STUDENT ACHIEVEMENT AND TIME SPENT IN COMPUTER ASSISTED LEARNING

by

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(Under the Direction of C. Kenneth Tanner)

ABSTRACT

As school systems are faced with an increased focus on student achievement and accountability, we must utilize every available resource to ensure that all children have access to the knowledge they need to become productive citizens of the 21st Century. Technology usage, specifically computers, has been shown to not only have a positive impact on the instructional process and student achievement, but is in fact, changing the way we deliver instruction to our students.

The research has shown that technology can have a significant impact on student performance, specifically with at-risk students (Branigan, 2000). This study focused on the amount of time students spent in the computer laboratory and the impact computer assisted learning has on student achievement. Further research suggests that students in technology rich environments; that is; classrooms where technology is available, experienced positive effects on achievement in all major subject areas (Silvin-Kachala, 1998).

Research has also indicated that by blending appropriate technology tools into the curriculum, it can support the many current dimensions of learning that have proven to provide a positive impact on student achievement. Marzano (2001) indicates that students need to be provided opportunities for practice in order to master concepts. Computer assisted learning can
provide students with the practice needed to use their knowledge in meaningful ways. “It is during the ‘shaping phase’ that learners attend to their conceptual understanding of a skill. When students lack conceptual understanding of skills they are liable to use procedures in shallow and ineffective ways.” (Marzano p. 69)

This study focused on the difference between the amount of time measured in minutes that students spent in computer laboratories as part of their teaching and learning and their achievement as measured on standardized assessments in both reading and mathematics. Students from School 1 spent time in a computer laboratory on a software program designed for skill and practice. Students from School 2 spent time in a computer laboratory using the technology as a productivity tool for practical application of the curriculum. Ten classes of fourth grade students were studied over a one-year period.

The results of the study showed that no matter how much time students spent in the computer laboratory there was little to no statistical significance implying that computer time is a predictor of student achievement. The school with the lowest amount of time in the computer laboratory was found to have statistical significance in mathematics when the computer was used as a practical application for the curriculum. The significance of this finding suggests that as we move into the accountability age in education, we need look at putting computer assisted learning into the classroom instead of the laboratory where it might make the biggest impact. These conclusions agreed with the research by Wright (1997) that the most important factor affecting student learning is the teacher. The implication of this study was that by improving the learning environment and the instruction from the teacher we can improve student achievement.

INDEX WORDS:
Computer Technology, Student Achievement, Computer Laboratories, Technology Access,
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DEDICATION

This dissertation is dedicated to my family and friends who stuck with me through it all and had faith in my ability to accomplish any goal. My family extends beyond my birth family, to many of you that have adopted me along life’s path and who have encouraged me to believe in and go after my dreams. You give me a dangerous amount of zest for life and a belief that I can do anything.

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CHAPTER 1

INTRODUCTION TO THE PROBLEM

Computers and various technologies are available in many different forms in nearly every elementary school. Education officials are faced with the costs involved in technology implementation and the evaluation of the benefits of technology. “To thrive in today’s world and tomorrow’s workplace, America’s students must learn how to learn, learn how to think, and have a solid understanding of how technology works and what it can do” (CEO Forum, Year 2 Report, 1999, p.4). School planners must design buildings and programs that allow teachers and students the access needed to use technology where everyday teaching and learning takes place. Students need to have access to the right technology at the right time to support the curriculum objectives they require. School buildings are still being designed using computer laboratories to support technology.

In the 21st Century the ability to access information quickly and efficiently, manipulate it and apply it to solve problems has become the primary asset of today’s worker. “Of the 54 jobs expected to experience the most significant growth between now and 2005, only eight do not require technological fluency” (U.S. Department of Labor, 2000 p.25). Traditional education environments void of technology do not prepare students with the necessary skills to thrive in today’s society, nor do they train them to prosper in tomorrow’s workplace (ISTE, 2000).

Statement of the Problem

This study compared students’ achievement in those who had access to technology in a computer laboratory on a regular basis as an integral part of their skill and practice to the student
achievement of students who did not have access to computer technology except occasionally in the laboratory to support teaching and learning as a practical application.

The literature did not link technology integration and the amount of time spent on the computer with student achievement. The literature did not provide adequate knowledge on the differences between student academic achievement where technology was used in the immediate classroom as part of the teaching and learning process, and those learning environments that only used technology sporadically. The literature was also limited in its discussion of technology that is used for skill and practice, and technology that is fully integrated in the classroom where the curriculum is being learned.

As school systems continue to fund additional technology initiatives, a technology model is needed to evaluate the best use of those dollars. Research has shown that technology increases student achievement, yet schools continue to only use computers sporadically in a laboratory setting. School planners should think like educators and place the technology at the fingertips of those who need it most, the students. “Placing all the computers inside a laboratory or media center does not provide suitable access to appropriately prepare our students to use technology as a tool for learning.” (Papert, 1993 p. 25)

Purpose of the Study

This study examined the difference in student achievement in both reading and mathematics as measured on standardized assessments. The study spanned one year of time and measured the amount of time students were exposed to technology in computer laboratories as measured in minutes. The study of minutes on the computer is in response to the vast amount of money being spent on technology initiatives, yet students are still unable to access technology where they need it, in their classrooms. The study was completed in a laboratory setting because
students do not have access to technology in their classrooms. Teachers were trained on how to integrate technology and then were not provided the technology in their classrooms where the learning takes place.

Research Hypotheses

The research hypotheses focused on student access, student achievement, interactive learning environments, staff development, pre-service teacher training, as well as student and teacher attitudes.

As student access to technology (computer usage) was measured in minutes, it was hypothesized that no significant academic achievement, as measured on standardized assessments scores in reading and mathematics, existed between students who used technology more than once a week for 20 minutes and those who did not. It was hypothesized that students who are taught with traditional pencil and paper will have no significant difference in their academic achievement than those who used computers to produce projects and have a more interactive learning environment. How does access to technology impact teaching and learning in our schools? Does an increase in computer usage have an effect on student achievement? How do students learn best and how does technology fit into that model?

Significance of the Study

The promise of technology seems to be a late arrival in our elementary schools, riding in on the coattails of being able to do everything better, faster, and cheaper. In American homes, nine in ten children have access to computers and the Internet is now “pervasive” (Newburger, 2001 p 9). “The continued success and quality of American public education depends on our collective ability to close the gap between technology’s mere presence and its effective
integration into the curriculum to enhance student performance and deliver the skills necessary for the 21st century.” (CEO Forum Year 3 report, 2000 p 6)

When President Bush signed the No Child Left Behind Act of 2001, the legislation brought many significant changes to school nationwide. Aligned with this study, the primary goal specified for Title II, Part D-Enhancing Education Through Technology is as follows: The primary goal of this part is to improve student academic achievement through the use of technology in elementary schools and secondary schools (NCLB, 2001). The No Child Left Behind Act is now here and will have to rely on technology to play an important role as a way to provide students with instructional opportunities, a means of analyzing student performance and how teachers shape the improvement of that performance. We must begin by allowing students access to that technology (CEO Forum, 2000).

Technology offers real time communication, hands on learning, multimedia presentation, and an infinite amount of information. “Technology moves a child further from the Industrial age and closer to the lifelong learners of the Digital Age” (McDonough, 2000 p3). To keep up with the times and remain successful, schools must integrate these capabilities into the hands of the learner within their learning environment. Equipping a classroom with only a chalkboard and an overhead assumes that every teacher has the same style of teaching and every student has the same style of learning (Schlechty, 2002). Technology will help teachers to use teachable moments, excite interest, and engage in discussion during a regular school day. “If we desire results in learning, we must focus on the students’ work each day as what really matters, and not the teacher’s presentation.” (Schlechty 2002, p. 18)

Consequent to this goal of technology integration, a plethora of changes must take place. Successful technology integration is measured using a variety of influences including, but not
limited to student access, student achievement, interactive learning, staff development, pre-service teacher preparedness, teacher attitudes, and student attitudes. To begin integrating the curriculum, although much of the knowledge we can access is considered “virtual,” it still must take place somewhere. At present most of the technology is placed in isolated computer laboratories or media centers. We must place it at the fingertips of the learners where the learning is taking place, the classroom.

The research literature reflects much controversy over appropriate types of computer applications. Papert (1993), a well-known researcher on children and computers, feels that computers should be integrated into the curriculum for greatest impact. He stated, “Computer labs are not integrated across the curriculum, they are integration across the hall. As such, they isolate the computer and make it [a separate] part of the very curriculum it should be supporting” (Papert, 1993 p.149). How are we designing the classrooms of the future? Are we still designing for the Industrial Age where large group instruction is the norm with the teacher standing in the front of the room, lecturing? “If we are going to move to the Digital Age, we are going to need to look at the way we are designing our classrooms so that we can incorporate student-centered, technologically integrated learning environments into our schools” (Lackney, 2001 p7).

While we have spent a considerable amount of money funding technology in schools, teachers have not been able to tap into the vast capabilities of technology for their students. We need to stop talking about computers and curriculum separately so that we can seamlessly integrate technology and curriculum in an educational climate in which digital learning exists. To recognize the pressures students and teachers feel from accountability and the push for digital infusion as a viable goal, we must extend accountability into the digital environment to link the technology integration, the learning process, and student performance (CEO Forum, 1999).
Children in technology-enriched classrooms appear to score higher on standardized tests in mathematics, to take control of their own learning environment, to work well in cooperative groups to accomplish a common task, and to place worth in their ability to be productive students (Page, 2002). “Schools cannot be made great by great teacher performances. They will only be made great by great student performance” (Schlechty, 2002 p xiii). Increased levels of student-to-student interaction in computer learning environments appear to provide positive levels of student achievement (Brush, 1997). This study indicated that technology-enriched elementary classrooms are conducive to higher levels of mathematics achievement, higher levels of self-esteem, and student-centered environments. “Initial research indicates that when correctly applied, technology can have a positive effect on student learning, particularly in honing higher order thinking skills” (Schrater, J. 1999 p 3).

While standardized tests measure basic skills and facts, performance assessment can be used to measure students’ attitudes towards technology and the impact technology is making on the way students are learning. Technology can shift assessment from the one shot snap shot into a diagnostic tool that can become the essential part of teaching and learning and instant feedback. Today’s standardized tests are still measuring yesterday’s skills using yesterday’s technology. Integrating technology can open a new way of assessing the mastery of our students that will make accountability successful. Schools across the nation are already searching for new ways to teach, organize and focus instruction and resources to maximize gains in a society driven for student accountability. “The options for tomorrow’s learning communities expands and grows more multifaceted not more restricted and uncomplicated” (DeAarmond, Taggart, & Hill, 2002 p 13).
What does it mean to move from a teacher-centered classroom to a learner-centered classroom? “Learner-centered classrooms are where students are in charge of their own learning, assignments are self-directed, and where teachers learn alongside the students and present material that is complex in nature, not just isolated facts” (Lackney, 2001 p 5).

The power and potential of digital learning must be realized to be desired. Digital Learning is interactive learning by which students manipulate information in a creative and engaging learning community. The learning environment becomes a dynamic, vibrant, interactive exchange. The power of interactive learning that technology provides stems from the dynamic characteristics that allow students to locate and construct information through a productive learning environment containing a vast reservoir of information, ideas, resources and experts (McGrath, 2002).

