An Investigation of the Relationships Between Educational Technology and Mathematics Achievement of Students with Learning Disabilities

Kenneth George McLeod

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AN INVESTIGATION OF THE RELATIONSHIPS BETWEEN EDUCATIONAL TECHNOLOGY AND MATHEMATICS ACHIEVEMENT OF STUDENTS WITH LEARNING DISABILITIES.

by

Kenneth George McLeod

Abstract of a Dissertation
Submitted to the Graduate School
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy

May, 2011
ABSTRACT

AN INVESTIGATION OF THE RELATIONSHIPS BETWEEN EDUCATIONAL TECHNOLOGY AND MATHEMATICS ACHIEVEMENT OF STUDENTS WITH LEARNING DISABILITIES.

by Kenneth George McLeod

May 2011

Educators are continually looking for ways to use technology that will help students who struggle with mathematics, especially students with learning disabilities. There is limited research on the effects of instructional technology resources on the achievement of students with learning disabilities in the state selected for this study. Therefore, the purpose of this study was to investigate the effects of instructional technology resources on the mathematics achievement of students with learning disabilities.

This study used a mixed-method triangulation concurrent design. In the quantitative portion of the study, the independent variable was 8th grade AMRT math scores in 67 school districts in the state selected for this study. The dependent variables were students per computer, internet access per students and teachers level of certification. The qualitative portion of the study involved interviews with twelve teachers across the state selected for the study. Teachers were asked four questions that covered implementing technology in the classroom, educational technology and student achievement, technology skill level, and financial issues.

Grounded theory analysis was used to interpret qualitative interviews for the purpose of discovering and labeling variables. Emerging categories and sub-categories
were analyzed. The quantitative date was analyzed using multiple regression analysis. This statistical model was chosen because this research is concerned with relationships between three independent variables and a dependent variable.

Results were mixed. School districts with lower ratios of students to computer and Internet access per students did not outperform districts with higher ratios (Beta= .064, p>.05). Districts with a higher percentage of teachers with advanced certification did outperform districts with a lower percentage of teachers with advanced certification (Beta= .289, p<.05). Teachers’ interviews revealed a number of themes. Teachers believe that instructional technology is improving achievement of students with learning disabilities in mathematics. Teachers also believe that technology should be used to reach students’ individual learning styles and technology should be used daily for instruction. All teachers interviewed reported that students are motivated by the use of modern technology. Most teachers believe they have the necessary skills to implement technology and the resources are available for them to do so.
The University of Southern Mississippi

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by

Kenneth George McLeod

A Dissertation
Submitted to the Graduate School of The University of Southern Mississippi in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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CHAPTER I
INTRODUCTION

This is an age of rapid technological advancements. Computer hardware and software are increasing in power every year as technology devices get smaller and cheaper. Technology is everywhere in our society – including our schools. High-tech devices have made their way into almost every corner of education from kindergarten to graduate school (Page, 2002).

Many teachers today are utilizing some form of computer-aided technology in the classroom (Ganesh & Middleton, 2006). Most schools have computer labs with Internet access that can be utilized for instruction (Vale & Leder, 2004). These resources give teachers the opportunity to break from traditional classroom instruction several times a week and easily integrate technology into their lesson plans. For example, many studies conducted to determine the benefits of using computer-based and Web-based instruction have indicated a positive relationship between using computer-based instruction and achievement and motivation (Cates, 2005; Connor, Moss & Grover, 2007; Deubel, 2001; Drickey, 2006; Hsieh & Lin, 2008; Stephens, & Konvalina, 1999). Other studies have concluded that the use of instructional technology has little or no effect on student achievement (Martindale, Pearson, Curda, & Pilcher, 2005; Mouza, 2008). Moreover, many students are still instructed with traditional methods that include no modern educational technology (Algozzine, Grets, Queen, & Cowan-Hathcock, 2007). Even though the aggressive approach to using modern instructional technology has its critics, there seems to be no slowing down the march toward saturating every classroom with high tech teaching tools.
According to the National Council of Teachers of Mathematics (2000), it is essential to integrate technology into lesson plans when teaching mathematics. Technology should also be integrated into the teaching of mathematics for at-risk learners (Li & Edmonds, 2005). Many students find mathematics difficult and boring and this impedes their motivation to learn (Stephens & Konvalina, 1999). Since most young people today are comfortable using computers and the Internet, researchers argue that computer-assisted learning using instructional technology may increase student achievement (Baki & Guveli, 2008). This interest educational leaders because schools and students are under pressure to meet the standards in mathematics for graduation requirements and the No Child Left Behind (NCLB) federal mandates.

When considering students with learning disabilities, the issues of mathematics standards and pressure to succeed are even more difficult (Martindale, Pearson, Curda, & Pilcher, 2005). Many students with learning disabilities have a history of failure in mathematics and their motivation is affected by past failures (Bryant & Bryant, 2008). Some of these students may benefit from a different approach to instruction that allows them to become more engaged, is more interesting and provides instant feedback. However, an extensive synthesis of the literature from 1996 to 2006 on instructional technology and achievement concluded that very little evidence exist to support the argument that computer mediated instruction improves the achievement of students with learning disabilities (Fitzegerald, Koury & Mitchem, 2008).

If instructional technology is the key to helping students with learning disabilities, then educational leaders need to listen carefully to researchers in the field of educational technology. Requirements of NCLB make it necessary to include the standardized
reading and math scores of students with learning disabilities with the general population (Foegen, 2008). When these students do not perform well, which is often, the entire school can be in danger of not reaching the required annual yearly progress numbers set by the state. Therefore, any additional benefit these students can receive from the use of technology can be critical to the school as a whole.

For many students, motivation is critical for achievement (Vale & Leder, 2004). This is especially true for students with learning disabilities who have a history of failure in mathematics. Some researchers argue that supplementing instruction with technology resources can give students a fresh approach to learning mathematics that may be more interesting than traditional instruction (King-Sears & Evmenova, 2007). Others believe that simply introducing technology into the classroom is not enough to stimulate students (Russell, O’Dwyer, Bebell & Tao, 2007). These researchers believe that the type of technology and the way technology is applied in the classroom is the key to student achievement.

More technology in the classroom means more costs. Computer hardware and software require regular upgrading; skilled personnel are needed to manage school technology; and teachers need ongoing professional development to keep pace with changing technology (Kafai, Nixon, & Burnam, 2007). The budget demands of technology are just one of many financial problems facing schools today. Budgets are tight and careful decisions must be made when allocating shrinking school funds. Because of these pressures, it is more important than ever for educational leaders to know how the money allocated to instructional technology is paying off in student achievement.
The factors outlined in this dissertation, such as educational technology, student achievement, teacher’s use of instructional technology, learning disabilities, and funding, are all critical factors for education in the state selected for this study. The state selected for this study is in the southern region of the United States with a population of 4.7 million. There are 67 school districts serving approximately 750,000 students. The state also serves 83,000 students who are identified with some level of disability through special education programs.

The state selected for this study was ranked 42nd in median household income by the U.S. Census Bureau at $32,400. This indicates a state with high levels of poverty, which affects educational funding. Approximately 64% of all breakfasts and lunches served in the schools of this state fall into the category of free or reduced meals. Expenditures per student and federal, state and local funding are also indicators of the levels of poverty in this state. Expenditures per student total $9,100. The state ranked 21st in federal funding, 10th in state funding, and 41st in local funding out of all states in the U.S.

In the state selected for this study, some of the academic statistics are encouraging. For example, 95% of high school students are passing the mathematics portion of the graduation exam. The average ACT score was 20.2, compared to the national average of 21.1. However, only 74% of 8th grade students were meeting or exceeding the mathematics standards set by the state department of education.

Statement of the Problem

A tremendous amount of resources are devoted to educational technology in public schools. There is a movement toward using modern technological devices in every
classroom and every grade in the state selected for this study, especially reading and mathematics. Federal mandates such as NCLB also call for the use of educational technology for teaching all students, including students with learning disabilities. However, research is mixed on the link between instructional technology and student achievement. Although the state in this study has collected data from thousands of teachers across the state on usage of technology in the classroom, no research is currently being conducted to compare this data to student achievement.

Purpose of the Study

Teachers of students with learning disabilities in mathematics need to follow best practices to help their students succeed in a world where math and science are more important than ever before in the job market (Bryant & Bryant, 2008). The use of instructional technology is being identified as an important factor for student achievement in public schools and considerable resources are being allocated, yet the math scores of 8th grade students across the state selected for this study rank in the bottom 20% of the U.S. (ALDE, 2009).

Although the use of instructional technology for teaching mathematics has shown to increase achievement and motivation in some studies, limited research is available with students who have learning disabilities in the state selected for this study. The purpose of this study was to explore the relationships between the use of educational technology and the achievement of students with learning disabilities in mathematics.

Research Questions

This study sought to answer the following questions:
1. Which independent factors (students per computer, level of internet access per student, and teacher’s certification level) can help predict 8th grade standardized mathematics scores of students with learning disabilities?

2. Are 8th grade math teachers integrating appropriate technology into instruction?

3. Is the use of instructional technology by 8th grade math teachers improving mathematics achievement of students with learning disabilities?

4. Is the skill level of 8th grade math teachers sufficient to utilize technology for student engagement?

5. Are sufficient technology resources available for teachers to use during mathematics instruction?

Definition of Terms

The following terms are defined to provide a conceptual understanding of the language used in this study and to offer operational definitions of how these terms are measured in relation to this work.

*Educational Technology* – The study and practice of facilitating learning and improving performance by creating, using and managing technological processes and resources (Mishra, Koehler, & Kereluik, 2009)

*Instructional technology* – The physical tools and systematic practices for the improvement of education (McDonald & Gibbons, 2007)

*Modern instructional technology* – Instructional tools that date back to the introduction of the personal computer into schools. This includes software, the internet, interactive whiteboards, digital projection system, student response systems, and document cameras.
Web-based Resources - The Web-based resources discussed in this field study are Web-based tools and activities for teaching and learning mathematics that are available free, or not, on the Internet.

Computer-based Instruction (CBI) - Many definitions are proposed. Computer-based instruction can be defined as, “…ranges from drill and practice for remediation to entire curricula and instructional process.” (Martindale, Pearson, Curda, & Pilcher, 2005, p. 350). In this study, computer-based instruction will be used to describe any curriculum related activities by students or teachers using a PC.

No Child Left Behind – NCLB act of 2001 requires states to create assessments in basic skills that will be given to all students in certain grades, including special education students. States must adopt NCLB in order to receive federal funds for education. There is no national standard for achievement; each state sets its own guidelines.

Learning disabilities - Can be defined as a group of different disorders that have a negative effect on the acquisition and retention of knowledge in the areas of reasoning, writing, reading, speaking, listing, and mathematics (Zafiropoulou & Karmba-Schina, 2005).

Effective instructional technology implementation – As defined by the International Society for Technology in Education (ISTE, 2008).

A or AA certification – Teachers with a masters or educational specialist degree.

B certification – Teachers with a bachelor degree.

Delimitations

This study was delimited to schools in a single southern state during the 2010-2011 school year. For the qualitative portion of the research, only middle school math
teachers were included. For the quantitative portion of the study, only data from a single southern state’s school districts was included. Test data only included 8th grade standardized mathematics scores from spring 2010.

Assumptions

It was necessary to make several assumptions in regards to this study. For example, the researcher assumes that teachers participating in the study will answer the interview questions honestly, that data collected from the state in this study will be reliable and accurate, and that student scores on standardized achievement test will actually reflect the amount of student achievement. Also, both special education and general education teachers will be interviewed during the qualitative phase of this study. Therefore, it is assumed that a moderate amount of student achievement can be explained by the effects of both types of teachers.

Justification

The purpose of this study was to explore relationships between teacher’s use of instructional technology and mathematics achievement of students with learning disabilities. Teachers of students with learning disabilities in mathematics need to follow best practices to help their students succeed in a world where math and science are more important than ever before in the job market (Bryant & Bryant, 2008). The use of modern instructional technology for teaching mathematics has shown to increase achievement and motivation in some students, but limited research is available to demonstrate this with students who have learning disabilities in the public schools targeted in this study.

There is major a focus on raising scores of students with learning disabilities in reading and mathematics. Over half of the students who are diagnosed with mild to
moderate learning disabilities score below the 25th percentile on mathematics achievement tests (Foegen, 2008). Educators need to know if certain instructional techniques or technology resources can prevent these students from falling further behind. This study is significant because it can add to the body of research and help demonstrate what benefits are being realized from the use of modern instructional technology when teaching students with learning disabilities.

