students. The need for review of basic facts would be minimal for many, but those students in need of remedial instruction could use these applications for practice. Students performing well in the classroom would have less need for computer remediation.

Why do first graders spend more time on techniques applications?

First graders use word processing and desktop publishing with the "Writing to Read" program. The elevated use of techniques applications by first graders may be a result of this instructional program that is used with first graders and encourages students to write stories as a technique to teach reading.

What are the implications of no difference in time usage for males and females?

Girls and boys in this study used computers in much the same way. There were no significant differences in the time spent on any computer application. Equal access is considered an important issue in computer instruction. According to several authors, boys often get more time on the computer (Sanders, 1995; Demetrulias, 1985; Campbell, 1984). Time may be a key factor in obtaining the most

benefit from an instructional strategy. However, the time needed to perform a specific task varies from student to student. It has been suggested in the review of literature that lower-ability students need more time to complete the same computer activities. There may be a similar situation here. Keyboarding skills can have an impact on the amount and quality of work students can perform on the computer. Lack of keyboarding skill has been a confounding variable in some research studies. Boys have been found to be faster at operating computer games, but could they be slower typists than girls? Teachers should consider if certain subgroups within the classroom need more time on the computer to complete the same activities.

An additional consideration could be level of interest. Girls have been found to have more interest in word processing than boys. Perhaps low interest can lead to less time on task. If boys are uninterested in techniques applications, perhaps they receive less benefit from the same amount of instructional time on this type of computer application.

Why are significant relationships found only for female students?

There is evidence of relationships between achievement test scores and time spent on the computer.

Time on techniques applications and CTBS subtest scores in vocabulary and language mechanics certainly appear to have moderate to strong relationships for first and second grade female students.

One hypothesized difference between boys' and girls' use of techniques applications found in the literature is the assertion that girls seem to enjoy word processing activities (Koch, 1994; Beynon, 1993). Although not stated directly, these works imply that girls like these applications better than boys. Preference for a specific type of computer application may play a role in the amount of time it is used and the attention it is given. In addition to liking word processing, girls may prefer reading and language arts activities to computer activities that involve mathematics. Girls may view word processing activities in language arts as more gender appropriate. They may have more interest in techniques applications and reap more benefits than boys by spending more time on task. Another explanation may be that girls are better at keyboarding and become more accomplished in a shorter amount of time. Consideration must be given to the possibility that teachers may use computers differently with boys and girls. Perhaps higher-ability girls are given more time on these applications, while the computer is used more with lower-ability boys.

Why are results significant in only first and second grade?

The computer may be used more in third grade for remediation. Students who have already mastered the skills may spend less time on computer applications. Perhaps interest in the computer has waned by third grade as well. If interest is low and students are given a choice, they may spend less time working with computers.

Are female students who have higher achievement scores in reading and language more likely to use the computer, or does using the computer facilitate learning for female students by improving reading and language achievement?

This study shows significant relationships between time on techniques computer applications and achievement test scores, but fails to answer this question. Becker (1987), however, has an idea. Becker (1987) reports that higher-ability students were more apt to use computers. Not only do the top students spend more time on computers, but more of their time is spent in higher-order activities such as programming and word processing. Lower-ability students use computers largely for tutorial and drill and practice applications, mainly in mathematics and language arts activities. This study produced similar findings for female students. Female

students with higher ability were apt to spend more time using word processing, desktop publishing, and cartoon captioning.

Why isn't computer usage predicting test scores?

The most probable reason is the number of variables that influence learning. However, many early studies did find that instruction on computers improved student achievement. What happened? Many of these studies were of short duration and measured the impact of drill and practice on mathematics achievement. Studies of reading achievement have produced mixed results.

Another consideration is the match of achievement test with computer application. According to test developers, higher-order computer activities should produce greater results than lower-order computer activities because the test is designed to measure depth of content and require the student to use complex thinking skills. Most of the computer activities available to students were of the lower-order type. Only word processing, desktop publishing, and cartoon captioning were available as higher-order computer activities.

Conclusions

Based on these results, it was found that individual vocabulary scores were significantly related to time on techniques applications for female first and second grade students. The vocabulary subtest measures the ability to construct and express meaning (CTBS, 1993).

Approximately thirty-four percent of the variance in the scores of first grade girls and seventeen percent of the variance in the scores of second grade girls can be explained by time spent on techniques applications. Vocabulary scores were significantly related to total time on reading and language arts activities as well. Thirty-six percent of the variance in the scores of first grade girls and 21 percent of the variance in scores of second grade girls can be explained by the total amount of time spent on these activities.

Reading comprehension subtest scores were significantly related to total time spent on reading and language arts activities for first grade girls. Sixteen percent of the variance in scores for first grade can be explained by the total time spent on these activities. The reading comprehension subtest measures the ability to construct and express meaning (CTBS, 1993).