Teachers can create multiple ways to achieve the objective so the same information can be accessed and mastered, but in ways that work best for students. If technology is available and used effectively it creates a unique learning environment where educational objectives are achieved in a dynamic, learner-focused, productive environment. To create lifelong learners, we can not just teach children facts; we must teach them how to attain those facts and what to do with them. If we can get computers into the hands of the learner we shift the role of the teacher from fact dispenser to the facilitator of gathering information (Fatermi, 1999).

As students gather information, the computer usage occurs logically, instinctively and inevitably. “If we learn 90% of our job skills on the job, then teaching facts will not do our children any good, they must know how to quickly retrieve information” (McDonough, 2000 p 2). In many respects, technology is driving the way we present our current curricula. The instructional process is moving towards self-directed learning and individualized instruction.
The basic view of teachers and the community of the benefits of educational technology include preparing students for jobs, increasing student interest in learning, increasing student access to information, and making learning an active experience (Milken Exchange, 1999). Teacher professional development is needed to move teachers from traditional styles of teaching and learning to student directed teaching and learning. Technology can be used as a key tool to achieve this goal but not without the staff development component.

In practice, student achievement outcomes are directly related to teacher integration of technology into the learning environment. If teachers are to accept the change in the teaching practice and embrace technology, significant teacher training on basic computer skills and more importantly, how to integrate technology with content specific curriculum is needed. We need a transition from inadequate support and training of teachers to support for all teachers to learn how to use technologies effectively in everyday teaching. Teachers are still relying on textbooks to deliver most of the core curriculum. The lack of training is the largest obstacle to full integration of digital content into the curriculum. Teachers who received training say they feel “better prepared” to integrate technology into their classrooms and are more likely to use them as learning tools for their students (Fatemi, 1999 p 8).

Changes are needed throughout the educational structure. Classroom designs will need to focus on rooms that incorporate flexible spacing, mobile furniture, vast infrastructure, and a demand for trained teachers. The philosophy of technology is shifting. Technology education is teaching technology as a curriculum, education technology is using technology to teach the curriculum. The focus is on teaching curriculum, not technology. Education technology is the use of technology tools to facilitate learning in a variety of subject areas.
It has been found that the number of years of teaching has no big impact on the use of computers. Although, those who have been teaching five years or less are more likely to use technology than those who have been teaching 20 years or more (Technology Counts, 1999) “Even though our younger teachers have grown up in a more computer literate environment, training teachers how to use technology to enhance and teach the curriculum is the training missing from our pre-service training institutions” (Fatemi, 1999 p 10). “The most significant barriers to the institutionalization of educational technology: in-service teacher resistance and faculty inexperience” (Strudler & Wetzel, 1999 p.72).

Many pre-service teachers seldom see technology integrated during their internships and often believe the poor availability of technology access would be a significant barrier to technology use in the classroom (Fatemi, 1999). But, we must forge ahead. Shaw warns, “limitations in our current knowledge must not be used as an excuse to allow our schools to fall further behind other information-based institutions” (Shaw, 1998 p.121). We do not have time to reflect and review how technology is going; technology will not stand still that long. We have to evaluate technology as a process not a program (Blanchard, 1999).

Students already show an interest in technology. Schools need to tap into that interest and create positive attitudes towards schools and learning. Research shows that successful implementation of technology into schools can be a powerful tool for increasing student achievement. In addition, it can boost school attendance, increase teacher professional development, assist at risk students, encourage student engagement, and motivate students (Sivin-Kachala, J., 1998). Why are computers so engaging? When children acquire knowledge for themselves, it becomes a thinking and connecting process instead of just a set of facts. Roger Schank states that: “We should spend one third of our day at the computer, one third talking with
others, and one third making something.” He contends that we learn by doing and that our classrooms rarely foster that experience (Fielding, 1999 p 1). Classrooms that are focused and personalized on mastery instead of breadth provide an atmosphere where students are excited about learning. “Assumptions that all students learn the same way and that there are smart kids and dumb students are obsolete” (DeAarmond, Taggart, & Hill, 2002 p 7).

Taken together, the five national trends, accountability on norm referenced tests, individualized instruction, new technology, changes in teacher training, and changes in student diversity, all have serious implications for the future of school facilities (DeAarmond, Taggart, & Hill, 2002). These implications can no longer be ignored.

Assumptions of the Study

• The teachers in the study had received varying amounts of staff development on how to integrate technology into the curriculum.

• All teachers had the opportunity to utilize the LSTC (Local School Technology Coordinator) and additional staff development throughout the school year.

• Teachers had equal access capability to the available computers.

• An increase in use of technology would show a difference in student achievement when compared to another sample classes.

• If computers were inside the classroom, students’ use of the computer would increase and therefore, have a positive impact on student achievement.

• Sample classrooms were academically balanced at the beginning of the year.

• Classroom teachers did not change their teaching style during the study.
Limitations of the Study

1. This study was completed using the data from a sample size of 200 fourth grade elementary students and ten classroom teachers exclusively.

2. The study compared standardized test results of students who used technology on a regular basis (approximately once a day for 20 minutes) on a program designed for skill and practice and of students who used technology as a productivity tool for practical application of the curriculum a minimum of 40 minutes per week.

3. The study was limited because the classrooms did not contain access to more than one computer. However, the teachers who allowed their students access to technology used the computer in their class and the computer laboratories and media center more often as documented than the other sample groups.

4. The sample was chosen from one suburban school system.

5. Students were measured on the same standardized test.

6. Technology access was measured with a sign-in sheet in the computer laboratories, media center and in each individual classroom.

Definition of Terms

**Infrastructure**: The wiring necessary to bring high speed Internet access into the school building and into individual classrooms.

**Drops**: The access terminal where each individual computer must plug-in to access the Internet and network programs. These drops may also be incorporated into a wireless network.

**Wireless Network**: A network that allows many computers to access the Internet and network without individual access points. Many computers may run off of only one access point in the classroom.
Network: The server in the school building that stores common programs for users to access without storing them on individual computers. The network also provides access to the Internet and a file storage system.

Server: A large storage facility designed to house information so that the individual computers’ hard drives do not get full. This is a large computer that runs many small computers. It also has the capability to save the information stored from the computers that are plugged into the server’s network.

LSTC: Local School Technology Coordinator is the person who supports teachers as they strive to integrate technology into the curriculum.

TST: Technology Support Technician is the person who supports the technology hardware and keeps the machines in working order including the daily backup of information.

CRCT: State required Criterion Referenced Competency Test given to all students in grades 1 –5 at the elementary level.

Research Design

Population Sample: The research sample included five classrooms of fourth grade students at Samuel Adams Elementary School (School 1) and five classrooms of fourth grade students at John Adams Elementary School (School 2). (Approximately 200 students and ten teachers). Classes were heterogeneously mixed and balanced according to ethnicity, socioeconomic status, and academic achievement. The schools used a computer program to ensure that every classroom was balanced in the beginning of the year. The schools had very small mobility rates and as new students entered the school, they were placed in classrooms accurately to maintain that balance throughout the school year.
**Dependent Variable:** The dependent variables for this study were the achievement scores in reading and mathematics as determined by the standard scores on the CRCT. The gain was then calculated using the third grade CRCT scores and the fourth grade CRCT scores in both reading and mathematics.

**Independent Variable:** The independent variable for this study was the total number of minutes each fourth grade student spent in the computer laboratory during the 2002-2003 school year. The minutes were also broken down into minutes that were spent on mathematics instruction and reading instruction in the computer laboratory. Classroom teachers signed a log every time they used the computer laboratory and indicated the activity and content area for the focus of the lesson. The minutes were further analyzed based on the type of computer usage during laboratory minutes. School 1 used the computers primarily as skill and practice using one program. Students visited the computer laboratory each day for approximately 20 minutes. School 2 used the computer as a productivity tool for students and used a variety of programs to integrate the curriculum into a practical application. Students visited the laboratory as teachers signed up for a minimum of one 40-minute visit per week.

Classes from School 1 identified as A, B, C, D, and E were scheduled into a computer laboratory approximately 20 minutes a day to work on a skill and practice computer program designed to improve reading and mathematics. Classes from School 2 identified as F, G, H, I, and J scheduled them into the laboratory as needed to use computers as an integrated part of the presentation of curriculum. They did not use a specific program each time they visited. Classes A, B, C, D, and E visited the computer laboratories, media center computers, and used the classroom computer more often than Classes F, G, H, I, and J.
A measure of each classroom’s academic achievement at the beginning of the year and at the end of the year was taken using the same instruments. A comparison was then made of the achievement of $A_1+B_1+C_1+D_1+E_1$ and the achievement of $A_2+ B_2+C_2+D_2+E_2$. A comparison was then made between the achievement of $F_1+G_1+H_1+I_1+J_1$ at the beginning of the year to that of the end of the year $F_2+G_2+H_2+I_2+J_2$. Additionally, comparisons of the totals of $A_1+B_1+C_1+D_1+E_1$ to $F_1+G_1+H_1+I_1+J_1$ and at the end of the year comparisons of the end totals of $A_2+ B_2+C_2+D_2+E_2$ and $F_2+G_2+H_2+I_2+J_2$ were made.

**Data Collection Procedures:** All students in Classes A - J were given a two standardized assessments to measure academic achievement. The curriculum areas measured for academic achievement were reading and mathematics. The assessment included:

**CRCT – Criterion Referenced Competency Test.** A test required by the state for all students that measures how much of the content students have mastered by May. The 3rd grade test (2002) was the pre-assessment and the results of the 4th grade test (2003) were the post assessment in both reading and mathematics.
Data Analysis: Scores on all assessments were analyzed to determine effectiveness of technology integration. Pre-assessment scores included the state administered CRCT in reading and mathematics. Post-assessment scores included the state administered CRCT in reading and mathematics. Gain scores were used from the CRCT.

Future studies:

1. How to better evaluate the effectiveness of technology integration to include higher order thinking skills, attitudes, student engagement, communication, and research skills.
2. Study on how the integration of technology impacts attendance, discipline issues; dropout rates, college readiness, and school climate.
3. LAN vs. WAN wave of the future.
4. Other technologies not restricted to computer use.
5. How to fund technology, traditional PC’s or wireless laptops?

Statement of the Problem

This study compared students’ achievement in those who had access to technology in a computer laboratory on a regular basis as an integral part of their skill and practice to the student achievement of students who did not have access to computer technology except occasionally in the laboratory to support teaching and learning as a practical application.
CHAPTER 2
REVIEW OF THE LITERATURE

There are computers and various technologies available in many different forms in nearly every elementary school. Education officials are faced with the costs involved in technology implementation and the evaluation of the benefits of technology. School planners must design buildings that allow teachers and students the access needed to use technology where everyday teaching and learning takes place. Students need to have access to the right technology at the right time to support the curriculum objectives they need. School buildings are still designed using computer laboratories to support technology. This research is an effort to show that students who have access to technology have greater student achievement than students who do not have access to computers.