Furthermore, this study is important because there is very little research on the effects of modern instructional technology on 8th grade students’ mathematics achievement in the state selected for this study. In the state selected for this study, teachers are directed to utilize technology in the classroom when teaching students with learning disabilities as mandated by the NCLB act of 2001. Therefore, specific targeted research needs to be conducted to validate the movement toward more technology programs in the classroom. If teachers who utilize these various resources, such as online textbooks, interactive programs, online tests, and interactive whiteboards are not effective in helping students with learning disabilities improve achievement scores, then educational leaders need to know so resources can be allocated more effectively.

The cost of educational technology was also an important factor in conducting this research. There are numerous costs associated with the integration of technology into education. These costs quickly add up and strain the already stretched budgets of most public schools (Martindale, Pearson, Curda, & Pilcher, 2005). Some of these costs are hardware, software, technical support personnel, professional development for teacher, and almost constant upgrading of systems due to obsolescence. Whether or not these expenditures are leading to increased student achievement that could not have been
realized with traditional teaching methods needs to be fully explored. This research is but
one step in exploring the relationships between math teacher’s use of technology and
mathematics achievement of students with learning disabilities.

The usefulness of the results of this research is a substantial justification for
pursuing the study. The data from this study can guide educational leaders when
allocating resources. For example, if students with learning disabilities in mathematics
are greatly benefiting from the use of various instructional technologies, while other
students are only experiencing marginal benefits, then technology spending can be
reallocated to benefit the students who seem to gain the most from the use of instructional
technology. The on-size-fits-all approach used by many schools may not be the best
application of technology in the classroom. Research that can help the school districts
selected for this study understand how to better apply technology can be very valuable.

Summary

The state selected for this study has several technology initiatives that are
encouraging more and more modern instructional technology into the classroom (ALDE,
2009). A substantial portion of the educational budget is being used to fund these
technology initiatives. These initiatives are backed by research that supports the link
between technology and students achievement. However, ample research exists that
questions any empirical link between the use of technology and student achievement
(Grimes & Warschauer, 2008; Martindale, Pearson, Curda, & Pilcher, 2005; Mouza,
2008). Federal mandates for achievement of students with learning disabilities and the
high cost of technology are just some of the pressures that make this a critical issue for
educators. Therefore, more research is needed to explore the specific links between student achievement and the use of technology in public schools.
CHAPTER II

REVIEW OF LITERATURE

The purpose of this study was to examine the relationships between student achievement in mathematics and the use of technology by mathematics teachers. This chapter presents a review of the relevant literature used to guide this study. The topics of this literature review focus on technology and instruction, theories influencing instructional technology, technology and student achievement, and accountability.

The various sections of this literature review cover effective instruction, the important educational issues that involve the use of instructional technology and special education students. Specifically, how the integration of instructional technology by mathematics teachers affects standardized math scores of students with learning disabilities. It was critical to review the literature related to past and current research in instructional technology, theories influencing instructional technology, and how mathematics teachers are integrating, or not integrating, instructional technology into their classrooms. Finally, a look at the issues surrounding accountability for test scores of students receiving special education services in public schools.

Theoretical Framework

In the field of educational technology, theories abound. Some of these theories have been tested extensively across all grade levels with students in the general education population, as well as students with learning disabilities, using a range of different instructional technology in a variety of settings. In education, many of the theories tested in the past, as well as those being tested today, have yielded inconclusive results. For example, some meta-analyses of the literature encompass studies that both support and
oppose theories linking educational technology and student achievement (Lin, Ching, Ke, & Dwyer, 2007; Lowe, 2002).

The difficulty with the study of educational technology and student achievement is that the variable being studied is human beings. This introduces a range of variables that are difficult to control. More specifically, arguments for the discrepancy in research may be found in the way studies are conducted, how teachers are implementing technology in their instruction, the level of teacher experience, instructional strategies, and the students involved in the research. In fact, there are so many variables that must be controlled that it may be very difficult to conduct a purely scientific study (Lowe, 2002). Also, the differences between states and how they structure their technology plans, implement the NCLB laws, and certify and train teachers may make generalizing results from one state to another difficult.

This study will attempt to explore the relationships between education technology and mathematics achievement of students with learning disabilities in a selected southeastern state. There is abundant literature that already supports the theory that technology and achievement are linked. Extensive literature reviews have shown that student achievement, engagement and motivation increases when teachers are integrating technology into instruction (Funkhouser, 2003; Lin, 2006; Vale& Ledger, 2004). This research is accepted by virtually all state departments of education, the U.S. department of education (USDE, 2010) and other creditable organization such as the International Society for Technology in Education (ISTE, 2008). Studies have also found that a smaller student-to-computer ratio can increase test scores (Penuel, 2006). However, other research studies have failed to establish a link between educational technology and
student achievement (Fitzegerald, Koury and Mitchem, 2008; Lin, Ching, Ke, & Dwyer, 2007; Ricer, Filak, & Short, 2005).

This study will also explore the way teachers are integrating technology into instruction. According to the International Society for Technology in Education (ISTE, 2008), there are several critical factors that need to be considered when integrating technology into instruction. These include appropriate professional development, alignment of instruction with state curriculum standards, daily integration of technology, individualized feedback, student collaboration, and real world problem solving using technology.

Past studies have looked at how teacher’s skill level with technology affects student achievement. Teachers with more technology experience and more confidence when using computers are more inclined to implement technology into instruction (Donovan, Hartley & Strudler, 2007). Teachers who report having high skill levels with technology are also more likely to teach mathematics using instructional technology (Lin, 2006).

It seems logical that teacher’s level of education, certification, and experience are linked to student achievement. According to Russell, O’Dwyer, Bebell and Tao (2007), teachers with more than 6 years of experience assigned more activities using computers and software than newer, more inexperienced teachers. Since a level of certification typically comes with more years of experience, one would expect teachers with higher levels of certification to also follow this pattern.
Effective Instruction

Researchers in the field of education have identified many instructional strategies that are designed to improve student achievement. There is a constant push in public education to develop and design new techniques to reach students. Some new ideas come forward while others seem to be recycled ideas from previous research. Effective instructional strategies can utilize technology to expose students to new knowledge, reinforce previous learning activities, and teach students to apply knowledge (Marzano, 1998). Therefore, a review of several prominent instructional strategies that may be encountered during the course of this study makes sense.

In the book, Classroom Instruction That Works (Marzano, Pickering & Pollock, 2001) the authors offers nine different instructional strategies. They are: identifying similarities and differences, summarizing and note taking, reinforcing effort and providing recognition, homework and practice, nonlinguistic recommendations, cooperative learning, setting objectives and providing feedback, generating and testing hypotheses, and cues, questions, and advance organizers. These strategies have been tested and found to be effective. Marzano (2009) points out, however, that standardizing instruction, as some schools have done, around these nine strategies is not wise because research findings on instructional strategies are general and more research is needed in pedagogical expertise.

Another effective instructional strategy that has gained a lot of attention is called Understanding by Design (UbD). This strategy was designed by Grant Wiggins and Jay McTighe and focuses on a backwards design by starting with desired outcomes. UbD is designed around teaching for understanding that’s purpose is to lead to deeper
understanding by teaching students to explain, interpret, apply, have perspective, empathize, and have self-knowledge (Wiggins & McTighe, 1998). UbD stresses big ideas and essential questions during the cycle of instruction and allows students to demonstrate understand by applying what they have learned. In the largest school district in the state selected for this study, UbD has been adopted as a standard framework for teaching.

Technology and Instruction

It is important to define the terms in any discussion of instructional technology or educational technology because these terms are often used interchangeably in the literature. Even though instructional technology and educational technology can have the same meaning at times, it’s important to distinguish between them in order to bring as much clarity to the discussion as possible. According to Mishra, Koehler, and Kereluik (2009), educational technology is “the study and practice of facilitating learning and improving performance by creating, using and managing technological processes and resources” (p. 48). McDonald and Gibbons (2007) describes instructional technology as the physical tools and systematic practices for the improvement of education. By these definitions, instructional technology may be defined as the actual hardware, software, and techniques used in practice by educators, while educational technology may be considered the theory and design of practices which use instructional technology for teaching and learning. In this research, instructional technology will be the primary focus of the discussion. However, educational technology will be discussed in general terms as it applies to research practices.

Technology has become an important part of instruction in public schools across a full range of subjects. The historical use of technology for teaching in virtually every
subject is well documented. According to Jones (1999), the oldest example of instructional technology is cave paintings by tribal elders. In a cave in Texas, a 4,000-year-old series of pictographs were discovered that illustrate sexuality and reproduction. These pictographs are believed to be a way to pass down knowledge and teach others. Interestingly, this very same subject is taught in public schools today, only using a much more advance form of instructional technology.

Modern research in educational technology can be traced back to the 1940s when the focus on technology was creating training materials for the military during World War II (Hew, Kale & Kim, 2007). Researchers such as Leslie Briggs and Robert Gagne were pioneers in the field and helped open up a new world of research on how individuals learn and process information. This early research defined instructional technology as things considered very low tech today, such as books, flow charts and recorded messages. Even so, these educational innovations were considered very important in standardizing the delivery of instruction and reducing cost.

After the war, research in educational technology continued to focus on emerging technologies like the overhead projector and movie camera, as well as existing technologies where research was scarce, such as the chalkboard (Guthrie, 2003). The overhead projector and movie camera gave teachers the ability to present information in multiple dimensions, which was believed at the time to be effective in capturing attention and enhancing retention (Jones, 1999). Chalkboard research was also developing and research suggested that various color contrasts between the foreground and background of text led to better visual discrimination. This research explains the move from black to green chalkboards.
The 1980s were a pivotal time in the history of educational research. A paper published by Richard Clark (1983) was an early entry in the debate as to how effective technology alone really is in improving student achievement. An argument began to emerge challenged the premise that the introduction of technology in the classroom will improve achievement with no regard for the other variables involved. Salomon and Gardner (1986) agreed with Clark and suggested that the way in which technology is used in the classroom is the determining factor for success, not the technology itself. Much of the research from this point forward started to focus on specific ways that technology is implemented in the classroom and the context in which it is used.

The field of research in modern educational technology has only been active for a relatively short period of time. Because of this, different methods of research and methodologies are still competing for recognition (Hrastinski & Keller, 2007). The questions posed while researching education technology involve complex issues, such as how people learn while using various technology media. The questions are difficult to answer because of the many variables involved and the ever changing nature of modern technology. However, there is a large body of literature dedicated to many areas of educational and instructional technology that researchers can draw from to guide and support new research.

Although the historical perspectives on instructional technology are interesting and can help shed light on modern practices, in this study the discussion of educational technology will focus on how modern technology is used in public school classrooms to teach mathematics to students with learning disabilities and what effect this has on student achievement. Modern instructional technology will be defined as computers,
computer software, the internet and other selected technologies such as interactive whiteboards, digital and analog visual presenters, and student response systems. These technologies are currently used to teach virtually all subjects, including mathematics in special education settings.

Computer-Based Instruction

Arguing against the use of technology in the classroom is difficult. According to Lowe (2002), “many educators believe that CBE is the panacea for education because of the education theories used in the development of the computer” (p. 164). Many studies have shown that the use of technology does facilitate learning (Hakkarainen, 2003). However, other research studies have failed to link the use of instructional technology to higher student achievement (Guthrie, 2003; Ricer, Filak & Short, 2005; Watson & Hempenstall, 2008). There are many variables to consider in educational technology research and this can make empirical findings hard to support. This does not negate the fact that many researchers have reported positive benefits from the use of instructional technology and that many benefits have been realized from its use, such as improvements in student motivation and satisfaction (Frye & Dornisch, 2008). Some of these improvements in students’ achievement and motivation that have been documented in the literature may be a combination of factors, with instructional technology being only one of the factors. When considering the growth of computer and web-based activities in public schools, it seems apparent that school leaders have taken the positive research seriously. There seems to be no end to the charge toward increasing budgets for more technological devices to install in the classroom.
Within the scope of instructional technology, computer-based technology (CBI) is a large slice of the pie. Computer-based instruction is defined by Lowe (2002) as “the process or management of instruction that uses a microcomputer as the medium” (p. 163). Since the personal computer was developed for widespread commercial use in the 1980s, schools have used this technology for direct instruction, self-guided learning, remediation, assistive learning, and almost every other form possible in an educational setting.

Virtually all schools in the United States have a computer laboratory that students can access during school hours, as well as at least one computer in half of the classrooms nationwide (Ganesh & Middleton, 2006). Computer-based technology instruction can be traced back as far as the 1950s (Hew, Kale & Kim, 2007) and has had a tremendous impact on teaching and learning in public schools (Hazzan, 2002; Kurtz & Middleton, 2006; Kynigos & Argyris, 2004).