Total reading scores were significantly related to time on techniques applications for first grade girls.

Almost twenty-three percent of the variance in reading scores can be explained by time spent on techniques applications. Total reading scores were also significantly related to total time on the computer. Over 28 percent of the variance for first grade girls and 17 percent of the variance for second grade girls' scores can be explained by total time spend on reading and language arts activities. The total reading score is derived from the vocabulary and reading comprehension subtest scores.

Only one significant relationship was found between scores on language expression and time on the computer applications. Nineteen percent of variance for second grade girls can be explained by time spent on reading and language arts activities. The language expression subtest measures writing ability using the higher-order skills of critical comprehension and complex thinking (CTBS, 1993). Roblyer (1989) writes that computer applications should be effective in teaching higher-level comprehension skills. Theoretically, one might assume that the use of techniques applications, which include word processing, and desktop publishing—reputed to build higher-order skills—would have a positive relationship with these subtest scores. This was not the case, however.

Language mechanics scores were significantly related to time on techniques applications for first and second grade girls. The language mechanics subtest measures the students' knowledge of writing conventions and strategies that enhance meaning (CTBS, 1993). Twenty-three percent of the variance in first grade scores and 34 percent of the variance in second grade scores can be explained by the time spent on techniques applications. Significant relationships existed as well between total time spent on reading and language arts activities and language mechanics subtest scores for first and second grade girls. Twenty-two percent of the variance for first graders and 25 percent of the variance for second graders was explained by total time spent on reading and language arts activities.

Total language scores were significantly related to time on techniques for both first and second grade girls. Total language scores are derived from the language mechanics and language expression subtest scores. Nineteen percent of the variance in first grade girls' scores and 21 percent of the variance in second grade girls' scores can be explained by time spent on techniques applications. The significant relationships found between total time on reading and language arts activities and test scores were probably caused by the strong correlations found between techniques and language

mechanics subtest scores. Seventeen percent of the variance in scores for first grade girls and 26 percent for second grade girls can be explained by the total time on computer activities.

Threats to Validity

The two most often mentioned threats to external validity in computer studies are the novelty effect and the Hawthorne effect (Kulik and Kulik, 1991; Clark, 1985; Niemiec & Walberg, 1987; Grayson, 1970). The novelty effect occurs when subjects display increased interest, participation, and motivation simply because they are doing something new and different (Gay, 1992). The Hawthorne effect occurs when subjects alter their behavior, not in response to the experimental treatment, but because they know they are participating in a study (Gay, 1992).

Kulik, Kulik, and Bangert-Drowns (1985) write that novelty is more of a factor in short-term studies. Short-term studies do, however, provide more control over extraneous factors than long-term studies. Long-term studies do provide better control of the novelty effect (Kulik, Kulik & Bangert-Drowns, 1985; Clark, 1985).

For this particular study, the novelty effect is not truly applicable. Students have had previous experience

working with computers. At Ingleside Elementary School, all students—grades K through three—are exposed to computers in the classroom. In addition, because data for this study were collected throughout the school year, this would typically be considered a long-term study.

Also, the Hawthorne effect does not apply in this study. Students were unaware they were participating in a study of any kind. The researcher made no direct contact with students. Information on computer usage was collected via the administrative staff.

Threats such as these rival hypotheses can diminish computing research in the development of instructional theory. They do not, however, diminish the importance of research in developing instructional delivery designs for the computer (Clark, 1985). It is important, though, not to overlook plausible rival hypotheses (Campbell & Stanley, 1963; Campbell, 1988).

Implementation Strategies

Studies done at a single school site should include a discussion of the context in which the results occurred. This is particularly true in a case where the school is unique. The school selected for this study is unique because of the educational technologies available to

students and the strategies employed to facilitate the implementation of technologies.

In evaluating the results of this study, it is beneficial to discuss the implementation strategies used by the staff at Ingleside Elementary School. Staff members had been involved in computer implementation since 1991. Many of the issues typically considered important in the successful implementation of computers for instruction had been addressed during the previous three year period. A long-term implementation plan was developed and computer applications were selected to meet the projected needs. The WICAT ILS was chosen to be installed. This system allowed teachers the opportunity to choose a variety of applications covering a variety of high- and low-order skills. Plans also included the implementation of communications and information technologies. This networked computer system was expensive. School system administrators solicited the financial support of businesses and evaluative support from educational consultants in order to install the computer system they considered to best meet the needs of the students.

Teachers involved in the implementation from year one were well trained. New teachers did not receive the thorough training of these teachers, but two things contributed to their acquisition of computer knowledge.

First, training was continuous through workshops and in-service sessions and, second, the school employed a computer consultant who was available on the school site. The computer consultant provided excellent support to both faculty and students.