With the arrival of technology into the workplace, it seems that the promise of educational technology has a late reservation for arrival in our schools. For most elementary teachers technology still remains a mere distraction. Lack of training and access are cited as the reasons for technology’s failure to live up to its expectations. Far too many classrooms are being built without access to the technology needed to be a contributing factor in today’s workforce. While technology provides the way for teachers to provide interactive instruction and learning and the opportunity to assess student achievement as a way to drive instruction, far too many classrooms are awaiting the arrival of technology. The technology exists in computer laboratories within a school building to be accessed only once or twice a week. How does access to technology impact teaching and learning in our schools? In most schools a classroom may
have one computer that a lucky few may “play on” when they finish their traditional paper and pencil work. Those that have integrated technology into their curriculum have noticed an increase in student engagement. Does an increase in computer usage have an effect on student achievement? Why do computers engage students and provide better teaching and learning opportunities? Additionally, teachers need training on how to integrate the technology across the curriculum. Schools try to retrofit new technology into an outmoded instructional model. As long as elementary teachers present didactic teaching as their dominant instructional model, we may never take full advantage of the speed and excitement of technology as an instructional tool. How does staff development impact the use of computers by both students and teachers? New teachers arrive into the field far more technologically proficient than those trained a mere 5 years ago, yet while they understand how to use technology for their own learning, why do they not use technology as a seamless part of instructional delivery? How does the pre-service training of teachers impact the ability to integrate technology? The use of technology both in teaching and learning has a positive impact on both the teachers and students’ attitudes towards technology and instruction, thus, resulting in greater student achievement. How do teacher attitudes affect technology integration in the classroom? Why do computers have a positive effect on teacher and student attitudes?

**Student Access**

Paramount to full and effective technology integration is student access. At present, most computers are housed in a technology laboratory where students use them once a week for 45 minutes or less. In the Digital Age, we are teaching students as if we are preparing them for the Industrial Age. To adequately prepare students for the Digital Age, all students must have access to computers when and where they need them, not just once a week in a technology laboratory.
Maine’s Governor, in a divisive and decisive move, gave a laptop to every seventh grader in the state at the beginning of this school year. After the first six months, school officials are awed at how students have taken to the technology. While the $37.5 million effort is called an extravagant program by many, “these laptops are changing the way learning happens and the way teaching happens. We don’t have a pencil lab or put eight pencils in the middle of the room and have kids take turns using them” (Mahoney, 2003 p. 8). Computers are becoming the paper and pencil of today, the very tools that children need, and every child in the school needs to have one (Mahoney, 2003).

Having a computer in the hands of every child eliminates the “haves” and the “have nots.” Although many children have computers at home, this does not negate the need of having computers in the classroom. Making children wait until they get home or wait for their turn in a computer laboratory does not produce an effective learning experience. To maximize student learning, children need timely and effective access to learning resources. By having access to computers and learning to use them early on, children will be more adept when they reach high school and college.

“The CEO Forum strongly believes that the integrated approach of digital learning is essential if we are dedicated to inspiring students to be lifelong learners and to preparing them for life and work” (CEO Forum, 2000 p 11). “An institution must commit to a vision of digital learning and must have a sufficient technological infrastructure and the professional development and process to support the use of digital content” (CEO Forum, 2000 p.15).

There is widespread agreement among parents, teachers and administrators that technology must be an integral part of the educational experience for today’s students to fully
succeed in the 21\textsuperscript{st} century (National Education Association’s Web site: www.nea.org/technology)

Although we are making progress towards this end, many of America’s classrooms are just scratching the surface. The obstacles that impede progress towards full integration include myriad things, but, also included is teacher preparation at technology experience. The quality of education depends on our ability to close the gap between technology presence and its effective use in the pursuit of school improvement and student achievement. The real strength of technology is letting students have access to the right technology at the right time to support the curriculum objective they need.

Other reasons teachers are using digital content more often include the fact that there aren’t enough computers available for teachers to use in their classrooms. 67\% of teachers in classrooms with six or more computers say they relay on digital content to a “very great” extent, compared to 40\% of teachers whose classrooms that have only one or two computers (Fatemi, 1999 p 6). If you have 25 students in your classroom, it would take you a week to get each child on the computer once to complete one activity. If you have five or six computers, a child can use the computer every day.

Computer laboratories and media centers full of computers have their place as we begin to immerse students and teachers in a technology atmosphere. As teachers and students become more comfortable with the use of technology and its possibilities, technology education needs to continue in the classroom. We need to move from using the computer as simple keyboarding and skill and practice machines to tools for learning. If the focus in the computer laboratories is introductory computer skills, research and basic skill and practice, then the most powerful
machines are needed in the classrooms where increased speed and capacity are required for students use on projects and presentations.

In a primary school in Australia, technology reflects the belief that learning should be personal, not mass-produced. “Each student has access to a wireless laptop allowing them to learn wherever the learning takes them, whether inside or outside of their classroom, their world becomes their classroom” (Nair, 2002 p 1). Though there has been some debate over whether schools should continue to fund traditional personal computers or move towards wireless laptops for students, the fact remains that either will provide the access students need to bring the world to their classrooms.

When planning a school we need to look at the activities that take place for students to have meaningful learning and plan our classrooms around the exploration, discovery, experimentation and mastery. “Architects need to think like educators” (Lackney, 2001 p 9). One of the areas assessed when looking at a school building’s developmentally appropriate design for learning environments, is technology. The assessment includes spaces with computers for students within the learning environment as an integral part of the curriculum. Additionally teachers’ access to technology include computers with Internet access and easily accessible for lesson planning, presentations, and research (Tanner, K. 1999). Since all of the students' learning takes place in the classroom it is critical that we pay attention to its design and function. To design such a classroom requires careful planning and consideration into the multifaceted ways that information can be presented and attained both visually and auditory now and into the future.

As a learning tool, student access to computers can assist teachers in meeting the challenge of accommodating the vast and individual needs found in the classroom. To improve
student learning, access to technology must increase to provide students with the standards-based learning opportunities needed for higher levels of student achievement. Students are motivated to use software that moves at the student’s pace and gives instant feedback. “To maximize student learning, everyone in the school community, including the students, need timely and effective access to just the right information and learning resources at just the right time” (Miller, & Simkins, 2002 p 23).

The goal of educational technology is to put technology into the classroom so that we can seamlessly help students focus on curriculum in the place where they can collaborate with peers and get the guidance they need from the teacher to further the learning goals, not focus on the technology. We can use the argument that computers must be placed in our classrooms so that all students can have access to their learning content. “Technology is here to stay whether we are prepared for it or not. We must become fluent in our new educational language” (Dusick, 1999 p.11).

The acceleration of technology has been phenomenal, many students know far more than most adults about computers. To accommodate this rapid change we must evolve our classrooms past the flip-top desks into a mobile, flexible, and convertible learning community.

Student Achievement and Accountability

According to a recent statistical analysis, a new two and a half year study linking technology with student achievement reveals that in Illinois public schools, technology had a significant impact on student performance (Branigan, 2000). The study performed by Westat analyzed the following variables: poverty, access to educational technology, professional development, extent of technology use, and scores from the state’s 1998-99 standardized tests (Westat, 2000). The technology impact was noted greatest in the higher grades, notably 11th
grade science and 10th grade reading test scores and there were no negative impacts noted in the study. “Westat also found technology use was positively influenced by the amount of access and teacher training a school had” (Branigan, 2000 p 2). Schools in higher poverty areas had less access to laptops, fewer computers per classroom, and fewer Internet connections. These schools were less affected on their test scores. Westat also suggested that the state place an emphasis on creating equality among its schools with special emphasis on teacher training. “Just putting a computer in a classroom doesn’t seem to be enough” (Branigan, 2000 p 3). Without teacher training, placing computers in a classroom is a futile attempt at technology integration. Another study on how video streaming technology affected student achievement reported that students who received instruction incorporated with hands-on technology showed a dramatic improvement in achievement (Boster, Myer, Roberto, & Inge, 2002).

Schacter (1999) summarized past research in the area of educational technology and student achievement. Past studies have concluded that students usually learn more in less time when they receive computer–based instruction. “On average, students who used computer-based instruction scored at the 64th percentile on tests of achievement compared to student in the control conditions without computers who scored at the 50th percentile” (Kulik, 1994 p 39). Some of the findings in Sivin-Kachala’s (1998) research suggested that students in technology rich environments; that is; classrooms where technology is available, experienced positive effects on achievement in all major subject areas and these findings included regular and special needs children, or children with learning disabilities. In the 1999 (Mann, 1999 p 6) review of the three years of research of 950 fifth grade students’ achievement in 18 schools across the state of West Virginia, Dale Mann’s findings indicated that
• the more students participated in Basic Skills/Computer Education, the more their test scores rose on the Stanford 9 achievement test.

• Consistent student access to the technology, positive attitudes towards the technology, and teacher training in the technology led to the greatest student achievement gains. All students’ test scores rose on the Stanford 9 because of the Basic Skills/Computer Education with lower achieving student scores rising the most.

• Girls and boys did not differ in achievement, access or use of computer in the West Virginia study.

Schacter’s (1999) conclusion on the impact and effectiveness of technology presented in over 700 studies including a national sample of 4th and 8th grade students is that students who have access to technology on a regular basis show positive gains in achievement on researcher constructed tests, standardized tests, and national tests. Coley (1997) also reviewed several studies and notes; “students in technology-rich environments experienced positive achievement in all major subject areas.” Another study conducted, Project CHILD (Computers Helping Instruction and Learning Development), reveals that through multiple evaluation studies and longitudinal data consistently show that the students of Project CHILD have higher test scores in reading, language arts, and mathematics “than do their counterparts in traditional classrooms” (Berquist & Orr. 1991; Butzin & King, 1993; Gill, 1995; Kromhout & Butzin, 1993 p 71). An underlying assumption is that a transformed learning environment provided by the use of technology provides motivation, feedback, and involvement, all factors that are positively associated with learning and achievement. Many of the previous studies I found indicate high levels of student engagement measured by time on task, more individualized instruction, and
more student centered interactions. The common thread mentioned in many of these studies was the side benefit of an increase in the positive attitudes of both teachers and students. Many studies noted a reduction in disciplinary measures and also an increase of attendance.

Providing activities that stretch students into learning engaged at the higher levels of Bloom’s Taxonomy (analysis, synthesis, and evaluation), result in students who are better prepared for standardized tests. Computers and instructional technology is the way to incorporate these higher order skills into all instructional areas. In a review, Atkins (1993) noted that the richer and more comprehensive the interactions between the learner and the material the more the learner masters. In a recent 20 week study (Hopson, Simms, & Knezek, 2002), research on the use of computers to enhance student development of higher order thinking skills in a technology enriched classroom revealed that “students scored higher in the area of synthesis and analysis and significantly higher on evaluation based on an assessment of Bloom’s Taxonomy” (Hopson, Simms, & Knezek, 2002 p 110).

Providing students with the interactive learning tools of technology has a positive effect on learning. Although virtually every school in America has computers, many have put them into computer laboratories. As the trend moves toward putting the computers into the classrooms, the focus must also move from a traditional learning environment to an interactive learning community. This transformation will only take place with significant staff development so that teachers can better understand how the computer is used as an assistant in the classroom, not a competitor. At this point most teachers are still struggling with integration of the computer. In fact, only 43 % of elementary teachers assign computer work frequently (Becker, Ravitz, & Wong, 1999). Actually, more often, students are assigned to the computer as an “extra” when they have finished their work or in need of remediation. To fully realize the benefits of improved
student performance we must not only look at the number of computers in the classroom, but how they are being utilized. The classroom must be redesigned from the traditional paper and pencil environment to an interactive learning community of students actively engaged in their learning.

In addition to the benefits of improved achievement on standardized test scores, technology provides the teacher with an assessment tool that can be used to plan for instruction for the students sitting in the classroom. Standardized tests are usually taken near the end of the school year, with results often coming back to schools in the summer after students have moved onto another teacher’s classroom. To measure student achievement in an ongoing manner, technology can be used as a tool for teachers and students in the classroom. Multiple measures of assessment can be used including presentations and electronic portfolios (Conner, 2002). These types of assessment compliment the technology enriched learning environment because of the exponential increase in available resources for students.