The effects of using computer-based activities to improve academic achievement has been researched extensively in the past, especially when micro-computers were first beginning to be introduced into classrooms nationwide. According to Deubel (2001), a meta-analysis of 26 studies conducted between 1984 and 1995 that included 3,694 students from all educational setting and subjects found that the effectiveness of computer-based software on student achievement was slightly positive. Funkhouser (2003) also found that computer-augmented activities improved students’ scores on standardized test and improved attitudes toward learning. Forty-nine high school students participated in this study that compared achievement of a control group to an experimental group. The experimental group followed the same curriculum as the control
group, except for the use of computer-based software activities in addition to the traditional instruction methods. As a result, the experimental group achieved stronger gains in knowledge than the control group.

Research conducted by Cates (2005) to compare computer-assisted mathematics drill with peer-assisted mathematics drill used a simple computer-based flash card program. The flash card program had the same characteristics of a deck of paper flash cards used by the peer-assisted group. The older students in the study that used computer-assisted flash cards performed better than the peer-assisted group. Of course, the limitation of this procedure is the cost of computer hardware and software. As schools become more dependent on computer hardware and software and make technology the foundation of their infrastructure, the costs have become a serious issue.

As a result of the increase in technological resources and schools’ ability to access those resources, many researchers have sought to establish how effective computer-based instruction has been for improving student achievement. Some research in this area supports the hypothesis that students using computer-based mathematics software achieve higher scores on standardized test of geometry (Hannafin, Truxaw, Virmillion, & Liu, 2008), and algebra (Stephens & Konvalina, 1999). Students who have greater access to computers have shown more engagement and achievement over students who had limited access to computers (Lei & Zaho, 2008). Whether or not this increased engagement is a direct result of the presence of computers is still being researched in all educational settings where computers are, and are not, being implemented for instruction.
Web-Based Instruction

In order to exploit the beneficial uses of technology, teachers need many resources. Today, many fee-based and free resources are available on the Internet for teachers who are computer literate and willing to try new technologies. For example, on Algebrahelp.com alone, there are hundreds of free resources for pre-algebra, algebra, algebra 2, and geometry. Students can receive free tutoring, participate in lessons, and watch videos of detailed voice and handwriting examples carefully designed to help middle and high school algebra and geometry students. According to Joseph (2008), the Internet has evolved into a massive collection of interactive multimedia tools and gadgets powered by the Web that has revolutionized the way teachers and students learn, share ideas and interact. When quality instruction and technology come together in the classroom, students’ achievement and satisfaction usually increase.

Starting in the 1990s, an explosion of Internet based instructional programs for almost any academic subject began to emerge (Hiemstra & Poley, 2007). Many of the software companies that developed programs for use in education started developing web-based programs that teachers can access from any computer without the need to load software on their local PC. This eliminated many of the technical problems associated with loading software and updating programs that were not compatible with the latest versions of Windows. In many cases, web-based educational applications are less expensive to use than purchasing software and loading it on each individual computer workstation. One factor is the technical support involved to load, update and debug individual computers in the school. This work becomes centralized when computer
applications and online course materials are web-based and eliminates the need to fix software problems on individual computers.

A logical argument can be made to link the past successes of computer-based instruction for students to Web-based resources for learning. The use of computers with software that resides on the hard drive is much like using computers with software resources that reside on the Internet. Although much research exists on the subject of computers-based software, less research exist for teaching in the classroom using web-based resources, even less research exists to support the use of Web-based resources for teaching mathematics to students with learning disabilities (Drickery, 2006). However, this area of research is sure to grow rapidly.

The advancements in web-based educational materials and learning were pioneered by major universities who led the way with online courses and degree programs, but were soon followed by accredited online programs for high school students (Peake, 2003). While the increase in online programs was taking place, thousands of independent Web sites were created that offered instruction and tutoring in all major academic subjects. Many of these sites are accessible by paid subscriptions while many are free to use by anyone who accesses the Internet. As a result, K-12 educators have utilized the abundant Web-based instructional resources available to them at an increasing rate (Joseph, 2008). This fact has led some researchers to consider the availability of free information resources on the Internet as an important aspect of teaching and learning in public schools today (Barabash, Guberman-Glebov, & Baruch, 2003). This is especially true in mathematics where teachers are looking for additional and interesting resources to teach concepts of algebra and geometry. Since the
availability of free resources is growing, teachers have more choices to offer students when planning instructional activities.

The effectiveness of using resources on the Internet for instruction has been supported by several studies. WebQuests have been found to increase student’s engagement, time on task and satisfaction (Halat, 2008). Halat argues that the use of technology in the classroom for teaching mathematics, such as WebQuests, has a positive effect on students’ attitudes, motivation and achievement. WebQuests do not involve a single Web site or a particular location on the Web, but involve using the Internet as a research tool for finding information from various resources that satisfy a classroom project. WebQuests are a very popular form of Web-based learning that can be used for mathematics instruction for students with learning disabilities.

Social networking has become a major form of communication and interaction for high school aged students. Some researchers have advocated the use of blogs and social networking sites, such as Facebook, as a tool for online information sharing which students may use for educational purposes. According to Churchill (2009), blogs can be utilized by students to publish their work for the teacher and their classmates to easily access and provide comments. By using blogs in this manner, students can peer review each other’s work. Also, blogs can make collaboration on projects much more efficient and effective. The efficiency is obvious in that students can share their work online for educational purposes in much the same way they share information and ideas on Facebook for purely social purposes.

In the course of researching blogs for educational use, Churchill discovered that students were working more efficiently. At the same time, the teacher’s work of reading
all the different blogs was time-consuming. In this case, the solution to a problem created by implementing new technology was solved by implementing more new technology. RSS (Really Simple Syndication) is a tool that allows the user to read all new blog posts in one location, which cuts down the time required to monitor blogs considerably.

Web-based Technology for learning mathematics has also been explored by researchers (Hodge, Richardson & York, 2009; Juan, Huertas, Steegmann, Corcoles & Serrat, 2007). Cavanaugh, Gillan, Bosnick, Hess, and Scott (2008) evaluated an online tool for learning algebra that assisted students with concepts such as graphing linear equations. Their research found equivalency between students who used the online tools to those who engaged in the same curriculum without the online tools. However, Hodge, Richardson and York (2009) found that students were motivated to complete more of their homework when presented with an online algebra homework tool to use as a supplement along with their algebra class. Many college courses have moved to online homework in classes that are not conducted online. High schools will no doubt follow this trend in the future since all the necessary technology appears to be in place in most high schools. The fast-paced movement to adopt more technology in K-12 education, along with the rapidly growing body of online educational resources, will most likely lead to a more hybrid classroom in the future that meets face to face, but conducts a portion of the class work online.

It is hard to doubt that the Internet is a powerful tool for instruction and learning, and although some teachers use computer-based instruction with Web-based applications, many do not – even when the technology is available (Norton, McRobbie, & Copper, 2000). Many professional development activities focus on technology in the classroom
and teachers are encouraged to integrate technology into their lesson plans more and more. However, teacher surveys, such as the LOTI (Levels of Technology Integration) show that many teachers do not utilize very much technology in their classrooms (Middleton & Murray, 2000). Whether this lack of technology integration is empirically tied to student’s achievement or not needs to be determined. This is imperative because much of the excitement for instructional technology (CBI, Web-based… etc.) comes from research that supports the use of technology in the classroom (King-Sears & Evmenova, 2007). However, Grimes and Warschauer (2008) suggest that “In spite of the proliferation of computers in schools… U.S. reading and mathematics test scores at the high school level are no higher now than they were 30 years ago” (p. 306). In fact, a review of five different meta-analyses by Lowe (2002) did not support computer based learning as superior to traditional talk and chalk methods.

It’s clear that an abundance of Web-based resources are available to mathematics teachers. A large variety of free sites are available that can supplement a traditional algebra curriculum and offer students the opportunity to participate in Web-based learning activities along with their traditional education. In many cases, these resources have been shown to be effective for student achievement and student motivation. Even with these results, many teachers are still not using internet resources in their classrooms. Whether or not web-based resources should matter to educators has yet to be settled. More research will no doubt be required to demonstrate the effectiveness of web-based resources for instruction.
Modern Instructional Technology

Computers, computer software and the internet encompass a large portion of the instructional technology currently discussed in the literature. However, there are other modern instructional technology devices that are integrated into the classroom by teachers. These include Interactive white boards, digital and analog visual presenters, and student response systems. These technologies have gained considerable attention since the late 1990s. Many teachers worldwide have integrated these devices successfully into their instruction and report increased student achievement (Hall & Higgins, 2005).

The traditional view of instructional technology could include calculators, books, overhead projectors, and even pencils and paper. This study will examine more modern devices that are typically a combination of computer hardware and software working together in an embedded system, such as a digital visual presenter or an interactive whiteboard. Devices like these are becoming more common in classrooms across the country for general and special education students and date back to around the mid-to-late 1990s.

Interactive white boards (IWB) are becoming very popular in U.S. schools and throughout the world (Schweder & Wissick, 2008). Interactive whiteboards make it possible to project data onto a large whiteboard from a computer. This data (text, pictures, sound) can be anything a computer is capable of displaying. What makes this technology so powerful is that the data on the interactive whiteboard can be manipulated by the teacher and students with special pens and remote handheld devices. For example, teachers can manipulate graphics on the board by sliding them around, making changes to the graphics, or covering them up so that students cannot see them until the teacher
wishes to reveal that part of the lesson. Just like a traditional dry marker board, students can also come to the interactive board and work problems in front of the class at the teacher’s direction. Moreover, all students can interact with the whiteboard at once with a student response system, which allows students to remotely select answers to problems displayed on the board.

The interactive whiteboard industry reached 1 billion in 2008 and is expected to continue to grow. It is expected that one in seven classrooms will have interactive whiteboards by 2011 (Davis, 2007). Based on these numbers there is no doubt that IWB technology has been accepted by many teachers. This popularity has prompted researchers to investigate the effectiveness of IWBs on student achievement.

Some research on the effectiveness of interactive whiteboards has yielded positive results. Researchers have found that students and teachers like using the technology (Smith, Higgins, Wall & Miller, 2006). This research supported the claims made by some that interactive whiteboards increase student engagement, motivation and achievement. This may be explained by the way interactive whiteboards shift the focus from presentation to interaction. This is not surprising since interactive lessons tend to be more student centered than traditional methods. In a study conducted by Smith, Hardman and Higgins (2006), 184 lessons using interactive whiteboards were observed over a two-year period. Their findings suggest that IWB technology has some impact in the classroom. Even though the research supports some of the claims of the promoters of IWB technology, not all claims about this technology were supported in the study.

Smith, Higgins, Wall and Miller (2005), conducted a literature review on interactive whiteboards in educational settings and found the tone of the literature to be
overwhelming positive. However, the researchers argue that available research at the time of the review is based on teachers and students views about the technology, and not actual evidence that links the use of interactive whiteboards to student achievement. For example, Smith et al. (2005) points to claims in the literature that suggests the multi-sensory representations presented on interactive whiteboards lead to better memory retention by students. This data came from asking students what they remembered about the lesson. The researchers argue that more recent studies show that, “It is not certain whether verbal and visual information are always best presented together, and if dynamic visuals are always better at promoting understanding than static visuals.” (p. 97).

According to Robert Marzano (2009), interactive whiteboards were used in a study involving 85 teachers and 170 classrooms that yielded a 16-point gain in student’s performance in the classrooms where the interactive whiteboards were used by the teacher. Marzano points to several other advantages of interactive whiteboards, such as the interactive response system that allows students to give answers that are displayed on the whiteboard, graphical visual aids, and applications that teachers can use to reinforce students’ responses. Marzano also points out that, “One of the more interesting findings from the study was that in 23 percent of the cases, teachers had better results without the interactive whiteboards” (p. 80). Marzano concludes that findings such as this can only be explained by looking at how the teachers are using interactive whiteboards and not the technology itself.

In 2010, interactive whiteboards can still be considered a new technology in the classroom. As will most new technology, the initial research was conducted by early adopters who are eager to prove the technology. Holmes (2009) argues that, “many of the
initial studies related to IWB use in classrooms were somewhat biased as they were
generally conducted by fervent ‘early adopters’ of the technology. However, they do
identify various benefits related to the use of IWBs” (p. 353). The researcher concludes
that even though interactive whiteboards may be a potentially powerful classroom tool,
there is no clear evidence that supports the case that this technology can improve teacher
performance and increase student achievement.

Clearly, interactive whiteboard technology is not going away and will most likely
be a ubiquitous component in the classroom of the future. There are certainly advantages
to using this high-cost technology for teaching and learning. As with all expensive
technology, the true impact of interactive whiteboards on students’ achievement should
be thoroughly explored.