The number of computers purchased and installed was adequate to meet the needs of most students. The school had approximately 60 networked computers. The ratio of computer to student was about one to five. Computers were available to all students and enough were available to provide the opportunity for frequent use by many students. Time spent on the computer for reading and language arts activities varied. The total time spent on these activities ranged from as little as 15 minutes to over 40 hours.

The software utilized was adequate in several ways. Software provided different computer applications, portrayed females and minorities in a variety of roles, and in some cases used audio and visual capabilities to enhance instruction.

Inequalities in computer usage were not found in this study. Females and males used the computer similar amounts of time in each application category. Other areas of inequality often addressed in the literature were not addressed here. There may have been some differences in the use of computer applications based on

ability level and ethnicity, but the number of students in this study proved too small to reach a determination. It is sometimes suggested that lower-ability students may require more time on the computer than other students because these students often take longer to complete the same task. Also, low-ability students are often given low-level drill and practice activities and do not receive as much time on computer applications that build higher-order skills.

Although not a part of this study, observations by Institute of Educational Technologies staff revealed that students were allowed to work in pairs or small groups on some occasions. This was not a daily practice for students, but did occur often enough as not to be unusual. According to several authors, this type of instruction is beneficial to many students and in fact should be implemented as part of an innovative computer education program.

The staff at Ingleside Elementary performed many of the preliminary and on going tasks deemed necessary for successful computer implementation by authors in the field. The importance of well-planned and orchestrated implementation cannot be overlooked.

Implications for Further Research

The best technology to choose is the one that provides the best learning opportunities for a specific population. This involves looking at the special features or attributes of each technology and determining how these influence achievement and instruction (Willett & Yamashita, 1983). Several authors suggest new ways of doing computer research. Bracey (1989) suggests we look at theoretical outcome measures instead of relying on test scores. Williams and Brown (1990) propose that researchers tie learning theory to instructional technologies. In addition, it is proposed that new indicators of higher-order thinking skills be identified and used for evaluation (Bliss, Firestone & Richards, 1991).

The statistical analyses of the data collected for this study revealed significant relationships between time spent on techniques applications and total time spent on reading and language arts activities and academic achievement as measured by achievement test scores for first and second grade girls. Based on these results and the conclusions of this study, the following recommendations for further research are offered:

1. A longitudinal study over several years should be conducted comparing the test score gains achieved by

certain subgroups while using the computer. These gains scores could be compared according to gender, grade level, ability level, ethnicity, and socioeconomic status.

2. Although this research did support the finding that a positive relationship existed between time on computer applications and achievement test scores, it did not prove cause and effect. A study with an experimental design that compares the test scores of high- and low-computer users and includes gender as a variable should be conducted.

As discussed in Chapter I, this study was important in that it could support or reject the contentions concerning the relationships between academic achievement as measured by achievement tests and time spent on computer applications. Because this study did find that significant relationships existed between the variables at two of the grade levels tested, efforts should be taken by public school educators to consider the test results and their implications for computer instruction in the primary grades. More specifically, issues of gender and sex equity should be addressed when purchasing computers and computer software and in planning for their implementation.

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APPENDIX

List of Tutorial Activities

Capital Letter Recognition
Capital Visual Discrimination
Comprehension/Paragraphs - First Grade
Comprehension/Paragraphs - Grade Three
Comprehension/Paragraphs - 2-A
Comprehension/Paragraphs - 2-B
Comprehension/Paragraphs - 2-C
Comprehension/Sentences - 1-A
Comprehension/Sentences - 1-B
Context Cue Analysis 3-A
Context Cue Analysis 3-B
Language Arts 1 Practice
Language Arts 2 Practice
Language Arts 3
Language Arts 3 Post
Long Vowel Sounds
Lower Case Letter Recognition
Lower Case Visual Discrimination
Phonics/Long Vowel Sounds - Grade One
Phonics/Short Vowel Sounds - Grade One
Readiness: Order and Sequence
Reading 1
Reading 1 Post
Reading 2
Reading 2 Post
Reading 3
Reading 3 Post
Reading/Fantasy Grade 3
Semantic Analysis 3-A
Semantic Analysis 3-B
Short Vowel Sounds
Sight Words - Grade Three
Sight Words in Context 1-A
Sight Words in Context 1-B
Sight Words in Context 1-C
Sight Words in Context 1-D
Sight Words in Context 2-A
Sight Words in Context 2-B
Sight Words in Context 2-C
Sight Words in Recognition 1-A
Sight Words in Recognition 1-B
Sight Words in Recognition 1-C
Sight Words in Recognition 1-D
Sight Words in Recognition 2-A
Sight Words in Recognition 2-B
Sight Words in Recognition 2-C
Vocabulary Comprehension 3-A
Vocabulary Comprehension 3-B
Vocabulary/Multiple Meanings - Grade 3
Writing - Make a Story Grade 1

List of Techniques Activities

Microsoft Works (Word processing)
Express Publisher
Comic Captions Grades 2/3

VITA

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