Interactive Learning Environments

The level of student engagement directly correlates to the level of mastery of the curriculum. Effort from students affects learning outcomes at least as much as students' intellectual ability (Schlechty, 2002). Students volunteer both their attention and their commitment to learning the required material. Technology provides the means for teachers to create meaningful schoolwork that will engage students from which students will learn what is intended for them to learn. (Schlechty, 2002) The key to student success is found in creating engaging schoolwork for students. Therefore, the teacher can directly affect student learning through the creation of meaningful work whose qualities engage the student. In the Maine study cited above, integrating technology into the schoolwork affected student engagement within the
first six months. Evidence of this engagement is found in the attendance and disciplinary statistics. Simply put, attendance went up as detentions went down.

Educators are observing that projects utilizing technology are powerful tools that engage the learner and produce higher levels of understanding. Technology provides a variety of support to this type of learning, whether it is data collection and analysis, collaboration, construction or communication of findings. The use of technology for projects generally focuses students on teaching and learning around authentic questions or problems that are central to the concept needing mastery (McGrath, 2002). This process usually involves a community of learners instead of a room full of independent learners and culminates with a presentation of findings. Students who regularly use projects and interactive learning perform as well, and often better than students who are taught in traditional classrooms (Thomas, 2000).

Students who use technology, and who are engaged in the research process, understand the subject matter at a deeper level than do their traditional counterparts. They are more deeply engaged in their work (Chen & McGrath, 2001). This type of learning is designed to engage students and empower them with responsibility for their own learning that is unheard of in the traditional classroom setting. According to Howard Gardner, every student is intelligent, just in different ways. Technology provides the avenue for teachers to meet and reach students at their level of intelligence in the manner in which they learn best.

This type of learning environment is very different than the traditional teaching and learning of the past. One of the obstacles to full technology integration has been teacher fear and resistance. Once a student owns his or her own learning, the teacher is no longer viewed as the sole authority that knows all on the subject. Rather, the teacher is now a leader and a facilitator who guides students through the inquiry necessary for subject mastery at a depth that is rarely
attained through traditional teaching. The teacher is no longer seen performing in front of the class all day, or expending energy just trying to keep the class quiet as students fill out a worksheet. Teachers now work directly with students as they discover new ideas and explore how things work. Teachers must get over the fear of missed daily grade collection and being “the all knowing” to become the facilitator needed in an interactive learning environment. Teachers no longer direct and manage student work, but in contrast, teachers advise and guide student work. By amplifying the curriculum, students learn how to think and discover knowledge for themselves. Students learn progressively more difficult concepts by engaging in the work and challenging themselves to discover new information.

Information technology has the potential to stimulate learning. As it becomes more and more pervasive in schools and society, schools must create competent teachers who can create integrated technology rich interactive learning environments. The numbers of computers have grown from one for every 125 students in 1993, one for every nine students in 1995, one for every six students in 1998 and one for every 4.2 students in 2001 (Glennan & Melmed, 1996; Market Data Retrieval, 1999, 2001).

Rapid change is here. Computer-based skills must be taught to children and teachers, but additionally, students must be provided with the tools in their classrooms with which to explore and initiate their own learning (Morton, 1996). Students in an interactive learning classroom gather their information from a variety of sources then synthesize, analyze, and derive knowledge from it. Their learning becomes intrinsically valuable because it is connected to something real and was initiated by the students themselves.

Student performance and assessment is derived directly from what the students have learned, how much of it they learned, and how well they communicated their learning. This
represents the higher order skills necessary to compete in the 21st century. Businesses need students who can apply technology, adapt to change, acquire workplace skills, communicate ideas, and use higher order thinking skills (Solomon, 2003). Technology allows the learners to explore a world beyond their teacher and their classroom by providing access to resources and experts. Taking learning outside the classroom and beyond the school creates an important connection for students between what they are learning and how that knowledge is part of the real world, thus narrowing the gap between learned knowledge and its real life application.

Elizabeth Cohen’s findings indicate that through cooperative group work students increase interactions and achievement. Cooperative classrooms are tolerant places where students work together and take risks. Collaboration is enhanced when students are encouraged to work with each other, share ideas, and respectfully criticize each others work, disagree honestly, and tolerate differences; skills that are needed in today’s workplace.

In a recent study, students who used computers when learning to write not only were more engaged and motivated, but their writing was of greater length and higher quality (Goldberg, Russell, & Cook, 2003). Educational technology provides the avenue to sustain students’ interest, develops student knowledge and skills, and helps teachers to extend and remediate student learning. An interactive learning environment engages reluctant students, accommodates the needs of a diverse population, and creates a learning environment that is more equitable for students of different backgrounds that come to schools with different experiences. Technology and interactive learning levels the playing field for a diverse student population.

Staff Development

As school officials continue to pour money into technology, one area that is missing the initial focus is teacher staff development. Being able to transform the hardware and software into
actual tools for teaching and learning depends on knowledgeable teachers who are prepared to put technology to work on behalf of their students. Despite the purchase of large amounts of equipment, the actual use of computers in the classroom remains minimal.

In the secondary schools, only 25% of English teachers, 17% of science teachers, 13% of social studies teachers, and just 11% of math teachers make weekly use of the computers in their classrooms (Becker & Ravitz, 2001). Teacher staff development is crucial to the full integration of technology and learning. In 2000, there was one computer for every five public school students, and in 2001 there was one computer for every 4.2 students compared to just one computer for every 125 students in 1984 (Johnston, 2001).

The addition of Internet access has also increased in schools. In 1996 only 65% of all schools had Internet access compared to 95% in 1999 (Web-Based Education Commission, 2000). Yet even when computers are used more regularly in the classroom, skill and drill practice and application software are more the case than true integration of technology into teaching and learning. Teachers feel uncomfortable using the computer and are unaware of the teaching and learning pedagogies that computers and the Internet are able to support. Most districts have been preoccupied with the acquisition of computer equipment and neglected to train the very teachers expected to use that equipment. Recently, however, districts have realized the need for staff development for technology integration to be successful. In the 1999-2000 school year, 17% of technology budgets went to teacher training compared to just 6% in 1996. Although this is a significant turn in the right direction, it is generally recommended that schools devote at least 40% of their technology budgets to teacher training (Web-Based Commission, 2000).
“The major challenge ahead for schools to integrate technology effectively into the classrooms is to provide adequate professional development for teachers” (CEO Forum on Education and Technology, 1999 p 8). In 1999, only one third of public elementary and secondary school teachers reported feeling well or very well prepared to use computers and the Internet for classroom instruction (U.S. Department of Education, 2000). While we might agree that professional development is the critical ingredient if we want to achieve effective use of technology in the classroom, there are two types of staff development necessary. One type is the skill training necessary for teachers to understand the computer and the other training is technology integration, or how to use technology to enhance teaching and learning. In a 1998 survey, only 31 % of teachers responded that they had received between one and five hours of skill based training during the academic year, while 27 % of teachers stated that they had received no training at all (Trotter, 1999). With regard to technology integration, the figures represent a dismal result. Only 36 % of teachers stated that they had received between one and five hours of technology integration training, while a huge 36 % noted that they received not integration training at all. Evidence exists that both skill based and integration training make a positive difference for the teachers who receive it. According to Fatemi (1999 p 9), “teachers who received skill based training felt more confident using technology, made more use of digital content in their classrooms and were more willing to experiment than teachers who received no such training”. Additionally, teachers who received technology integration training were much more prepared to integrate technology in their classrooms. Teachers who received both types of training, felt significantly more prepared to use technology in their teaching than those who received training of just one type (Trotter, 1999).
To have meaningful and effective staff development training, teachers cannot just sit and get information. Additionally, support must be provided to the teachers once they are trained. The literature sites a number of reasons for the failure of professional development activities. Some of them include: irrelevant activities, training conducted away from the school, workshops without follow up support, and the inability to address individual needs and concerns of the teachers (Fullan, 1991; Miller, 1998). Continuing to use the “training” model where a group of experts come in and teach teachers new strategies has only been found to be effective in skill development and does not adequately prepare teachers to respond to the teaching demands of integration of technology. Without substantial and effective professional development, teachers naturally gravitate toward their comfort zone of more familiar methods that they remember when they were students themselves (Sparks & Hirsh, 1999). Effective staff development is organized around practice of providing access to outside resources and expertise, community support, and is modeled after adult learning theories. Effective staff development also provides teachers with in classroom support and assistance while they attempt to develop and implement new instructional practices. It is unrealistic to expect teachers to integrate technology into their classrooms in new and innovative ways in a relatively short period of time. For teachers to successfully integrate technology into their classroom, an ongoing professional staff development plan must exist at the local school.

Quality staff development in the use of technology seems to be a necessity if we want to build teachers with the knowledge necessary to integrate technology with teaching and learning. It is only through this professional development opportunity can teachers acquire the skills and confidence necessary to make use of the digital resources placed in their classrooms. This training must be more than a quick application course or a how to surf the Internet training.
Teachers need staff development that is placed where they teach, in their schools, with their students, using their curriculum. This training needs to be hands on and allows for follow up support in their classrooms (Putnam & Borko, 2000).

Finally, it isn’t enough to provide teachers with the “hours of training.” Professional technology-related staff development needs to provide teachers with a variety of activities such as modeling, discussion, brainstorming of ideas, hands on activities and “just in time” support, when they need it, as they need it, in their classrooms. Teachers need to be able to reflect on what they have learned and apply this new knowledge under the supportive wing of a local school technology coordinator. They need to be provided with continuous practice to become comfortable, confident integrators of technology.

Pre-Service Teacher Preparation

There is widespread agreement among parents, teachers and administrators that technology must be an integral part of the educational experience for today’s students to fully succeed in the 21st century (National Education Association’s Web Site: www.nea.org/technology). Although we are making progress towards this end, many of America’s classrooms are just scratching the surface. The obstacles that impede progress towards full integration include myriad things, but also included is teacher preparation and technology experience. The quality of education depends on our ability to close the gap between technology presence and its effective use in the pursuit of school improvement and student achievement. “To thrive in today’s world and tomorrow’s workplace, America’s students must learn how to learn, learn how to think, and have a solid understanding of how technology works and what it can do. Teachers hold the key. In fact, teachers are perhaps the single most important factor determining the quality of education” (CEO Forum, Year 1999 p 4).
Preparing teachers, while important for those already in the classroom, begin in college as we build our future workforce. Over the next decade, K-12 schools are likely to hire roughly two million new teachers (Gerald & Hussar, 1998). These numbers represent retiring teachers as well as an increase in student population. Colleges and Universities are now coming to terms with the awesome task of preparing these future teachers to understand access and bring technology-based experiences into the learning process. Unfortunately, despite the importance of creating a workforce prepared in teacher education, it is not central in the teacher preparation experience of most colleges. “Most new teachers graduate from teacher preparation institutions with limited knowledge of the ways technology can be used in their professional practice” (Office of Technology Assessment- OTA, 1995, p. 2)

While many of today’s future teachers come to school with a better technology skill base than many of those currently in the classroom, the application of how to integrate technology into the curriculum is still lacking in their training. In what is our most technologically ready generation of teachers, we are still forced to provide remediation to them when they become new teachers on how technology can support their teaching and their students’ learning once they are in the classroom. Additionally, many of these student teachers do not observe technology integration during their field experiences (Milken, 1999). To further compound the situation, many of the faculty members at our colleges do not have the technology skill and confidence or experience to model effective technology integration (Milken, 1999). While some faculty members’ technology skills might compare to the skills of their students, many professors do not model how to integrate technology into the curriculum during college courses.