Student response systems (SRS) are another modern instructional technology
device that has been adopted by many teachers at all grade levels. Most SRS systems in
classrooms today are an optional subsystem of the interactive whiteboard. An SRS is a
wireless handheld device in the hands of each student in the classroom that works along
with the interactive whiteboard. The teacher can pose a question and each student can
answer with their handheld clicker. The clicker sends the information instantly to a
computer that can display all responses in graphical form on the teacher’s computer or an
interactive whiteboard for the entire class to view. This system allows the teacher and
students to receive instant feedback on class responses. Is a SRS effective in increasing
students’ achievement or motivation? Some research has been very positive. For
example, Blood and Neel (2008) conducted a study to analyze the results of adult
students using a Student Response System to determine if there was an increase in
content mastery and engagement. They wanted to show that an SRS system helps to engage students beyond what is possible with the standard chalk board and lecture format. The researchers chose 35 students from different classrooms throughout a university. Random sampling chose some students to receive instruction using a PowerPoint presentation, while others received the same instruction with PowerPoint and an SRS system on an interactive whiteboard. At the end of the 10 week period, students who used the SRS system demonstrated higher mastery of the content and reported more engagement in the class. The researchers conclude that the SRS system was successful in increasing learning and engagement, and argue that other research supports their findings.

Theories Influencing Instructional Technology

It is difficult to categorize theories that influence instructional technology because the classifications tend to overlap. Moreover, different learning theories can be seen in use at the same time in technology rich environments (Hung, 2001). For example, direct instruction can be part of a software program that also stimulates higher order thinking and creativity in the learner. Because of this melting pot of theories that seem to be in use in most schools, many classrooms that implement instructional technology use more than one theoretical approach to teaching with computers, software and interactive whiteboards. Even so, many researchers have developed instructional technologies that are designed to utilize the strengths of only one theoretical approach. For the purpose of this literature review, several major classifications of learning theories will be discussed as well as other learning theories and modalities that were more difficult to classify in the three major categories of behaviorism, constructivism and cognitivism.
Behaviorism

According to Burton, Moore, and Magliaro (2008), Behaviorism has had a greater impact on the development of instructional technology than other learning theories. Behaviorism is based on the principal that successful instruction will result in observable outcomes by the learner. Unlike cognitive theory, which focuses on the learner and the learner’s thought processes, behaviorism only looks at the behavior of the learner after the instructional intervention. After an instructional intervention, there should be some change in the student’s behavior that can be observed and measured. Students should be able to do something they could not do before the intervention, and researchers must be able to test and document this behavior. An example of this would be a change in test scores or a change in attitude toward learning that is observable. Measureable outcomes in students are highly desirable when initiating a computer-based intervention. If a change in behavior can be measured immediately after the intervention, then researchers have a better chance of gathering reliable data (Burton, Moore, & Magliare, 2008).

Students with learning disabilities have been shown to respond well to behaviorist intervention such as classical conditioning, operant conditioning, and direct instruction (Zafiropoulou & Karmba-Schina, 2005). Many computer-based instructional programs follow a behaviorist approach to learning by requiring specific and immediate responses to stimuli. Many mathematics programs require specific behaviors by the learner after prompting for a response. These behaviors are recorded by the program and used to grade the student’s progress. Many programs can make adjustments to the pace and difficulty level of the instruction based on student’s specific responses. This practice of individualizing each lesson would be very difficult for a teacher with a full classroom.
Students with learning disabilities can benefit from these computer-based programs when they follow a behaviorist approach to instruction (Burton, Moore, & Magliaro, 2008).

**Constructivist Theories**

Constructivist theories center around the idea that learners construct knowledge for themselves based on their own individual experiences. According to Rakes, Fields & Cox (2006), learners create their own knowledge based on past and present experiences blended together with what they already believe to be true. Much of the constructivist philosophy of learning can be traced to John Dewey and Jean Piaget during the early to middle part of the 20th century. During this period, theories of learning began to shift from behaviorism to constructivism based on the idea that learning is primarily an internal process by the learner. The implication of constructivist theory is that we must focus on the learner and not the lesson or subject that is being taught.

**Anchored Instruction**

Anchored instruction is a learning theory within the constructivist paradigm. Anchored instruction uses realistic problems presented via instructional media that serve as ‘anchors’ for all instruction and learning that follows. This technology-based learning theory was pioneered by John Bransford and the Cognition & Technology Group at Vanderbilt University using interactive videodisc that present instruction using a video format to implant complex problems and related sub-problems in pragmatic situations (Bottge, Rueda, Kwon, Grant, & LaRoque, 2007).

According to Bottge et al. (2007) students can benefit from the audio and visual aspects of the anchored instruction environment to reduce reading comprehension problems. This is a positive aspect of this learning theory for students with learning
disabilities who are engaged in mathematics, since student progress in mathematics may be hindered by a disability in reading comprehension. The idea is to given these students the opportunity to “practice emerging skills and deepen their understanding of important concepts” (p. 530)

**Cognitive Flexibility**

Cognitive flexibility follows the constructivist theory by focusing on the learner in complex and unstructured environments (O’Tool & Barner-Holmes, 2009). In this paradigm, the learner demonstrates cognitive flexibility through adaptive responses to quickly changing stimuli where knowledge is spontaneously restructured. Because learning materials should be presented from multiple perspectives, the cognitive flexibility theory is compatible with multi-media computer-based instruction, as well as other forms of modern interactive instructional technology.

Cognitive flexibility theory is concerned with transfer of knowledge and skills. This is an area where students with learning disabilities struggle (Fuchs, Fuchs, Hamlett, & Appleton, 2002). Transfer of knowledge is critical if students are to carry their knowledge to real world situations. Like transfer of knowledge, the cognitive flexibility theory also states that context is important for effective learning, instruction must be very specific, and learner constructed knowledge is critical. These elements of cognitive flexibility allow students the opportunity to develop their own representations of information that are crucial to proper learning (O’Tool & Barner-Holmes, 2009).

**Social Constructivism**

Social constructivism is a variety of constructivism theory that centers on the collaborative nature of learning. This theory was developed by Lev Vygotsky in the
1970s and emphasized the importance of interaction with people (Hung, 2001). Vygotsky believed that it was impossible to separate learning from its social context. He argued that all cognitive functions originated in social interactions, and learning happens as a result of the learner interacting in a community of knowledge that includes their parents, teachers, and other students. Vygotsky believes that every element of a child’s development first appears on the social level and, as a result, all higher functions of learning are a function of relationships between people.

Teachers working from a social constructivist orientation take the student’s social context into consideration when applying lessons. Some of the aspects of social constructivism may be difficult for a teacher to apply because of the lack of background knowledge on each student. However, there are common social interactions that seem to attract most children today, such as computers and the internet which make social networking on Facebook and MySpace possible. Therefore, Computer-based collaborative activities that take place in a social context might be considered the most recent application of the social constructivist theory (Dudley-Marling, 2004).

Cognitivism

Cognitivist theories of learning became a major paradigm in the late 1960s. Cognitivism is concerned with the inner mental activities and focuses on how the mind works as the path to understanding how people learn. Cognitivist study mental processes such as thinking, knowing, problem-solving and memory. They view the brain as a computer with mental structures that represent aspects of the individual’s world. Thinking can be defined as the process of manipulating these internal representations of the mind, and learning as changes in the learner’s mental structure (Hung, 2001).
Cognitivism was a response to the theories behind behaviorism that, the cognitivist believe, suggest that people are simply programmable or trainable like animals and merely respond to external stimuli (Foxall, 2008). The cognitivists believe that people must act and participate in the learning process in order to truly learn. Behaviors are not merely cause and effect, but considered the result of the complex mental processes taking place in the learner’s mind. Many of the arguments of the cognitivists have been heard because there has been a trend toward Cognitivism in education. According to Lowe (2002):

As computer technology became more sophisticated, CBE changed from a behaviorist instructional orientation to a more cognitive orientation. The cognitive orientation comes from a belief that students need to develop an understanding of the underlying concepts associated with any task and that this understanding is developed by allowing the students to interact actively with the environment. (p. 164)

*Distributed Cognition*

Distributed cognition theory suggest that thinking and learning are not totally within the individual but rather spread out, or distributed, among other people and tools. The purpose of distributed cognition is to explain how all aspects of the learner’s environment are coordinated by analyzing how people, their environment, and the representational media used in learning interact together.

Distributed cognition theory has implications for the design of instructional technology because it stresses the significant of artifacts and tools, such as computers and software as part of the distributed framework. According to Hwang, Hsu, Tretiakov,
Chou, and Lee, (2009), learners construct mental process based on objects and people outside themselves and use these constructs to facilitate their own learning. Instructional technology can offer many avenues to facilitate this theory of learning.

*Dual-Coding Theory*

The dual coding theory states that information is processed by the learner through two channels - visual and auditory. The theory suggests that equal weight should be given to both verbal and non-verbal processing channels of the mind. The idea that drives the theory is that each individual channel is not sufficient to process incoming information, therefore the two channels working together actually build the complex mental process that facilitate learning.

Much of the modern instructional technology seems to follow the dual-coding theory pattern. If learning is enhanced when coordinated information is presented in two different channels (multi-media), then computer-based programs that present images with matching sound are following aspects of the Duel-coding model. There is ample research to suggest this method of presenting information to the learner is effective (Brunye, Taylor, & Rapp, 2008).

*Situated Cognition*

Situated cognition is a learning theory that suggests learning is highly connected to the activity, the context in which the activity takes place, and the culture in which it takes place. In this model knowledge is not simply a mental state, it is a set of experiences that are related to the context, activities, and tools involved in the learning process and have no meaning outside of this relationship (Hung & Chen, 2001).
Like anchored instruction, situated cognition theory maintains that all learning should take place in authentic situational context that involves other individuals, artifacts and tools. Hung and Chen (2001) argue that learning environments such as online learning communities can be richly contextual as well as socially and intelligently relevant to the learner.

**Elaboration Theory**

Elaboration theory promotes the concept that information should be organized from simple to complex. This organization of information should also include a meaningful context that learners can use to integrate ideas. The process of elaboration theory has been refereed to as “chunking” by some researchers, which means reorganizing large chunks of information into smaller chunks that can be presented to the learner using a scaffold approach (Wegener, Petty, Blankenship & Detweiler-Bedel, 2010). This instructional design has been very helpful to students with learning disabilities who usually have problems digesting large amounts of information in quick succession.

The key idea of elaboration theory, simple to complex with relevant context, can be effectively delivered via many different computer programs. These programs not only deliver instruction at increasing complexity, but can adjust the content and complexity based on answers form the learner. If the student is very successful with the first set of questions, more complex problems follow. If the student is struggling, the program slows down and remediates the student (Reigeluth, 1992). This is important in mathematics where basic concept mastery is critical before more complex ideas are presented.
*Experiential Learning*

Experiential learning theory states that the process of learning involves experiences that are transformed into knowledge. Because experiential learning is based on how the learner processes personal experiences, motivation and relevance of topic are key factors in this learning theory. Experiential learning involves self-initiation and personal involvement on the part of the learner. The central role that experience plays in experiential learning distinguishes it from cognitivism and behaviorism.

Technological support for experiential learning has been established. A learning activity with a mobile technology system was designed by Lai, Yang, Chen, Ho, and Chan (2007) to help aid students with experiential learning in Taiwan. Their research involved two fifth grade classes, one using personal digital assistants (PDAs) and the other using traditional curriculum. The results support the use of mobile technology for improving knowledge building during experiential learning.

*Multiple Intelligences*

The theory of multiple intelligences argues that individuals have a unique combination of distinct intelligences. These intelligences are grouped into 7 main categories: linguistic, logical-mathematical, spatial, musical, body-kinesthetic, intrapersonal and interpersonal. More are being added as the theory evolves. The implications for educators is that students learn best when the curriculum, materials and activities match the individual student’s intelligence type. This theory has been widely supported because traditional education focuses on only two types of intelligences – mathematical and linguistic (McCoog, 2007).
There are many opportunities for educators to use technology to differentiate instruction and appeal to various learning styles. According to McCoog (2007), word processors can help teach writing and language skills (linguistic); computer programs can teach logic and critical thinking skills (logical-mathematical); Graphics intensive programs can develop visual skills (visual/spatial); there are programs that write and play music (musical); Computer learning games can help develop eye-hand coordination (body-kinesthetic); Students can work in groups using computers or students response systems (interpersonal); computers can help students work on personal skills while working alone.