The benefits of a strong teacher preparation program that incorporates technology integration extend beyond the teachers they educate into the buildings they infuse. Well-prepared
teachers go beyond improving students in their classrooms, to sharing knowledge with colleagues, modeling best practices, and motivating other teachers to teach with technology (Persichitte, Tharp, & Caffarella, 1998). More than 70% of teacher preparation programs require three or more credit hours of technology courses. About 50% of that instruction is part of another course, such as methods or curriculum. It is important to note that the courses that integrate technology into another curriculum discipline more positively correlate the ability to integrate technology than the stand-alone technology courses (Milken, 1999).

We are making strides in the right direction. Today 25 states require computer education for an initial teacher certificate. The National Council for Accreditation of Teacher Education (NCATE) has recognized the importance of preparing teachers to use technology. NCATE has now issued a series of standards and curriculum guidelines to receive accreditation. At this time, approximately one third of schools of education that produce two thirds of the country’s new teachers are NCATE accredited with these new standards (NCATE, 1997). Without quality preparation we are sending new teachers into schools to prepare students for the Digital Age using techniques more appropriate for the Industrial Age.

Teacher Attitudes

The growth of technology as an instructional tool instead of just as skill acquisition is greatly reliant on the teachers’ attitudes towards the technologies expected to be used and the ability to use them successfully. Teachers are faced with the new technology tomorrow as they are still struggling to cope with the effective use of today’s technology (Planow, Bauder, Carr, & Sarner, 1993). Although the common belief is that the integration of all types of technology will be viewed as an effective instructional strategy for improving student achievement, many teachers often do not have favorable attitudes towards the effectiveness of technology. This
attitude towards technology has a direct influence on the utilization of technology (Office of Technology Assessment - OTA, 1988). In 1982 a study revealed that there is a positive correlation between attitudes and the use of technology in the classroom. In review of the literature on how attitudes affect the use of technology in education, Lawton and Gerschner (1982) reported that the successful use of computers in the classroom is dependent on the teachers’ attitudes toward computers. Changing teachers’ attitudes from reluctant and resistant to embracers of technology is key to full implementation of instructional technology (Marcinkiewicz, 1993/1994). Knowing a teacher’s attitude toward technology should influence the beginning stages of staff development.

As teachers gain confidence in their ability to integrate technology with the curricula, fear diminishes. This positive attitude toward computers is widely recognized as a necessary condition for the effective use of information technology in the classroom (Woodrow, 1992). The major cause of resistance to the use of computers and related technology is anxiety (Gardner, Discenza, & Dukes 1993). Increasing confidence and computer experience is one way to reduce teacher anxiety. However, the ability to reduce anxiety may also depend on the type of computer experience to which the teachers are exposed (McInerney, McInerney, & Sinclair, 1994). Beasley and Sutton (1993) found that at lease 30 hours of instruction and practice were required just to reduce anxiety about information technology. As computers have increased in schools, teachers’ attitudes have not always been identified as a key factor in fostering technology integration. Although teachers’ attitudes have not been historically considered, many scholars now contend the future successful integration of technology will need to address teachers’ attitudes towards computers. According to Hignite and Echternacht (1992) it is critical that teachers possess both positive attitudes and adequate computer literacy skills to successfully
incorporate technology into the classroom. Recent studies have shown that the greater the teacher’s confidence, the greater the performance and the effort and persistence (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). In contrast, the lower the confidence, the less effort, the more likely to give up, which leads to poor teaching outcomes which then lowers teacher’s confidence (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998).

Teachers’ attitudes not only influence the integration of technology from a teaching standpoint, but they also influence students’ attitudes towards technology. Teachers are the main gatekeepers in allowing educational innovations into the classroom. These innovations often have a direct influence on student achievement. Studies have shown that students’ attitudes about school and learning are likely to affect student achievement (Office of Technology Assessment-OTA, 1995). Therefore, the key factor for effecting an integration of computers in the school curriculum is adequate training of teachers in handling and managing these new tools in their daily practices. Pierce reported in 1998 that appropriate teacher training in classroom computer use could be associated with higher student achievement (Educational Testing Service [ETS], 1998 as reported in Pierce, 1998). In the words of Pierce, “Not surprisingly, the [ETS] study found that students whose teachers had been trained to teach with computers scored higher than students whose teachers lacked such training” (Pierce, 1998, p. 2). Thus, the missing link might be teacher preparedness and a positive attitude resulting in positive attitudes in students and increased achievement. A number of studies have investigated teachers’ attitudes toward use of technology and anxiety about technology (Kay, 1989; Koohang, 1987; Marshall & Bannon, 1986). Thus, stating teachers cannot be held responsible for full integration of technology into the curriculum unless we fully investigate their attitudes towards computers and technology as educational tools.
To fully impact the curriculum, teaching methodologies and the role of teacher and student, we must influence teachers’ attitudes towards technology to infuse a change towards those agents. One might infer that if we improve teachers’ attitudes so that they embrace technology and make it a part of their teaching culture, we can positively improve instructional technology and its use among students.

Some of the positive indicators of teachers’ attitudes towards technology include; reading and buying books about technology, taking classes on technology, using new technology in place of old methodologies, talking to colleagues about technology, and encouraging people to use technology. In contrast, negative anxiety towards technology seems to exist because of influences that include; fear of a loss of authority, age barrier to learning new information, view of technology as being more work, new required classes as taking too much time, a fear of being unsuccessful, and a fear of reduction of interaction with their students.

Student Attitudes

“The value of educational time spent on using technology to support students’ literacy development rests on its ability to promote higher-level thinking, collaboration, constructivism, speed and information evaluation – i.e., those competencies required for the 21st century” (Asselin 2001 p 3). Students will not be authentically engaged if the learning process itself does not motivate them. Technology offers the ability to motivate students to become engaged learners. Research is beginning to show a correlation between the integration of technology and student achievement. This is partly due to the fact that technology is a great motivator for students.

Having a positive attitude towards technology will likely result in the students applying their newly acquired skills. In addition, students who enjoy technology and find it useful will
more likely use technology as a way of learning in the future. Although technology training for teachers is one of the solutions to technology integration, a look at the attitudes of the student towards computers might yield other solutions. Fostering positive attitudes and developing them in students might render other objectives secondary (Bear, Richards, & Lancaster, 1987). Several studies have suggested that attitudes may be an important element in teaching children about computers (Woodrow, 1990). Researchers have reported that students like to use the computer and are positively motivated by them and want to use them (Shade, 1994). Early studies showed that mostly the teachers showed negative attitudes and fears about computers not the students (Martin, 1992).

Some of the reasons children are motivated by computers might include the fact that they find them infinitely patience, the computer never grows tired, the computer often immediately praises children for positive performance, the computer is not partial to race, age or gender, the computer is often self paced, it gives immediate feedback, and does not embarrass the child when a mistake is made. Researchers have found that students view the computer, not as a science, but as a tool to be used in everyday life (Barba & Mason, 1994). The U.S. Congress (Office of Technology Assessment- OTA, 1995) has found that student achievement is likely affected by students’ attitudes about school and learning and suggests that we not only focus on student achievement, but the attitudes that affect it.

The research literature reflects much controversy over appropriate types of computer applications. Papert (1993), a well-known researcher on children and computers, feels that computers should be integrated into the curriculum for greatest impact. He stated, “Computer labs are not integrated across the curriculum, they are integration across the hall. As such, they isolate the computer and make it [a separate] part of the very curriculum it should be
Integration of the computer in the classroom is often difficult because drill and practice software is about 80% of the software available to elementary school children (Haugland & Shade, 1992). Teachers are more familiar with this type of computer use and it doesn’t require additional skills from the teacher for use. Although students enjoy this type of computer use, it is the authentic engagement of the learner that will ultimately improve student achievement, which students can attain from full integration of technology into the curriculum. This authentic engagement provides a positive attitude, not only towards the computer, but learning itself. With more open-ended applications and product-based usage, the boring skill and practice applications can be replaced by something with which students can control and are allowed to be creative (Shade, 1994)

Students skill levels vary from the expertise and fearless to the frustrated and fearful student. The computer allows students to pace themselves, accordingly, from the fearful waiting for the instructor to show them the way step by step, to the fearless student who anxiously forges ahead of instructions, recklessly pushing buttons and clicking feverishly without reading the screen. The computer technologies are able to address many different levels and types of learners found in the typical classroom. Educational technology empowers the fearful and the fearless, thus, improving the attitude of all types of student learners. While a positive attitude is not the only factor in improving student achievement, a negative attitude significantly impedes learning.

Summary

As American politicians scream for accountability among American schools, we must use every available resource to Leave No Child Behind. Technology is already pervasive in every school and nine out of every ten homes (Newburger, 2001). It is time for us to redesign our classrooms so that students have access to the technology they need when they need it.
Technology has been shown to not only have a positive impact on the instructional process and student achievement but is, in fact, changing the way we deliver instruction to our students. The literature supports the premise that the absence of technology is directly related to the lack of computer usage. Technology can no longer live in a vacuum across the hallway. Computer laboratories do not integrate the curriculum when they exist across the hall. This design isolates the very curriculum we are trying to integrate. We must redesign schools so that technology becomes a part of the whole educational environment.

Studies on student achievement in the past have found that students who use technology learn faster and have higher academic achievement. Technology placed in the classrooms alone will not raise student achievement without also looking at other factors affecting technology integration including professional development and attitudes towards technology.

Computers often result in higher student engagement because they can work at their own pace and manipulate their information. This interactive learning environment results in significantly better attitudes among teacher and students as opposed to the traditional paper and pencil classroom model. There are many benefits that are enjoyed by students who have developed a positive attitude towards technology and ultimately school. These benefits include, but are not limited to: A positive attitude towards self and learning, success in school and a motivation to learn, increased self confidence and self esteem, a sense of control over learning, improved student achievement, improved student behavior and school discipline, and improved student attendance. These are especially noteworthy when students are in at-risk groups such as special education, low socioeconomic, and minority students.

The attitude of the teacher also has a direct influence on the utilization of technology. Changing teacher’s attitudes from reluctant to embracers of technology is key to full
implementation of instructional technology. As we begin to train our teachers, knowing a
teacher’s attitude also influences where we begin the stages of professional development. As new
teachers enter the field of education many of them are already technologically proficient.
However, it was found that pre-service teacher training is often lacking in providing instruction
on how to integrate technology into classroom instruction, thus requiring school systems to
provide additional training of its new teachers.

This study focused on the difference between students who were exposed to technology
as part of their teaching and learning and those who were exposed to technology occasionally.
The study compared the student achievement of each group as measured on standardized tests
and locally derived assessments in both reading and mathematics.
CHAPTER 3

PURPOSE, METHODS, AND PROCEDURES

An overview of the design of the study is presented in this chapter. The purpose, population, sample of participants, instrumentation, data collection procedures, data analysis, research design as well as the strengths and limitation of this study are also presented. The null hypotheses were also derived from the original research questions and the identification of the dependent and independent variables are included.

The literature review in Chapter 2 discussed the amount of money that is being spent on technology in schools. The literature also presented discussions on student and teacher access to technology, student achievement, learning environments, professional development, pre-service teacher training and teacher and student attitudes. This literature review supports efforts to answer important questions related to the full integration of technology in our elementary schools.

The purpose of the study was to examine the difference in student achievement in both reading and mathematics as measured on standardized assessments and to determine what relationship, if any, was present for those students who spent more time on the computer doing skill and practice and those students who spent time on the computer using it as a productivity tool for practical application of the curriculum. Specifically, the researcher examined minutes spent on the computer in a laboratory setting, the activity that was taking place on the computer, and the achievement scores of each student.

The design of the study was a quantitative descriptive study that incorporated descriptive statistics to examine the student achievement in reading and mathematics and the minutes spent on the computer.
Population

The fourth grade students used in this study came from a large suburban school system in the southeast. This county is one of the largest in the southeast with over 120,000 students and still posts some of the highest achievement scores as compared to schools across the nation. The population sample for this study consisted of 200 students from 10 classrooms within two elementary schools. The scores used to measure achievement came from the 2001-2003 and the 2002-2003 school years.

The school district has an emphasis on student achievement and accountability and is aligned with the No Child Left Behind Act of 2001 (NCLB). The school district has created its own Criterion Referenced Test (S-4) to measure the academic skills of all fourth grade students. This proactive approach is to ensure that all schools within the district achieve Adequate Yearly Progress as outlined in NCLB. Teachers are continually offered a wide range of professional development opportunities including the integration of technology to support teaching and learning. Each school has a staff member dedicated to the alignment of technology with the curriculum to support teachers and students on a daily basis. The district has also funded computer laboratories at every school and one computer workstation in each classroom. The use of these computers will be specifically targeted in this study.

Sample

Students from these suburban schools were selected from the entire fourth grade classes during the 2002 – 2003 school year. Individual scale scores in reading and mathematics were collected from the third grade standardized Criterion Referenced Competency Test (CRCT) given during the 2001-2002 school year. These scores were used as a pre-test. Individual scale
scores in reading and mathematics were collected from the same students in the fourth grade CRCT given during the 2002 – 2003 school year. These scores were used as a post-test.

In addition to the assessments, each classroom was balanced at the beginning of the school year. Some classrooms did not remain balanced by the end of the year based on students moving in and out of the school’s attendance zone.

Instrumentation

The instruments used for this study were the Criterion Referenced Competency Tests in both reading and mathematics (CRCT). The test was given to grades 1, 2, 3, and 5 in 2001-2002 and grades 4 in 2002-2003 school years. The CRCT was given to all students in grades 1 – 5 in 2003-2004.

Data Collection

Data were collected in a variety of ways. The researcher gathered the CRCT scores by individual classroom and student. The gain scores from the CRCT given in the spring of 2002 and the CRCT given in the spring of 2003 were compared by individual students as well as by class average. Each student had a reading and mathematics score from third grade in 2001-2002 and a reading and mathematics score from fourth grade in 2002-2003. Scores showed whether an individual student increased in a particular content area, as well as if the entire class showed a gain in student achievement.

The researcher had access to these scores because they are submitted to her to compare classroom achievement levels between fourth grade classes. These scores were reported on the local school plan for improvement each year.

Data Analysis
Scores on all assessments were analyzed to determine effectiveness of technology integration. Pre and post assessment scores included the CRCT. The gain was computed between the third grade and fourth grade scores in reading and mathematics. The minutes each student spent on the computer were also measured. Additionally, data were collected to determine the type of computer activity students were engaged in while working on the computer. This computer laboratory activity separated the students into ten classroom groups. Five classrooms from School 1 participated in skill and practice activities on one computer program everyday for approximately 20 minutes. Five classrooms from School 2 participated in productivity on the computer as a practical application of the curriculum on a variety of computer programs for approximately 40 minutes per week. A test of Homogeneity of Variances and an Analysis of Variance (ANOVA) were run to determine evidence to support the differences among the means of the groups.

The descriptive statistics that were calculated showed the mean, standard deviation, standard error of measurement, and the confidence intervals for all ten groups. A Levene Test of Homogeneity of Variances was performed revealing the degrees of freedom and significance for the two schools. An ANOVA was completed to compare the means of the ten groups.

A table was constructed to show the relationship of mean scores of the ten groups and the relationship of the minutes on the computer. Another table also showed the difference between the population and how the sample was selected. Students who did not have third grade and fourth grade CRCT scores were eliminated from the sample. The population began with 200 students from two schools and ten classrooms. School 1 sample of 76 students was 67% of the total sample size. School 2 sample of 116 was 94% of the total sample size. The total sample size
of 192 students was 81% of the beginning 200 students. The variation in sample size can be attributed to mobility of students.

The dependent variable in this study was the reading and mathematical achievement data as reported as gain scores on the CRCT from the third grade administration and the fourth grade administration of this test.

The independent variable in this study was the minutes each student spent on the computer. Five classrooms in School 1 spent approximately 20 minutes per day on one computer program designed as skill and practice. The other five classrooms in School 2 spent approximately 40 minutes per week on a variety of computer programs designed as a productivity tool for practical application of the curriculum.

Null Hypotheses

The following null hypotheses were tested in this study:

Ho1: There is no statistical difference in the CRCT reading gains for the 2001-2002 and the 2002-2003 school year for fourth grade students in School 1 who spent time in the computer laboratory as part of their instruction on a program designed as drill and practice.

Ho2: There is no statistical difference in the CRCT mathematics gains for the 2001-2002 and the 2002-2003 school year for fourth grade students in School 1 who spent time in the computer laboratory as part of their instruction on a program designed as drill and practice.

Ho3: There is no statistical difference in the CRCT reading gains for the 2001-2002 and the 2002-2003 school year for fourth grade students in School 2 who spent time in the computer laboratory on a variety of programs design for productivity by the students related to their curriculum instruction.
Ho4: There is no statistical difference in the CRCT mathematics gains for the 2001-2002 and the 2002-2003 school year for fourth grade students in School 2 who spent time in the computer laboratory on a variety of programs design for productivity by the students related to their curriculum instruction.

A significance level of p<.05 was incorporated in this study to assess the evidence against the null hypotheses. This significance level informed the researcher that if the P-value is .05 or less, then the null hypotheses would occur no more than 5% of the time.
CHAPTER 4

ANALYSIS OF DATA AND FINDINGS

The results of the study are reported in this chapter. A review of the groups along with a description of the treatment is provided. Analyses of the data are presented.

Review of Sample/Population

The sample for this study consisted of two elementary schools in a large suburban school district in Georgia. Each school provided scores from five classrooms of fourth grade students in 2002-2003. The students are now in fifth grade in 2003-2004 school year. Each classroom measured the amount of time spent in the computer laboratory during the 2002-2003 school year by minutes. School 1 spent time in the computer laboratory working on a specific computer program designed for drill and practice. Students were brought to the laboratory on a daily basis for approximately 20 minutes. School 2 spent time in the computer laboratory on productivity projects which included, but were not limited to, analysis of data, creation of spreadsheets, graphs and timelines, writing activities, research on the Internet, and creating reports. Teachers determined when to bring their students to the laboratory for practical application of the curriculum.

In order to attribute differences in achievement performance to the implementation of technology integration, it was necessary to collect third grade CRCT and fourth grade CRCT scores. Table 1 summarizes the number of students at each school. The decrease of students in each school can be attributed to the student mobility during the school year. The only students used for the study had available scores for the third grade CRCT and the fourth grade CRCT.
The researcher verified the scores of students from both schools and eliminated students who did not have the third grade CRCT scores in reading and mathematics, fourth grade CRCT scores in reading and mathematics.

Table 1

*Sample Size for the Study*

<table>
<thead>
<tr>
<th>Groups</th>
<th>Number of students with 3rd grade CRCT scores</th>
<th>Number of students with 4th grade CRCT scores</th>
<th>Number of students with both 3rd and 4th grade CRCT scores</th>
<th>Percent of students remaining in the study</th>
</tr>
</thead>
<tbody>
<tr>
<td>School 1</td>
<td>88</td>
<td>114</td>
<td>76</td>
<td>67%</td>
</tr>
<tr>
<td>School 2</td>
<td>122</td>
<td>124</td>
<td>116</td>
<td>94%</td>
</tr>
<tr>
<td>Total</td>
<td>200</td>
<td>238</td>
<td>192</td>
<td>81%</td>
</tr>
</tbody>
</table>

**Dependent Variable**

The dependent variables for this study were the achievement scores in reading and mathematics as determined by the standard scores on the CRCT. The gain was then calculated using the third grade CRCT scores and the fourth grade CRCT scores in both reading and mathematics.

**Independent Variable**

The independent variable for this study was the total number of minutes each fourth grade student spent in the computer laboratory during the 2002-2003 school year. The minutes were also broken down into minutes that were spent on mathematics instruction and reading.
instruction in the computer laboratory. Classroom teachers signed a log every time they used the computer laboratory and indicated the activity and content area for the focus of the lesson. The minutes were further analyzed based on the type of computer usage during laboratory minutes. School 1 used the computers primarily as skill and practice using one program. Students visited the computer laboratory each day for approximately 20 minutes. School 2 used the computer as a productivity tool for students and used a variety of programs to integrate the curriculum into a practical application. Students visited the laboratory as teachers signed up for a minimum of one 40-minute visit per week.

Results

The findings in this section are the results of statistical analysis of the data collected from the two suburban schools. The results include Descriptive statistics, a Levene Test of Homogeneity of Variances, and an ANOVA.

The Analysis of Variance (ANOVA) assumes that variances are equal. This study incorporated the ANOVA, so the Levene Test was used to verify the assumption of equality. Table 2 shows the range of scores on the CRCT and their determination for student success along a continuum. The scores are reported numerically and those numbers fall into three categories: does not meet, meets, and exceeds in both reading and mathematics.

Table 2

Levels of Achievement Scores for the CRCT

<table>
<thead>
<tr>
<th>CRCT Levels of Achievement</th>
<th>Does Not Meet</th>
<th>Meets</th>
<th>Exceeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading</td>
<td>&lt;300</td>
<td>300-349</td>
<td>350+</td>
</tr>
<tr>
<td>Mathematics</td>
<td>&lt;300</td>
<td>300-349</td>
<td>350+</td>
</tr>
</tbody>
</table>
The researcher computed the scores for the same students in fourth grade to show the gain between the third grade reading and mathematics. Table 3 shows the scores by classroom in each school for the CRCT and the CRCT gain scores for the third and fourth grade reading tests. Table 4 shows the scores by classroom in each school for the CRCT scores and the CRCT gain scores for the third and fourth grade mathematics tests. Table 5 shows the mean CRCT reading and mathematics scores of School 1 and School 2 and the mean minutes spent in the computer laboratory. The mean minutes were also computed for time spent on reading and mathematics in the computer laboratory. Table 5 also shows the mean of the gains in both reading and mathematics on the CRCT.
Table 3

*Class Average 3rd and 4th grade Reading CRCT Scores and Gain Scores for Teachers in School 1 and School 2*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Avg. 3rd grade CRCT reading score</th>
<th>Avg. 4th grade CRCT reading score</th>
<th>Avg. CRCT reading gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>352.8</td>
<td>352.6</td>
<td>-0.2</td>
</tr>
<tr>
<td>2A</td>
<td>355.4</td>
<td>364.4</td>
<td>9.0</td>
</tr>
<tr>
<td>3A</td>
<td>366.5</td>
<td>354.7</td>
<td>-11.8</td>
</tr>
<tr>
<td>4A</td>
<td>363.6</td>
<td>375.3</td>
<td>11.7</td>
</tr>
<tr>
<td>5A</td>
<td>359.7</td>
<td>363</td>
<td>3.3</td>
</tr>
<tr>
<td>Total Avg. School 1</td>
<td>359.6</td>
<td>362</td>
<td>2.4</td>
</tr>
<tr>
<td>1B</td>
<td>357.6</td>
<td>380.2</td>
<td>22.6</td>
</tr>
<tr>
<td>2B</td>
<td>346.5</td>
<td>351.2</td>
<td>4.7</td>
</tr>
<tr>
<td>3B</td>
<td>350.6</td>
<td>355.2</td>
<td>4.6</td>
</tr>
<tr>
<td>4B</td>
<td>345.3</td>
<td>360.4</td>
<td>15.1</td>
</tr>
<tr>
<td>5B</td>
<td>368.3</td>
<td>384.4</td>
<td>16.1</td>
</tr>
<tr>
<td>Total Avg. School 2</td>
<td>353.66</td>
<td>366.28</td>
<td>12.62</td>
</tr>
</tbody>
</table>
Table 4