Technology and Student Achievement

The link between technology integration in the classroom and student achievement has been the subject of much research (Hrastinski & Keller, 2007). Even though many researchers have established a link between technology and achievement, the findings are mixed (Ricer, Filak, & Short, 2005). However, even to the casual observer technology would seem to have more proponents than opponents. Many states, including the state selected for this study, have adopted aggressive and ambitious technology plans that require teachers and students to be proficient with computers and software applications. The No Child Left behind act also requires schools to implement technology into all areas of the curriculum. As a result, many teachers have expensive technology tools such as electronic white boards and digital projections systems to use as part of their daily teaching activities. Whether or not some researchers accept the premise that technology integration leads to student achievement, it’s obvious that most schools have accepted this argument almost without question.
According to the International Society for Technology in Education (ISTE, 2008), who has monitored research on the link between technology and student outcomes for 20 years, a definite link exists between the correct use of technology and student achievement. This position is supported by several states that have led the way with successful technology programs, such as Texas, Missouri, and Michigan. The ISTE’s position on the link between technology and student achievement is qualified by stressing “correct implementation” of technology in schools. There is little doubt that some of the research resulting in little or no improvement in student achievement due to technology was a result of improper implementation or poor teacher training. According to Mouza (2008) the way in which technology is implemented in the classroom is the single most important factor for success. Having more technology is good, but it must be used properly following researched-based teaching strategies along with activities that are carefully aligned with state curriculum guidelines.

Many educators, researchers, and parents agree that technology enhances learning environments and enables higher levels of conceptual understanding while helping students become more engaged in their activities (Spires, Lee, Turner & Johnson, 2008). Technology has been found to promote better communication and collaboration between students and teachers (Holmes, 2009), while improving motivation (Li, 2006). There has also been specific improvement in GPAs and standardized test scores as a result of increased laptop use by students (Dunleavy & Heinecke, 2007), which can also be considered a lower ratio of student to computer.

In order to lower student to computer ratios, many schools have opted for 1 to 1 laptop programs, with some schools issuing a laptop to each student to take home.
A study by Grimes & Warschauer, 2008 found that a one-to-one laptop program in a large public school system yielded excellent results after an initial slow start. This is probably due to teacher training and adapting to the new instructional paradigm. A review of the literature by Dunleavy & Heinecke (2007) yielded at least five studies that documented significant increases in student achievement across all core subject areas when students have increased access to computers. In a study by William Penuel (2006) that examined one-to-one computer initiatives in several countries, student achievement in writing, as well as student and teacher satisfaction was increased.

There is little doubt that legitimate arguments can be made that technology and student achievement are empirically linked. There is evidence in the research to make such arguments (Watson & Hempenstall, 2008). Yet major research initiatives over the years that date back to the 1980s have shown mixed results. For example, James Kulik (1983) conducted a meta-analysis of 51 research studies on computer based instruction using five different types of computer applications: Drill and practice, tutoring, computer assisted teaching, problem simulation, and programmed problem solving. Kulik’s findings suggest that computer-based instruction can yield moderate-size improvement in student achievement. He also points out that the research from the time period suggest that computer-based instruction saves teacher’s instruction time and significantly influences student attitudes, which “are potentially important” (p. 21). Overall, Kulik does not argue that a strong correlation exist between computer-based instruction and student achievement, and he points out that this result is consistent with research up to that point in time. “None of the relationships between study features and outcomes that we investigated, in fact, could be considered clearly statistically significant with the
number of studies available to us. Nonetheless, the few small correlations of borderline significance that we found were interesting because they confirmed findings from earlier meta-analyses” (p. 21).

The Apple Classrooms of Tomorrow (ACOT) project was a well-funded five year initiative started in 1985 in five school sites across the United States. The purpose was to help teachers appreciate the value of computers in the classroom and stimulate creativity in producing learning materials, sharing ideas and support long-term projects. According to Schacter (1999), Baker, Gearhart and Herman evaluated the impact of this program in 1994. Their evaluation suggests that the program did have a positive effect on student’s attitudes toward learning. However, on standardized test ACOT students did not outperform their counterparts who were not participating in the program. This was an interesting finding for two reasons: Apple computer had considerable resources to allocate to this project and a considerable interest in seeing it succeed since the results could lead to increased computer sales to school districts nation-wide. Also, standardized test scores are one of the most important indicators to school leaders (Bottge, Rueda, Larogue Serlin & Kwon, 2007), yet this was the one area where the program failed to yield positive results.

In 1994, Kulik again conducted a meta-analysis that involved 500 individual studies where educators used computers and software to individualize instructions and use various drill and practice methods. On average, students achieved higher scores in some areas and appeared to learn more in less time. Also, student’s attitudes toward their classes were higher than students in classes where traditional instructional methods were used. However, in other areas, there was not a significant improvement in student
achievement. Again, computer-based instruction was found to be effective with some teachers in some environments, but not all. This result may lead some to conclude that teaching methods are more critical to student achievement than simply the presence of computers in the classroom.

In 1998, Sivin-Kachala reviewed 219 research studies from 1990 to 1997 to evaluate the impact of instructional technology on student achievement in all core subject areas and all grade levels (Schacter, 1999). The findings from this meta-analysis indicate that students in technology rich environments are more likely to experience higher achievement levels in all subject areas than students in low technology environments. These finding also extended to students who received special education services from their school districts. Along with these positive numbers, Sivin-Kachala reported that the effectiveness of instructional technology on student achievement is not occurring without the influences of other variables. Other variables identified that influence student achievement along with instructional technology are the demographics of the student population, the role of the teacher, the type of software used, the curriculum, and student access to technology.

Wenglinsky’s (1998) national study of technology’s impact on mathematics achievement was conducted in 1998 and involved standardized mathematics scores (National Assessment of Educational Progress in Mathematics) of over 13,000 students. This study compared the test scores with computer usage time, types of computer-based instruction, access to computers at home, and teacher professional development. Wenglinsky controlled for socioeconomic level, teacher status, and class size. Most of the findings were slightly positive, but the final conclusions were, again, mixed. Wenglinsky
concluded that computers were not a cure-all for academic success or a passing fad. The evidence once again indicated that student achievement was affected by how technology was used - and not just access to the technology alone.

Obviously, controlling outside variables is critical to research in the effectiveness of instructional technology. A meta-analysis conducted by Bayraktar (2002) reviewed 42 studies where computer-assisted instruction was used in science education. Bayraktar acknowledges in the introduction of the meta-analysis that, “Research on the effectiveness of computer-assisted instruction (CAI), however, does not provide consistent results” (p. 173). In this meta-analysis, statistical procedures were used to isolated study characteristics in order to compare the actual effect of CAI without the influence of other variables. The results indicated a small positive effect from the use of CAI in science education. One of the interesting factors revealed in the analysis was that CAI seems to have an effect when students were able to work individually with the computer. This single factor agrees with other researches who argue that one-to-one laptop use results in greater student achievement than comparable learning activities in classrooms where each student does not have their own individual computer (Bayraktar, 2002; Lei & Zhao, 2008; Movza, 2008).

Lin, Ching, Ke, and Dwyer (2007) conducted a meta-analysis of 12 experimental studies that evaluated the effectiveness of animation in learning. In the 12 studies, the instructional content and four independent criterion measures were held constant to reduce the effects of outside factors form skewing the research results. The conclusions were mixed. Some of the animations strategies were positive and others negative. Gains in achievement were marginal at best. The researchers concluded that, “The
enhancements themselves may have distracted students’ attention from the critical information designed to be imparted by the animation, thereby reducing their effectiveness” (p. 234). This seems to agree with results from research outside of the field of public education when graphics and animation are used for instruction. Ricer, Filak, and Short (2005) found that computerized digital presentations used as instructional tools in medical school had no effect on student learning compared to traditional overhead projectors. Of course, sometimes certain technology may have merit solely on the basis that it helps the teacher become more efficient and reduces teacher workloads. Ricer, Filak, and Short (2005) concluded that whether or not digital presentation systems increase student achievement, they do seem to make presenting information easier on the teacher.

These meta-analyses of instructional technology are not, by any measure, a condemnation of technology in the classroom. On the contrary, in most cases there was some advantage indentified when instruction was enhanced by different technological devices. Sometimes student achievement increases (Blood & Neil, 2008; Connor, Moss & Grover, 2008; Hazzan, 2003) and other times only student attitudes and motivation improve (Movza, 2008; Li, 2007; Vale & Leder, 2004). Even though there are no definitive answers on the effectiveness of the different instructional technologies available to teachers, detractors are not suggesting a reduction or elimination of instructional technology (Ricer, Filak & Short, 2005). Even so, in a review of five major meta-analysis of instructional technology research Lowe (2002) concludes that instructional technology does seem to increase student achievement. However, the researcher conclude that, “Unless a design can hold all the variables constant except CBE
compared to traditional classroom instruction, these results have limited validity” (p. 169). And even after agreeing that results from these major meta-analyses contend that instructional technology increase student achievement, the researcher states, “In the five meta-analyses, there were either great differences or very small differences in the instructor bias. Therefore, no conclusion could be drawn” (p. 169).

Varying results from the research in instructional technology is the best argument for more research. As stated, some researchers are concluding that instructional technology is linked to student achievement and they have good data to support their view. However, large scale studies have produced mixed results that are inconclusive. These results are supported by many other researchers, in and outside of public education. The best course of action for educational leaders is to continue reviewing up-to-date research on instructional technology so they can and make decisions based on realistic expectations.

Learning Disabilities

In addition to the reported successful use of technology to teach students in the general education classroom, students with learning disabilities have shown great progress when instructed using computer-based instruction (CBI) and Internet resources (King-Sears & Evmenova, 2007). Many of these students are at high risk of failure and need the additional benefits that may be achieved with the use of instructional technology. In the area of mathematics instruction, which is an area of high failure for students with learning disabilities (Fuchs et al., 2002), computer-augmented resources have shown to be effective in increasing scores on standardized tests (Funkhouser, 2003). Research on the integration of technology into instruction of mathematics has shown that
students with learning disabilities have been able to improve their achievement scores (Lin, 2006) and attitudes toward learning mathematics (Vale & Leder, 2004).

Learning disabilities can be defined as a group of different disorders that have a negative effect on the acquisition and retention of knowledge in the areas of reasoning, writing, reading, speaking, listing, and mathematics (Zafiropoulou & Karmba-Schina, 2005). Students with learning disabilities may have short and long term memory problems, trouble with transfer of knowledge, poor sequential thinking skills, have slower response time to questions, difficulty with number concepts, and generally need more explanation and remediation with concepts (Elbaum & Vaughn, 2003).

Many students with learning disabilities in mathematics experience problems in the early elementary grades and continue to struggle through high school. Their disability may be more pronounced in a certain area of mathematics reasoning or problematic throughout all areas. Specific learning disabilities in mathematics in the early years typically occur as problems with basic arithmetic facts and combinations, counting strategies, number relationships, number sense, and an overall limited mastery of basic math facts (Bryant & Bryant, 2008). When these students reach high school, their frustration level and anxiety toward mathematics can be quite pronounced.

According to Xiangdong, Shaftel, Glasnapp, and Poggio (2005), students with learning disabilities need individual remediation that is tailored to their specific disability. As directed by the NCLB act of 2001, students with learning disabilities are provided with an individual learning plan (IEP) that details their specific strengths and needs. The IEP document follows the students throughout their school years starting at the time each student is identified and made eligible for special education services. The IEP sets goals
for the students for each school year and benchmarks that are evaluated throughout the year by an IEP team. The IEP team consists of the student, parents, special education teacher, general education teacher and a local educational agency representative.

Research supports computer-based resources for teaching students with learning disabilities. Fuchs et al. (2002) found that students with learning disabilities using computer-based instruction increased in real world problem solving skills and transfer of knowledge skills at a faster rate than their counterparts who were instructed in traditional methods. Other research even suggest that students with cognitive disabilities can improve learning behaviors such as strategizing, critical thinking, synthesizing, and giving and receiving feedback (Maccini, Mulcahy & Wilson, 2007). However, other researchers are less enthusiastic about the results of instructional technology’s impact on students with learning disabilities. Fitzegerald, Koury and Mitchem (2008) conducted a synthesis of the literature from 1996 to 2006 on the effects of computer-mediated instruction on the achievement of students with learning disabilities. In their concluding remarks the researchers state, “There is little evidence that any of the uses of CMI reported in this review, even when combined with effective instructional approaches, narrowed the gap in achievement for students with mild disabilities” (p. 227). Even with mixed results, these research findings should be of great interest to teachers of students with learning disabilities and should be considered when educational leaders make decisions concerning students receiving special education services.

Learning Disabilities and Mathematics

There exist a diverse group of students who struggle with mathematics. Students with learning disabilities can be particularly vulnerable to low achievement in math.
According to Skylar (2007), some of the characteristic that contribute to poor performance in mathematics by students with learning disabilities are “learned helplessness, passive learning (failure to connect prior learning with new information), memory problems, attention problems, strategy deficits (failure to use metacognitive or cognitive strategies), low academic achievement, and math anxiety” (p. 47).