*Class Average 3rd and 4th grade Mathematics CRCT Scores and Gain Scores for Teachers in School 1 and School 2*

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Avg. 3rd grade CRCT math score</th>
<th>Avg. 4th grade CRCT math score</th>
<th>Avg. CRCT math gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>348.6</td>
<td>330.3</td>
<td>-18.3</td>
</tr>
<tr>
<td>2A</td>
<td>355.8</td>
<td>340</td>
<td>-15.8</td>
</tr>
<tr>
<td>3A</td>
<td>346.7</td>
<td>339.8</td>
<td>-6.9</td>
</tr>
<tr>
<td>4A</td>
<td>353.8</td>
<td>350.1</td>
<td>-3.7</td>
</tr>
<tr>
<td>5A</td>
<td>349.2</td>
<td>338</td>
<td>-11.2</td>
</tr>
<tr>
<td>Total Avg. School 1</td>
<td>350.82</td>
<td>339.64</td>
<td>-11.18</td>
</tr>
<tr>
<td>1B</td>
<td>353</td>
<td>332</td>
<td>-21</td>
</tr>
<tr>
<td>2B</td>
<td>337</td>
<td>332.4</td>
<td>-4.6</td>
</tr>
<tr>
<td>3B</td>
<td>343</td>
<td>338.5</td>
<td>-4.5</td>
</tr>
<tr>
<td>4B</td>
<td>342.2</td>
<td>346.3</td>
<td>-4.1</td>
</tr>
<tr>
<td>5B</td>
<td>348.8</td>
<td>350.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Total Avg. School 2</td>
<td>344.8</td>
<td>339.94</td>
<td>-4.86</td>
</tr>
</tbody>
</table>
Table 5

School Average 3<sup>rd</sup> and 4<sup>th</sup> grade Reading and Math CRCT Scores, Minutes on the Computer, and Gain Scores for School 1 and School 2

<table>
<thead>
<tr>
<th>School</th>
<th>Mean 3 Reading</th>
<th>Mean 3 Math</th>
<th>Mean 4 Reading</th>
<th>Mean 4 Math</th>
<th>Mean Gain 4 Reading</th>
<th>Mean Gain 4 Math</th>
<th>Mean Total Min</th>
<th>Mean Reading Min</th>
<th>Mean Math Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>359.60</td>
<td>350.82</td>
<td>362.00</td>
<td>339.64</td>
<td>2.4</td>
<td>-11.18</td>
<td>3545</td>
<td>2705</td>
<td>840</td>
</tr>
<tr>
<td>2</td>
<td>353.66</td>
<td>344.80</td>
<td>366.28</td>
<td>339.94</td>
<td>12.62</td>
<td>-4.86</td>
<td>1492</td>
<td>1376</td>
<td>120</td>
</tr>
</tbody>
</table>

Hypothesis One

Ho1: There is no statistical difference in the CRCT reading gains for the 2001-2002 and the 2002-2003 school year for fourth grade students in School 1 who spent time in the computer laboratory as part of their instruction on a program designed as drill and practice.

The Levene Test of Homogeneity of Variances was performed to determine whether or not the samples in the study have equal variances, or homogeneity of variance. If the Levene statistic is significant at the P< .05 levels, the researcher reject the null hypothesis that the groups have equal variances. The results of each Levene test for each group provided evidence that the researcher should accept the null hypothesis and conclude that the groups are homogeneous in variance. The significance level for School 1 Reading Gain is .310 (Table 6). The researcher accepts the null hypothesis and concludes that the Reading groups are homogeneous.
The mean of the third grade reading CRCT for School 1 was 359.6 and the mean of the fourth grade reading CRCT for School 1 was 362.0 giving them a gain score of 2.4. The average time in the computer laboratory doing reading skill and practice was 2705 minutes. (see Table 5) When further analyzed Table 7 includes the descriptive statistics from the gain scores and the minutes spent in the computer laboratory. The students were analyzed in seven groups based on the minutes on the computer. There was very little difference in the mean gain score in reading between the groups. The 42 students who spent the fewest minutes on the computer (3200) had an average gain score of 21.3333 and a standard deviation of 32.3816. The 29 students who spent 3740 minutes on the computer had an average gain score of 9.7931 and a standard deviation of 40.3001. This group had the largest standard deviation and smallest average gain in reading scores. The 95% confidence interval for the mean of the reading gain analyzed by the researcher indicates that given another sample the mean gain score would fall within the upper and lower bound gain scores described in Table 7.
An analysis of variance was performed between the reading gain scores in School 1 and the total minutes the students spent on the computer. The researcher performed this test to compare how far apart the gain score means in the sample are with the variation of computer laboratory minutes within those samples. The minutes on the computer were broken into seven groups of students. In Table 8, the F statistic of .572 and its P value of .751 suggest evidence of very little difference between those students who spent more time on the computer doing reading skill and practice. The researcher concluded that there was no significant statistical difference between the groups. (F=.572, P >.05) (see Table 8). The minutes in the computer laboratory did not contribute to the variation in test scores and gain scores. The graph depicted in Figure 1.
actually shows that students who spent more time in the computer laboratory doing skill and practice had a lower gain score than students with fewer minutes.

Table 8

ANOVA - Reading Gain School 1

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>4398.066</td>
<td>6</td>
<td>733.011</td>
<td>.572</td>
<td>.751</td>
</tr>
<tr>
<td>Within Groups</td>
<td>88466.092</td>
<td>69</td>
<td>1282.117</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>92864.158</td>
<td>75</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1

Graph of Laboratory Minutes and Reading Gains on CRCT School 1
Hypothesis Two

Ho2: There is no statistical difference in the CRCT mathematics gains for the 2001-2002 and the 2002-2003 school year for fourth grade students in School 1 who spent time in the computer laboratory as part of their instruction on a program designed as drill and practice.

The Levene Test of Homogeneity of Variances was performed to determine whether or not the samples in the study have equal variances, or homogeneity of variance. If the Levene statistic is significant at the P<.05 level, the researcher rejects the null hypothesis that the groups have equal variances. The results of each Levene test for each group provided evidence that the researcher should accept the null hypothesis and conclude that the groups are homogeneous in variance. The significance level for School 1 Mathematics Gain is .451 (Table 9). The researcher accepts the null hypothesis and concludes that the mathematic groups are homogeneous.

Table 9

<table>
<thead>
<tr>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>.972</td>
<td>6</td>
<td>69</td>
<td>.451</td>
</tr>
</tbody>
</table>

The mean of the third grade mathematics CRCT for School 1 was 350.82 and the mean of the fourth grade mathematics CRCT for School 1 was 339.64 giving them a gain score of –11.18. The average time in the computer laboratory doing mathematics skill and practice was 840 minutes. (see Table 5) When further analyzed Table 10 includes the descriptive statistics from the gain scores and the minutes spent in the computer laboratory. The students were analyzed in seven groups based on the minutes on the computer. There was a significant difference in the mean gain score in mathematics between the groups. The 42 students who spent the fewest minutes on the computer (3200) had an average gain score of .1190 and a standard deviation of
22.2417. The 29 students who spent 3740 minutes on the computer had the highest average gain score of 7.4483 and a standard deviation of 20.9397. The 95% confidence interval for the mean of the mathematics gain analyzed by the researcher indicates that given another sample the mean gain score would fall within the upper and lower bound gain scores described in Table 10.

Table 10

Descriptives- Mathematics Gain School 1

<table>
<thead>
<tr>
<th>Minutes</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Upper Bound</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3200</td>
<td>42</td>
<td>-.1190</td>
<td>22.2417</td>
<td>3.4320</td>
<td>-7.0500</td>
<td>-71.00</td>
<td>43.00</td>
</tr>
<tr>
<td>3740</td>
<td>29</td>
<td>7.4483</td>
<td>20.9397</td>
<td>3.8884</td>
<td>-.5168</td>
<td>-54.00</td>
<td>54.00</td>
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<td>76</td>
<td>2.0132</td>
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<td>2.4737</td>
<td>-2.9147</td>
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An analysis of variance was performed between the mathematics gain scores in School 1 and the total minutes the students spent on the computer. The researcher performed this test to compare how far apart the gain score means in the sample are with the variation of computer laboratory minutes within those samples. The minutes on the computer were broken into seven groups of students. In Table 11, the F statistic of .819 and its P value of .559 suggest evidence of very little difference in the means between those students who spent more time on the computer.
doing mathematics skill and practice. The researcher concluded that there was no significant statistical difference between the groups. (F=.819, P >.05)(see Table 11). The minutes in the laboratory did not contribute to the variation in test scores and gain scores. The graph depicted in Figure 2 actually shows that students who spent more time in the computer laboratory doing skill and practice had a higher gain score than students with fewer minutes.

Table 11

ANOVA- Adjusted Mathematics Gain School 1

<table>
<thead>
<tr>
<th>Sum of Squares</th>
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<th>F</th>
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<tr>
<td>Between Groups</td>
<td>2319.410</td>
<td>6</td>
<td>386.568</td>
<td>.819</td>
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<td>Within Groups</td>
<td>32559.577</td>
<td>69</td>
<td>471.878</td>
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<td>34878.987</td>
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Figure 2

Graph of Laboratory Minutes and Mathematic Gains on CRCT School 1
Hypothesis Three

Ho3: There is no statistical difference in the CRCT reading gains for the 2001-2002 and the 2002-2003 school year for fourth grade students in School 2 who spent time in the computer laboratory on a variety of programs design for productivity by the students related to their curriculum instruction.

The Levene Test of Homogeneity of Variances was performed to determine whether or not the samples in the study have equal variances, or homogeneity of variance. If the Levene statistic is significant at the P<.05 level, the researcher rejects the null hypothesis that the groups have equal variances. The results of each Levene test for each group provided evidence that the researcher should accept the null hypothesis and conclude that the groups are homogeneous in variance. The significance level for School 2 Reading Gain is .730 (Table 14). The researcher accepts the null hypothesis and concludes that the reading groups are homogeneous.

Table 12

<table>
<thead>
<tr>
<th>Test of Homogeneity of Variances- READING GAIN SCHOOL 2</th>
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<tr>
<td>Levene Statistic</td>
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<td>.508</td>
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The mean of the third grade reading CRCT for School 2 was 353.66 and the mean of the fourth grade reading CRCT for School 2 was 366.28 giving them a gain score of 12.62. The average time in the computer laboratory doing reading productivity on a variety of programs was 1376 minutes. (see Table 5) When further analyzed Table 13 includes the descriptive statistics from the reading gain scores and the minutes spent in the computer laboratory in School 2. The students were analyzed in five groups based on the minutes on the computer. There was a
significant difference in the mean gain score in reading between the groups. The 25 students who spent the 1400 minutes on the computer had an average gain score of 13.8800 and a standard deviation of 39.5320. The 21 students who had a mean gain score of 3.7619 and had fewest minutes spent (920) on the computer. The students who spent 1640 minutes on the computer had the highest average gain score of 21.8000 and a standard deviation of 38.8988. The 95% confidence interval for the mean of the reading gain analyzed by the researcher indicates that given another sample the mean gain score would fall within the upper and lower bound gain scores described in Table 13.

Table 13

<table>
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<tr>
<th>Minutes</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error</th>
<th>95% Confidence Interval for Mean</th>
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<td>920</td>
<td>21</td>
<td>3.7619</td>
<td>22.5985</td>
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<td>10.0000</td>
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<td>1400</td>
<td>25</td>
<td>13.8800</td>
<td>39.5320</td>
<td>7.9064</td>
<td>-2.4380 30.1980</td>
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<td>1640</td>
<td>20</td>
<td>21.8000</td>
<td>38.8988</td>
<td>8.6980</td>
<td>3.5948 40.0052</td>
<td>-38.00</td>
<td>93.00</td>
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<tr>
<td>2200</td>
<td>22</td>
<td>5.0909</td>
<td>33.8533</td>
<td>7.2180</td>
<td>-9.9197 20.1015</td>
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<td>59.00</td>
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<td>Total</td>
<td>110</td>
<td>10.8545</td>
<td>33.1784</td>
<td>3.1634</td>
<td>4.5847 17.1244</td>
<td>-69.00</td>
<td>93.00</td>
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An analysis of variance was performed between the reading gain scores in School 2 and the total minutes the students spent on the computer. The researcher performed this test to compare how far apart the gain score means in the sample are with the variation of computer laboratory minutes within those samples. The minutes on the computer were broken into five
groups of students. In Table 14, the F statistic of 1.006 and its P value of .408 suggest evidence of very little difference between those students who spent more time on the computer doing reading productivity and practical application. The researcher concludes that there was no significant statistical difference between the groups. (F=1.006, P >.05)(see Table 16). The minutes in the laboratory did not contribute to the variation in reading test scores and gain scores in School 2. The graph depicted in Figure 3 actually shows that students who spent more time in the computer laboratory doing productivity and practical application had a lower gain score than students with fewer minutes. The graph also shows a peak gain score at 1400 minutes.

Table 14

**ANOVA- READING GAIN SCHOOL 2**

<table>
<thead>
<tr>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
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<td>4428.205</td>
<td>4</td>
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<td>Within Groups</td>
<td>115559.468</td>
<td>105</td>
<td>1100.566</td>
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<td>Total</td>
<td>119987.673</td>
<td>109</td>
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Hypothesis Four

Ho4: There is no statistical difference in the CRCT mathematics gains for the 2001-2002 and the 2002-2003 school year for fourth grade students in School 2 who spent time in the computer laboratory on a variety of programs designed for productivity by the students related to their curriculum instruction.

The Levene Test of Homogeneity of Variances was performed to determine whether or not the samples in the study have equal variances, or homogeneity of variance. If the Levene statistic is significant at the P<.05 level, the researcher rejects the null hypothesis that the groups have equal variances. The results of each Levene test for each group provided evidence that the researcher should accept the null hypothesis and conclude that the groups are homogeneous in variance. The significance level for School 2 Mathematics Gain is .601 (Table 15). The
researcher accepts the null hypothesis and concludes that the mathematic groups are homogeneous.

Table 15

Test of Homogeneity of Variances- MATHEMATICS GAIN SCHOOL 2

<table>
<thead>
<tr>
<th>Levene Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
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</thead>
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<tr>
<td>.690</td>
<td>4</td>
<td>105</td>
<td>.601</td>
</tr>
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The mean of the third grade mathematics CRCT for School 2 was 344.8 and the mean of the fourth grade mathematics CRCT for School 2 was 339.94 giving them a gain score of –4.86. The average time in the computer laboratory doing mathematics productivity on a variety of programs designed for productivity and practical application was 120 minutes. (Table 5) When further analyzed Table 16 includes the descriptive statistics from the mathematics gain scores and the minutes spent in the computer laboratory in School 2. The students were analyzed in five groups based on the minutes on the computer. There was a significant difference in the mean gain score in mathematics between the groups. The 25 students who spent the 1400 minutes on the computer had an average gain score of 2.7200 and a standard deviation of 26.9344. The 21 students who had a mean gain score of -8.2381 and had fewest minutes spent (920) on the computer. The 95% confidence interval for the mean of the reading gain analyzed by the researcher indicates that given another sample the mean gain score would fall within the upper and lower bound gain scores described in Table 16.
An analysis of variance was performed between the mathematics gain scores in School 2 and the total minutes the students spent on the computer. The researcher performed this test to compare how far apart the gain score means in the sample are with the variation of computer laboratory minutes within those samples. The minutes on the computer were broken into five groups of students. In Table 17, the F statistic of 4.072 and its P value of .004 suggest evidence of significant difference between those students who spent more time on the computer doing mathematics productivity and practical application. The researcher concluded that there was significant statistical difference between the groups. (F=4.072, P <.05)(see Table 17). The minutes in the laboratory contributed to the variation in mathematics test scores and gain scores in School 2. The graph depicted in Figure 4 actually shows that students who spent more time in the computer laboratory doing productivity and practical application had a lower gain score than students with fewer minutes. The graph also shows a peak gain score at 1400 minutes.
Table 17

ANOVA - MATHEMATICS GAIN SCHOOL 2

<table>
<thead>
<tr>
<th></th>
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<th>df</th>
<th>Mean Square</th>
<th>F</th>
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<td>Within Groups</td>
<td>48972.877</td>
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<td>56569.964</td>
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</table>

Figure 4

Graph of Laboratory Minutes and Mathematics Gains on CRCT School 2
In interpreting the results, emphasis was placed on examining the difference in gain scores relative to time spent in the computer laboratory. The descriptive statistics for the two schools revealed a mean gain score of 2.4 in reading in School 1 and a 12.62 in reading in School 2. In mathematics the statistics revealed a gain score of –11.18 in School 1 and –4.86 in School 2. Despite the higher gain scores in School 2, they spent less time on the computer averaging only 1492 minutes compared to 3545 minutes in School 1. The analysis of variance results revealed that only one group scored statistically significantly different using the computer as a productivity tool and for practical application of the curriculum in mathematics in School 2. The students who used the computer program for skill and practice for reading and mathematics in School 1 and the students at School 2 who used the computer laboratory for reading practical application and productivity did not have statistically significant impact on gain scores on the fourth grade CRCT in reading and mathematics.
CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Chapter 5 contains the summary of the study and conclusions. The recommendations for further study are provided following the conclusions.

Summary

This study examined the difference in student achievement in both reading and mathematics as measured on standardized assessments. The sample was comprised of third grade students in 2001-2002 who are the fifth grade students in 2003-2004. The study examined students in two elementary schools in a large suburban district in Georgia. School 1 used the computers in the laboratory primarily as drill and practice on one computer program for both reading and mathematics. Teachers were scheduled into the laboratory approximately 20 minutes each day. School 2 used the computer laboratory as a practical application tool and for productivity related to teaching the curriculum using a variety of computer programs for both reading and mathematics. The teachers in School 2 signed up for the laboratory as they needed it an average of one 40-minute visit per week. The study spanned one year of time and measured the amount of time fourth grade students were exposed to technology in a computer laboratory setting as measured in minutes. Data on matched students for grades three and four were compared between the two-year in achievement on the standard scores of the CRCT and the gains were computed in both reading and mathematics. The study of minutes on the computer was in response to the vast amount of money being spent on technology initiatives, yet students are still unable to access technology where they need it, in their classrooms. The study was
completed in a laboratory setting because students do not have access to technology in their classrooms. Teachers were trained on how to integrate technology and then were not provided the technology in their classrooms where the learning takes place.

Discussion

This study was a comparison of fourth grade students who visited the computer laboratory an average of 20 minutes per day to increase their reading and mathematics achievement through a computer program designed for drill and practice and fourth grade students who visited the computer laboratory an average of 40 minutes per week to increase their reading and mathematics achievement using a variety of computer programs designed as practical application and productivity for the curriculum instruction. The fourth grade students’ CRCT scores were examined for gains made in reading and mathematics from their third grade school year. Four analyses of covariance were used to analyze the data and determine statistical significance at the p<.05 alpha level. In the study, statistically significant gains were found in the mathematics group in School 2 who worked for approximately 40 minutes per week on a variety of programs designed for productivity and practical application of the curriculum. The students who used the drill and practice computer program every day for approximately 20 minutes to enhance reading and mathematics showed no statistically significant gains. The students in School 2 who used the computer laboratory for practical application and productivity in the reading curriculum did not show any statistically significant gains.

The analysis of descriptive statistics showed and average gain score of 12.62 points for the students in School 2 on the fourth grade reading CRCT compared to a 2.4 gain for the student in School 1. The mathematics analysis revealed a drop in scores for both schools in the fourth
grade year. However the decline in scores was reduced in School 2 with an average of –4.86 compared to the School 1 average of –11.18.

Conclusions

The results of this study indicated that there is a need for differentiated instruction in reading and mathematics in the classroom. The students who use the computer for productivity and as a practical application in mathematics showed the most statistically significant gains related to the amount of time spent on the computer. In the area of reading at both schools, all but two classrooms showed an average gain on their fourth grade CRCT scores. In mathematics, only two classrooms in either school showed a gain on their fourth grade CRCT scores. Only when teachers vary the ways in which students work and apply their knowledge will schools maximize the learning capacity of each student. The minutes spent on the computer in the laboratory setting does not serve as a predictor of CRCT gain scores except over an extended period of time using a variety of mathematical programs designed for practical application and productivity. This result does not agree with other research in the field regarding computer integration and academic achievement.

After further analysis of the line graphs located in Chapter 4 (Figures 1-4) it is noted that the minutes represented on the X-axis can also represent the teacher given that the teacher brought the students to the laboratory. Further analysis of Figures 3 and 4; reveal identical peaks for the teachers with 1400, 1640, and 2200 minutes. This similarity could be contributed to the teacher as a variable for student achievement more than the minutes in the laboratory as a profound influence on learning. The results of the study show that no matter how much time students spent in the computer laboratory there was no statistical significance that computer time is a predictor of student achievement. The significance of this finding was that as we move into
the accountability age in education, we need look at putting computer assisted learning into the
classroom instead of the laboratory where it might make the biggest impact. These conclusions
agree with the research by Wright (1997) that the most important factor affecting student
learning is the teacher. The implication of this study is that by improving the learning
environment and the instruction from the teacher we can improve student achievement.

Additional analysis of Table 5 reveals that even though statistically significant
differences were found in mathematics, the majority of minutes spent in the laboratory were
spent on reading activities.

Recommendations

Based on the observations and findings of this study, the following recommendations are
suggested for consideration:

1. This study involved data collection without field observations in the classroom to
determine teacher quality. A qualitative study should be conducted to determine whether
or not teacher quality affects student achievement.

2. A study should be conducted by placing computers inside the classroom to be used on a
daily basis for productivity and practical application. The time on the computers can be
calculated with a password log in for each student. Achievement scores should be
collected and analyzed for statistical significance.

3. A survey should be used to determine teacher attitude and training with regard to
integration of technology and the curriculum and incorporated into a qualitative study.

4. Analysis of data on student attendance and discipline referrals should be conducted to see
if students who use computers daily as an integral part of teaching and learning have a
lower absentee rate and lower discipline incidents.
### Tables

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