Also, students with particular types of learning disabilities, such as specific learning disabilities (SLD) in mathematics, benefit from more differentiation in learning that is made possible with CBI tools than their counterparts that are instructed with traditional resources (Skylar, 2007). When students use Web-based software tools for experimental activities in mathematics, their learning grows from memorizing procedures to conceptual understanding (Samuelsson, 2007). Because of these encouraging findings, many teachers are interested in utilizing Web-based applications for teaching mathematics to students with learning disabilities.

The national reports of mathematics achievement for students with learning disabilities are not very encouraging. Over half of the high school students who are diagnosed with mild to moderate learning disabilities score below the 25th percentile on mathematics achievement tests (Foegen, 2008). Some researchers believe that half of all students in middle and high school are at-risk learners (Li & Edmonds, 2005). Students with learning disabilities do not make up the entire group of at-risk learners. However, it can be difficult to distinguish between these students based on their academic performance alone. In either case, extra effort is needed to help these students achieve in mathematics, and many educators feel that computer-based instruction is one of the best supplemental tools available to teachers (Drickey, 2006).
The No Child Left Behind Act (NCLB) of 2001 has increased efforts to raise the mathematics scores of students with learning disabilities. These students are being asked to enhance their mathematics skills and test scores while completing more advanced levels of mathematics courses (Foegen, 2008). Many students with learning disabilities enter high school with serious deficits in mathematics. Facing more pressure and more failure, many of these students are in danger of dropping out of school due to frustration with the curriculum. Teachers must be equipped to help these students succeed with research-based instructional technologies that keep students interested and on-task.

Many researchers and educational leaders have called for more technology-based interventions to help students with learning disabilities succeed in mathematics (Kurtz & Middleton, 2006). A growing number of Web applications offer increasing flexibility to students for everyday learning activities, especially Web 2.0 based Internet sites (Churchill, 2008). Many of the historically effective instructional techniques for teaching students with learning disabilities in mathematics have been incorporated into computer-based instruction. For example, virtual manipulatives, sound, scaffolding techniques, and various types of animation have been effective in increasing students’ engagement. According to Drickey (2008), the use of technology for teaching mathematics enhances higher order thinking, student and teacher communication, and student participation. Students reported enjoying their interaction with manipulatives and considered them fun and interesting. Computer-based manipulatives are becoming more common on the Internet. Teachers can find many manipulatives available for a variety of subjects, including mathematics.
The use of technology to teach mathematics is widespread. According to Baki and Guveli (2008), many educators and researchers suggest that technology should be a regular part of mathematics instruction for all students and argue that student achievement in mathematics could increase with the use of technology. Since technology has changed the way students interact and communicate with each other, students are well positioned to take advantage of the many technology tools available in education. These technology tools for learning mathematics may even encourage higher order thinking and increased motivation (Baki & Guveli, 2008).

Students today must succeed in high school mathematics, especially algebra and geometry. The ability to learn the basic concepts of algebra and geometry can lead students to many other opportunities in education and employment (Bryant & Bryant, 2008). Students who do not master these basic skills will have limited opportunities in universities, technical schools and technology related employment. This is true for a diverse population of students including students with learning disabilities. According to McKinney and Frazier (2008), the urgency for learning mathematics and science is at a critical level. This urgency is pushing educators to find new ways to engage students in learning mathematics.

Graduation requirements in many schools are also making it difficult for students who score low on standardized mathematics exams (Foegen, 2008). Graduation requirements in many school districts around the country require knowledge of algebra and geometry to pass the mathematics portion of the exam. Because of the mathematics skills needed to graduate from high school and the increasing need for technology-based skills in the workforce, students who struggle with mathematical problem solving are
under more pressure than ever before. When considering students with learning disabilities, this pressure is even more apparent (Bottge et al., 2007).

Mathematics anxiety is linked to poor performance in mathematics and is common among high school students; particularly students with learning disabilities. According to Rameau and Louime (2007), a decrease in math anxiety can lead to higher achievement. One factor that may decrease mathematics anxiety and improve self-esteem among students with learning disabilities is the use of effective teaching methodologies, such as computer-based instruction (Page, 2002). Because of their high anxiety and fear of mathematics, students with learning disabilities should be provided with resources that can help them overcome their negative attitudes toward mathematics. Computer-based learning has been reported by students to be a comfortable and relaxing method for learning that feels natural (Vale & Leder, 2004). Since students find working with computers to be a natural environment, computer-based and Web-based learning should be incorporated into mathematics instruction for students with learning disabilities.

In research conducted by Hwang, Tseng, and Hwang (2008), students in an experimental group using a computer-based software program for mathematics instruction and assessment outperformed students in the control group who were taught by the same teachers with the same curriculum. The only difference was supplemented instruction by a computer-based program that students used for assessment feedback and homework instructions. This research is supported by other similar studies that involved students with learning disabilities and CBI (Hsieh & Lin, 2008).

Software tutoring systems for learning mathematics are plentiful. Computer-based tutoring and Web-based tutoring and testing systems have been shown to match the
quality of paper-administered test (Hwang, Tseng & Hwang, 2008) and many students with learning disabilities have responded well to interventions with online software applications for learning mathematics (Lin, 2006). Stevens and Konvolina (1999) found that students who were taught algebra using a popular computer-based software application for part of the lesson outperformed students who were taught in the traditional chalk and lecture method. The findings suggest, as others have pointed out (Cates, 2005; Hsieh & Lin, 2008), that computer software and the Internet can make mathematics more interesting and therefore increase students’ engagement in learning.

Student Attitudes

Students’ attitudes and perceptions about learning affect their academic performance (Vale & Leder, 2004). When students are comfortable in a learning environment, their attitudes toward learning are more positive. According to Drickery (2006), students’ attitudes toward mathematics can seriously affect their performance. When students were pretested to assess their attitudes toward mathematics, those who viewed mathematics as negative scored lower in math courses than their counterparts who viewed mathematics as positive. Also, many students will stay on task when they enjoy the activity in which they are participating. A study by Blood and Neel (2008) found at the end of a ten week period that students who used a Student Response System (SRS) demonstrated higher mastery of the content and reported more engagement in the class. The researchers conclude that the SRS system was successful in increasing learning and engagement because students enjoyed using it during class. This enjoyment on the part of the students can lead to more on-task behavior.
The Internet is changing students’ attitudes and the way they access information, communicate, and think. Hodge, Richardson and York (2009) describe the current information age and its impact on students and teachers as fundamental and dramatic. Educators must understand how young people are using the Internet in order to direct teaching efforts in an effective and interesting direction.

Past studies that explored the impact of technology on student learning and engagement have found that technology can motivate students to learn mathematics (Stephens & Konvalina, 1999). A very well known program for learning algebra called MAPLE was used in a study to investigate if student achievement and motivation would increase as a result of using the computer-based software. The researchers in this study concluded that student achievement and motivation increased as a result of using the software in mathematics instruction. After the study, student evaluations were higher than either of the researchers had ever received. Stephens and Konvalina (1999) also found that students using a popular off-the-shelf algebra instructional software package, Derive, outperformed students who did not use the software package and showed a higher degree of satisfaction with learning algebra. Software programs like Derive can be based on the host workstation or the Web. Software such as this can be a powerful tool for learning algebra and can display variables, functions, expressions, vectors, Boolean expressions, and matrices.

In cases where the Internet was available to students for learning, students found the resources highly desirable for pursuing classroom activities. Students have consistently acknowledged that using computers and the Internet for learning is desirable (Cates, 2005), but also view computers and the Internet as a supplement to learning and
not the primary way in which they want to learn (Hazzan, 2002). Working with computers has been found to enhance motivation, enjoyment, and lead to more involvement in the lesson (Halat, 2008).

Research has shown that students want more control over their learning environment (Kopcha & Sullivan, 2008). Computer-based instruction can benefit student achievement because many learning programs give students control over their learning environment. Many software programs and online learning sites allow students to decide which activities they want to learn first. Even programs that guide students and suggest activities may still allow students some flexibility over how they structure the learning activities. Kopcha and Sullivan (2008) found that when students are provided with a learner-controlled environment, such as many software programs can provide, their attitudes toward learning are more positive and they tend to outperform students who are in a more structured teacher-controlled environment.

Many students with learning disabilities begin a math course feeling inferior due to their special education status. These students have a history of failure in mathematics and this fact affects their attitudes when faced with mathematics courses. Research has found that these students identify mathematics as their least favorite subject (Foegen, 2008). The same study found that students with learning disabilities are interested in getting more assistance from teachers. These students want different teaching styles, group work opportunities, and more interesting assignments. Web-based resources may provide some of these needs.

Students with learning disabilities generally have positive attitudes toward computer-based learning (Li, 2007). Although for many students, that positive attitude
does not extend to mathematics. However, according to Halat (2008) computer-based instruction can have a positive effect on students’ achievement, motivation, attitudes, and peer-interaction. Others (Drickey, 2006; Martindale, Pearson, Curda, & Pilcher, 2005) argue that students with learning disabilities tend to view mathematics instruction more favorable when they are able to use a computer and the Internet for a portion of the instructional time.

Students with learning disabilities view computer and Internet use for learning mathematics as a positive activity (Kopcha & Sullivan, 2008). However, some research on the ability of computer-based instruction to increase achievement levels of students with learning disabilities is mixed (Page, 2002). This same research showed comparable levels of achievement between students who use CBI and students who do not, even when motivation is higher.

One of the struggles for teachers is keeping students engaged and on-task. On-task behavior can be difficult with students who are easily distracted by extraneous event or the actions of their classmates. If technology-based resources can keep students interested, it should affect their ability to stay on task and improve achievement scores.

Teacher Integration of Technology

Computers, the internet, and instructional technology devices have had an impressive impact on all areas of education. This is due in large part to teachers taking the initiative to integrate technology into their classrooms and their daily instructional practices. Also, research has been prolific in the area of instructional technology over the last four decades (Hew, Kale, & Kim, 2007). Early research supported the use of computers in the classroom and educational leaders were quick to adopt a technology
policy for the purpose of increasing student achievement (Grimes & Warschauer, 2008). This positive research only added to the growth of instructional technology available to teachers and continued the push toward more technology in teachers’ and students’ hands.

The growing body of research in educational technology has attempted to answer questions that will lead to a better understanding of the predictive factors that facilitate successful technology integration by teachers. Some of these factors are: effectiveness of professional development programs for technology training (Kafai, Nixon, & Burnam, 2007), how teachers use technology to teach (Sahin & Thompson, 2007), teachers’ views and beliefs on technology integration (Milman & Molebash, 2008; Palak & Walls, 2009), barriers to technology integration (Swan, 2009), and how technology integration by teachers affects students’ achievement (Teo, 2008). Mixed results and a refocusing of the research over the years from rote learning with computers to more complex and higher order thinking activities using computers and software has helped to continue the evolution in research.

According to the International Society for Technology in Education (ISTE, 2008), there are several critical factors that need to be considered when integrating technology into instruction. The correct implementation of technology is critical in order to achieve the desired results – increased student achievement. ISTE has monitored the research on educational technology and student achievement for 20 years, which led to the formulation of seven critical factors. They are appropriate professional development, alignment of instruction with state curriculum standards, daily integration of technology,
individualized feedback, student collaboration, and real world problem solving using technology.

It seems clear that teachers must be trained and motivated to use technology effectively in the classroom. Research has pointed to professional development programs and teachers’ perceptions about CBI as two issues that heavily influence teachers’ use of technology in the classroom for instruction (Algozzine, Greit, Queen, & Cowan-Hathcock, 2007; Schnellert, Butler, & Higginson, 2008). Availability of computers and Internet connectivity is rarely an issue since most school systems have spent a great deal of money on these technologies (Page, 2002).

The majority of new teachers who enter the classroom today have grown up in a technology-rich environment (Bebell, Russel, & O’Dwyer, 2004). Most of these teachers are entering an environment in K12 education where it is understood that professional development courses in educational technology are essential to in-service teachers’ success in integrating technology into their classrooms. However, according to Milman & Molebash, (2008), these programs are consistently found to be ineffective based on the low percentage of teachers who report being prepared to use technology for instruction. Many teachers leave these training sessions and return to their traditional teaching methods. Others contend that the problem is with the professional development programs themselves and improvements in professional development programs geared toward technology are the answer (Sahin & Thompson, 2007). One improvement may be the method by which teachers can access professional development. According to Cole and Styron (2006), teachers prefer online professional development programs over traditional
delivery. This preference is important to note because it may lead to more teacher participation in training programs that improve technical skills.

One might assume, based on a cursory review of the literature, that one the most studied aspect of teacher integration and adoption of technology is teachers’ attitudes toward the use of instructional technology. This data is easy to collect and is based on teachers’ self-efficacy, which is a good indicator of how confident teachers will be when it comes to adopting and effectively using new technology into the classroom. Teachers with low levels of confidence toward technology have been found to resist implementing new instructional technology in their classrooms (Donovan, Hartley & Strudler, 2007). Also, if the school administration is proposing a new technology-based initiative in the classroom, teachers who do not immediately see this technology as beneficial to themselves or their students will resist the program (Nicolle & Lou, 2008). Educational leaders must understand how teachers perceive the benefits of new technology if they want to see their school technology plan for student achievement succeed.

For the effective use of technology in the classroom, teachers must be willing to accept technology as an important part of regular instructional activities. Many teachers are comfortable with basic technology, such as an overhead projector, but are not comfortable with more advanced technology, such as computer software for teaching mathematics. According to Hazzan (2003), the number of math teachers in high schools across the nation who integrate technology into their mathematics instruction is relatively low. New teachers who participated in a study to determine attitudes toward technology in the classroom did not assume that computers would help them solve educational problems. The same study found that veteran teachers typically were not receptive to the
idea of technology integration in the classroom. A more recent study by Kurz and Middleton (2006) found that most pre-service teachers are open to using technology in the classroom, but could not discuss specific areas where they would use technology because of their lack of knowledge. An even more recent study sought to investigate teachers’ attitudes toward using computers and Internet resources for teaching mathematics (Lin, 2006). This study found that teachers with a positive attitude toward computers were less anxious about teaching mathematics using technology.

It has been suggested that teachers’ attitudes toward the integration of technology into their classrooms may be influenced by age. According to Gou, Dobson & Petrina (2008), it’s a common view that young people are more comfortable with technology and therefore more competent. Gou et al. defined young as persons born after 1980 and argued that this age group has been exposed to more technology than any generation before them. It’s appears to be a plausible argument that young people who grew up in the age of the PC and video games would be more proficient than the older generation who had to adopt technology after the fact. However, Gou et al. argue that years of experience with computers is not a valid measure of computer skill. This argument is supported by their research study conducted between 2005 and 2007 that found no statistically difference between the computer tech skills of young and more mature teachers.

Time of service may be another important aspect of teacher adoption and integration of technology. Russell, O’Dwyer, Bebell and Tao (2007) reviewed the literature and found that in 2003 new teachers with less than 6 years of service were not assigning class activities that involved the use of technology as frequently as teachers
who had more than six years experience. Because the use of technology in schools is changing rapidly, the same research was examined again in 2005. It was discovered that students with less than three years of teaching experience reported higher levels of comfort with technology, but lower levels of technology use during class time for the delivery of instruction. Based on their own study of 2,864 teachers’ use of technology compared to time of service in 2007, Russell, O’Dwyer, Bebell and Tao reported that new teachers who are comfortable with a technology rich environment do not appear to use technology for delivering instruction or class activities more than their counterparts with more than six years experience. The researchers admit that the relationship between teachers’ time of service and technology use is complex and many variables must be considered in order to accurately assess technology usage. Some of these variables are specific uses of technology, general uses of technology, teacher demographics, and technology use after a teacher transitions to a new school.

Presumably, the considerable resources allocated to increasing teachers’ use of instructional technology are primarily aimed at increasing student achievement. But is this always the case? It seems clear that teachers in various educational settings have found opportunities to enhance their curriculum by integrating technology into their instructional activities (Kurtz & Middleton, 2006). Some teachers have reported that integrating computer-based instruction into their lesson plans have increased students’ engagement in learning and raise standardized test scores (King-Sears & Evmenova, 2007). Research has supported this finding in many different grade levels and subject areas. However, research has also found that having access to technology will not, by itself, increase student achievement. For example, Norton, McRobbie, and Copper (2000)
found that teachers’ attitudes toward the traditional methods of teaching mathematics were more favorable than a computer-based approach to teaching. Seven years later, Russell, Odwyer, Bebell and Tao (2007) found that a significant number of teachers with 15 years of experience or more were still not using very much instructional technology in their instructional activities.

Teacher’s integration of technology into instructional activities has been the topic of much research. There are many variables involved when teachers use technology and these variables must be taken into consideration. However, educational leaders are primarily concerned with student achievement and look to instructional technology as an opportunity to raise standardized test scores (Hew & Brush, 2007). As pointed out, much research tends to indicate that instructional technology, when integrated into the curriculum properly by well trained teachers, can increase student achievement and motivation. If these results can continue to be reproduced and the key variables that lead to successful implementation of instructional technology can be isolated, then educational leaders can direct their resources with a better understanding of how technology impacts their students’ success.

Barriers to Technology Integration

The integration of instructional technology into public education has increased yearly. However, the fusion of technology and instruction has not always been easy (Norton, McR Robbie, & Copper, 2000). In the past, some educational leaders and teachers resisted instructional technology initiatives. In some schools where technologies are available for all students, many teachers report little or no usage of computers or other modern instructional technology (Peake, 2003). This resistance extends to all subject
areas, as well as special education teachers. Although many education teachers are using technology for a portion of their instruction, many are not. Educational leaders who are attempting to implement technology programs must understand what barriers are preventing teachers from embracing more instructional technology in the classroom.

Although research has supported the use of instructional technology as a method to increase student achievement, Hew and Brush (2007) argue that its use seems to always be affected by certain barriers. They content that barriers to the use of instructional technology are pervasive even in the most technology-rich environments. If this is true, and there is an almost insidious presence of barriers to the use of instructional technology, then educational leaders would be wise to understand these barriers and prepare to confront them.

According to Lowther, Inan, Strahl, and Ross (2008), barriers to the use of instructional technology involve cost, complexity, location of computer labs, number of computers available, and teacher training. Others argue that the traditional school structure hinders new teaching techniques and the introduction of new technologies in the classroom (Williams, Atkinson, Cate, & O’Hair, 2008) because public schools can be inflexible and resistant to change.

In order to examine barriers to the use of instructional technology, Hew and Brush (2007) analyzed 48 research studies spanning from 1995 to 2006. They found 123 barriers and categorized them into six main areas in the order of frequency they occur. They were: resources, knowledge and skill, institution, attitudes, assessment and culture. This review of research is supported by Bore (2008), who found knowledge, skill and resources to be leading barriers to the use of instructional technology. A study by
Donovan, Hartley and Strudler (2007) also showed that teachers concern for their level of technical skills was a major concern when implementing a new instructional technology program involving laptops.

Many teachers have reported a lack of confidence in using technology in their instruction based on their training and preparation. They worry that technical problems will hinder their classroom activities if they adopt a complex technical teaching apparatus. A crash of the system or a malfunction would be yet another issue added to the long list of challenges associated with daily life in the public school classroom. Sahin and Thompson (2007) argue that since technical confidence is a serious barrier to the use of instructional technology, it should be high on the list of priorities. It seems plausible that when teachers have a high comfort level with technology, they will be able to overcome many of the other barriers to the use of instruction technology.

Based on the results of a study involving 26 schools and over 12,000 students, Lowther et al. (2008) argue that when the barriers to technology integration are removed, teachers’ have significantly higher confidence to integrate technology into the classroom. Since it usually takes leadership to remove barriers, the school principal must be a proponent of technology in the classroom. Without leaderships, the integration of technology will move slowly, or not at all. Considerable resources are needed to support a technology program. These resources will never materialize without a school leader who is committed to technology-based instruction.

**Accountability in Public Schools**

School leaders in U.S. public schools are under increasing pressure to raise scores of all students, as well as students with learning disabilities (Ysseldyke & Bolt, 2007).
The No Child Left Behind Act (NCLB) of 2001 mandates that all schools must meet annual yearly progress (AYP) toward the goal of all students performing at grade level by 2014. To help students with learning disabilities meet AYP and move closer to performing at grade level, schools must provide a variety of instructional delivery. Computers, internet, and electronic white boards are forms of modern instructional technology that teachers can use for first or second delivery of instruction that have shown to be helpful and educational leaders are constantly being reminded of the benefits of technology by researchers and technology industry professional. And even though some of these advocates may have a biased stake in the success of technology in the classroom, these tools must be seriously considered by school leaders during instructional planning for special populations. This is important because even small increases in student achievement of special populations can make the difference when reporting average yearly progress.

Public schools have made changes to facilitate learning for students in the general population as well as students with learning disabilities. In the state selected for this study, annual yearly progress (AYP) is reported in four categories: reading, math, additional academic indicators (attendance and graduation rates), and overall score. School improvement is defined by how a school or school system met its annual yearly goals. Schools are identified for school improvement if they do not meet their annual goals for two consecutive years. This is determined by a proficiency index that tracks progress and ranks school improvement.

All teachers in each school share accountability along with the school administrators. For acceptable annual yearly progress, students must perform at grade
level, pass end of subject criterion reference test, pass all parts of the graduation exam, achieve a 90% graduation rate, and maintain 95% attendance rates. This aggressive level of accountability extends to students with learning disabilities and their scores are counted in the proficiency index. Because of this, teachers of students with learning disabilities must find ways to help these students stay engaged in learning and perform at grade level while making accommodations for their disabilities.

Based on NCLB guidelines, technology plays an important role in the accountability plan of public schools. According to the report, No Child Left Behind: A Desktop Reference (2002), “Technology can be used to enhance curricula and engage students in learning. In addition, the job market increasingly demands technology skills for new workers” (p. 85). The NCLB act promotes the use of educational technology so educators can leverage the unique power of technology to provide challenging and stimulating learning opportunities to students. By using the most up-to-date technology tools and applications, students will be better prepared to become successful adults. This is a strong endorsement of technology in the classroom stemming from the BCLB law. Because of this emphasis on technology, teachers and school leaders are required to show that part of the curriculum is being delivered via some type of instructional technology.

The accountability at hand in this study is 8th grade math achievements scores. According to Anderman (1998), there is a dramatic decrease in academic performance and motivation in the middle school years. This is thought to be a result of the substantial transition from elementary school. This is an important time for most students when they are making important decisions regarding life and careers. When considering students
with learning disabilities, the stakes are even higher because most only make small gains in achievement levels during these years (Graham, Bellert, Thomas & Pegg, 2007).

Instructional expectations for 8th grade mathematics in the state selected for this study include the integration of new and prior knowledge to solve problems dealing with all mathematical strands. There is an emphasis on algebra, geometry and proportional reasoning. The 8th grade curriculum, subtitled Pre-Algebra, involves a more in-depth study of mathematical concepts than in past years.

In the state selected for this study, priority is given to helping students become better problem solvers. This is accomplished with the 8th grade course of study by guiding students to choose problem solving techniques that fit different situations, articulate the reasons for their choice, and identify the methods used to solve math problems. The teacher is expected to guide students in developing these skills by encouraged them to verbalize, illustrate and record their math processes, to work with and learn from other students, to build on their knowledge rather than memorize facts, use modeling to solve problems, and connect the algebraic concepts in the classroom to real world applications.

Technology Budgets

Many school districts in the US are increasing their technology budgets every year (Stover, 2008). The demand for new hardware and software is increasing due to technology professional development activities that are training teachers on the use of technology in the classroom, and constant upgrading and replacing of obsolete hardware and software. The financial cost of continually updating computer hardware and software has been cited as the number one problem by many school districts (Drickey, 2006). To
make matters worse, one of the main reasons cited for resistance to further integration of instructional technology is insufficient funding (Guthrie, 2003).

Funding technology in K-12 schools has been ranked as the number one problem for two years in a row by EDUCAUSE, a lobbying organization for the use of information technology (Distance Education Report, 2005). Moreover, special education costs can be a substantial burden on school districts, consuming up to 25% of the district’s budget for only 12% of students (Fratt, 2008). These budget demands sometimes make it difficult for individual teachers to purchase new software for mathematics instruction in special education when budgets are already stretched to the limit. Also, commercially available computer-based and Web-based software applications for mathematics instruction can be very expensive to purchase and maintain/upgrade.

Even with the high cost of modern hardware and software technology, the state selected for this study has made a commitment to creating a technology infrastructure that will support students and teachers in all areas of the curriculum. This commitment is based on the guidelines laid out in NCLB that highly promotes the use of technology (No Child Left Behind: A Desktop Reference, 2002). For example, schools are cited that have low student per computer ratios and high levels of internet connectivity as being good models for schools with lower levels of technology. States grants for the purchase of technology hardware, software and training are available to schools who meet certain requirement. A central focus is preparing students to be efficient in the use of technology by 8th grade. As stated by No Child Left Behind: A Desktop Reference (2002):

The principal goal of the Educational Technology State Grants Program is to improve student academic achievement through the use of technology in
elementary and secondary schools. It is also designed to assist every student in becoming technologically literate by the end of eighth grade and to encourage the effective integration of technology resources and systems with teacher training and professional development to establish research-based instructional models.

(p. 85)

District and building level leaders are seeking more funding to support their expanding school computer networks and expensive instructional devices, such as interactive whiteboards. All forms of funding are needed, such as federal grants, state grants, local funding, and building level resources.

It’s clear that educational leaders have accountability issues and financial pressures facing them over the implementation of educational technology. State have tied student achievement to the use of technology in schools and have a vested interest in demonstrating results. This means that not only do educational leaders have to demonstrate that students can meet state and federal standards for NCLB, they must also show students achievement to justify the ever increasing cost of technology. If all the resources are allocated and no benefits can be shown, then educators are placed in a light. However, the added costs of hardware, software and teacher training would be justified by even moderate gains in student achievement in the core academic areas.

Summary

Researchers began the study of educational technology in 1940s and focused on how learners respond to different low-tech educational media. As time has passed, the field of research in modern educational technology has grown significantly and a large body of data exists. Instructional technology has been shown to benefit students in all
grade levels from general education to special education settings. Research supports the use of technology driven educational activities to improve students’ achievement scores, time on task, engagement and satisfaction (Cates, 2005; Connor, Moss & Grover, 2007; Deubel, 2001; Drickey, 2006; Hsieh & Lin, 2008; Stephens, & Konvalina, 1999).

Research in educational technology has explored how learning theories have driven the development of various instructional technology devices. Behaviorism, constructivism and cognitivism have all had an impact on the evolution of instructional technology (Burton, Moore, & Magliaro, 2008; Hung, 2001; Rakes, Fields & Cox, 2006).

Although research results are mixed, some experimental research with technology-based instruction has shown that students in the experimental group outperform students in the control group (Frye & Dornisch, 2008; Funkhouser, 2003; Hakkarainen, 2003; Watson & Hempenstall, 2008). Mechling, Gast and Thompson (2007) found that student achievement increased when interactive whiteboard technology was used compared to instruction with traditional flash cards. These finding also agree with research on student achievement when using electronic white boards and student response systems (Blood & Neel, 2008). However, some large-scale studies on the effectiveness of instructional technology have not been able to demonstrate that student achievement will always increase. In some areas of research, achievement was lower for students who were taught using instructional technology than students taught using traditional methods (Grimes & Warschauer, 2008). When other researchers conducted meta-analysis of research, the results were slightly positive, mixed or inconclusive (Mouza, 2008; Martindale, Pearson, Curda, & Pilcher, 2005).
If the benefits from instructional technology are to be accepted as fact, which it the advocates of NCLB have done done, then building-level educational leaders must be aware of how the integration of technology, and the resources dedicated, is affecting student achievement in the classroom. This is not a minor issue since the resources being allocated toward instructional technology in the form of hardware, software, teacher training, and technical support are staggering. Moreover, there appears to be no end in sight to the initiative for a more technical classroom. This may be what public education needs, but many questions remain to be answered. The purpose of this study was to help answer some of these questions by looking at relationships that may exist between the levels of technology integration of mathematics teachers and student achievement in mathematics.
CHAPTER III

METHODOLOGY

Introduction

The purpose of this study was to examine the relationships between instructional technology and mathematics achievement of students with learning disabilities. Many states have made a substantial investment in educational technology with the intent to raise student achievement, motivation and engagement. This move toward more technology seems reasonable based on past and current research on student achievement and instructional technology (Frye & Dornisch, 2008). Research from the 1940s to present has made the case for using various forms of technology for teaching students in all subjects (Hrastinski & Keller, 2007), including students with learning disabilities (Kurtz & Middleton, 2006). However, there is a large body of research that has reported little or no relationship between the use of various instructional technology devices and student achievement on standardized test scores (Li, 2007; Movza, 2008; Vale & Leder, 2004). Based on the size of the financial commitment required to purchase hardware, software and provide ongoing training for teachers, the question of the effectiveness of technology remains an important one. More specifically, the effectiveness of instructional technology in the state selected for this study needs to be answered. Moreover, how is technology affecting the achievement students with learning disabilities? Research is scarce in this area making it impossible to argue if more computers in schools are improving student achievement, or improvements in achievement are a result of competent teachers and teaching methods. This study explored questions such as this via a mixed methods approach. This chapter includes a description of the research design,
participants, procedures, ethical standards, independent and dependent variables, data collection procedures, data analysis, and a summary of the methodology.

Research Design

In general, there are three major research paradigms that can be applied in educational research: quantitative, qualitative, and mixed methods (Creswell & Plano Clark, 2007). Quantitative research has a distinct advantage because it can produce reliable data that is quantifiable and potentially useful for generalizing results to the greater population. The weakness of quantitative research lies in its inability to explain why certain phenomena occur. According to Crestwell and Plano Clark (2007), quantitative data analysis may ignore the role of human behavior and its effects on the outcome of research. It may overlook the context or setting in which people interact and therefore negate important variables that affect outcomes.

Qualitative research seeks deeper meaning than raw date can provide through investigating human behavior and the causes of that behavior. Qualitative studies are typically focused on description and understanding. Creswell (1998) argues that qualitative research acknowledges a subjective factor in the research process that results from investigating human behavior through an inquiry process. Qualitative research is designed to explore and explain social phenomenon as it occurs in a naturalistic setting as the research becomes the data collection instrument (Denzin & Lincoln, 2008). Some limitations of qualitative research result from the personal interpretations of the researcher, which can inevitably lead to some degree of bias in the findings. Also, qualitative research is more difficult to generalize to larger populations because of the small number of subjects typically involved (Fraenkel & Wallen, 2006).
A mixed methods approach which combines both quantitative and qualitative data can help to overcome some of the limitations in each individual method (Creswell & Plano Clark, 2007). Mixed methods research can help answer questions and provide more depth of understanding than single methods alone can provide (Fraenkel & Wallen, 2006). In recent years, combining quantitative and qualitative data has shown to broaden the understanding of certain issues being studied, which has led to an increase in the use of this research model (Creswell, 2009). The research questions in this study led to the selection of the mixed model approach. This study sought to answer the following questions:

1. Which independent factors (students per computer, level of internet access per student, and teacher’s certification level) can help predict 8th grade standardized mathematics scores of students with learning disabilities?
2. Are 8th grade math teachers integrating appropriate technology into instruction?
3. Is the use of instructional technology by 8th grade math teachers improving mathematics achievement of students with learning disabilities?
4. Is the skill level of 8th grade math teachers sufficient to utilize technology for student engagement?
5. Are sufficient technology resources available for teachers to use during mathematics instruction?

Some of the research questions asked in this study can be answered with descriptive data and easily analyzed using a quantitative method. For example, the number of computers per student in a school district, the level of internet access, the certification level of teachers, and standardized test scores are all hard numbers that can
be efficiently analyzed using a quantitative model. Other questions were better addressed through qualitative inquiry. To address how individual teachers are using technology in their classroom and how that affects their individual students requires a conversation between researcher and subject. Mere numbers cannot describe how a teacher is personally adapting and evolving in the use of instructional technology, it’s effectiveness in the teacher’s classroom, and the individual perspective of the teacher in context to their environment.

Although many mixed method designs are available to researchers, a concurrent triangulation mixed method design, as conceptualized by Creswell and Plano Clark (2007), will serve as the model for this study as described in Figure 1.

![Figure 1. Triangulation mixed methods design.](image)

The concurrent triangulation mixed model design involves concurrent data collection. Quantitative and qualitative data are collected at approximately the same time. One set of data does not need to be collected before the other, as with sequential mixed methods. This process is followed by data analysis and the combination of interpreted
results into a meta-analysis. Since quantitative and qualitative methods are given the same priority and used concurrently, the design is notated as: QUANT + QUAL (Creswell, 2009). With the concurrent triangulation design, data is collected at the same time but analyzed individually. Once individual analysis of data is complete, the results are integrated into the discussion of findings (Creswell & Plano Clark, 2007).

The quantitative component of this research was designed to investigate relationships between each school district’s educational technology and personnel resources and the achievement of students with learning disabilities on standardized mathematics tests. Data was collected from public sources. A multiple regression analysis was use to look for correlations in the data. Independent variables in the quantitative component of the study were: students per computer, level of Internet access, and teacher certification level. The dependent variable was 8th grade mathematics scores of students with learning disabilities.

The qualitative component of this research used a semi-structured interview process with a small number of mathematics teachers who had students with learning disabilities in their classrooms. According to Lindlof and Taylor (2002), a semi-structured interview is flexible, and allows additional, unplanned questions to be asked based on initial feedback from the interviewee. The semi-structured interview is typically driven by a framework of themes to be explored. Grounded theory will drive the qualitative research phase. In grounded theory the researcher allows the theory to emerge from the data, as opposed to generating theory in advance and using data to support that theory. Using a grounded theory approach, researchers allow the various themes and ideas to emerge through a process described by Glaser (2005) as data collection, note
taking, coding, sorting and writing in mostly overlapping stages. In this study the researcher primarily used data collection, note taking and coding.

Figure 2. Grounded Theory Methodology.

Qualitative research using the grounded theory model includes a series of specific steps. When these steps are carried out carefully and methodically, using what Strauss and Corbin (1998) call theoretical sensitivity, a good theory usually emerges. Theoretical sensitivity can be defined as the ability to perceive variables and relationships in the data and is affected by the researcher’s knowledge of the literature and professional experience.

Participants

Quantitative data was retrieved from a state department of education website. Each data point represented a single school district. Most of this data describes technology hardware that resides in public schools across the state. Teacher demographic data was included that describes the percentage of teachers who have various certification
levels in each school district. Standardized mathematics scores of 8th grade students were used that reflect average math scores from each school district. No individual teachers or students were selected or identified for the quantitative component of this research.

Twelve participants were chosen for the qualitative component of this study, all from the state selected for this study. The number of subjects to use in qualitative research varies based on many factors. It has been argued that the number of subjects to include in qualitative research is a matter of judgment (Sandelowski, 1995). Other qualitative researchers have suggested guidelines to help less experienced researchers make decisions about sample size. For grounded theory, suggestions range from 6 – 20 (Creswell, 2002). As a general guideline, sample size in qualitative research should not be so small that data saturation is not achieved, or too large to hinder a deep, investigative inquiry (Sandelowski, 1995).

The subjects in this study were 8th grade mathematics teachers who teach students with learning disabilities. Of the 12 teachers, three were selected from each region of the state: North, North Central, South Central, and South. Of the three teachers within each region, one was selected from an urban school, one from a suburban school, and one from a rural school. This study employed a purposeful, criterion sampling method (Creswell & Plano Clark, 2007; Weiss 1994). This method was used because teachers in the study were required to meet certain criterion that could not be assumed with random sampling. According to Patton (2001), criterion sampling is very strong in quality assurance. The researcher requested participation from subjects via phone calls.
Procedures

*The Quantitative Component*

The quantitative data collected for this study was used to look for relationships between technology, teachers, and student achievement. The quantitative variables were as follows:

- **IV₁** – Students per computer
- **IV₂** - Level of internet access
- **IV₃** – Teacher level of certification
- **DV** - 8th grade standardized mathematics scores.

The data was collected by the researcher from the following publicly available sources:

1. The standardized mathematics scores were retrieved from a publicly available source on the state’s department of education web site. These scores represent the percentage of all 8th grade students in each district with learning disabilities who met or exceeded the mathematics standards in 2010.

2. The data for students per computer and internet access per student came from a publicly available source on the state’s department of education web site.

3. The certification level of teachers in each district came from a publicly available source on the state’s department of education web site.

This data was collected from the above sources and entered into an excel spreadsheet for later analysis by the researcher.
The Qualitative Component

A list of middle schools in the state selected for this study that meets the stated criteria was created by the researcher. From this list, twelve schools were identified across the state, three in each region, one representing an urban school, one suburban school, and one rural school. Teachers were contacted by phone and asked if they would participate in a phone interview. All teachers asked to participate were math teachers who have special education students in their classes. This included both special education and general education teachers. Teachers that agree were sent a letter of informed consent explaining the study and asking for their written consent (see Appendix B). The consent form explained who is conducting the study, the purpose of the study, what data was being collected, who will receive the data, how the participant’s identities will be protected, how to withdraw from the study, how to contact the researcher to ask questions, and how there is no risk to anyone who participates.

Seventy-five percent of the interviews were conducted on the phone at a time that was convenient for the subjects and took approximately 30 minutes each. Twenty-five percent of the interviews were conducted in person to ensure that some of the qualitative data was collected face-to-face. According to Creswell (2002), this is important because non-verbal cues and body language may allow the interviewer to extract more depth of meaning from the individual interviewee. The face to face interviews were conducted first, followed by the phone interviews. All three of these interviews were conducted in the southern region of the state.

All subjects in the study were asked four questions from the interview questionnaire (see Appendix C), with follow up questions based on responses from the
subjects. This study used a semi-structured, one-on-one format to allow the researcher the option to fully explore any relevant issues that arose during the interview. Four questions were chosen based on Creswell’s (2009) recommendations of no more than five questions to keep the subject focused and allow the interviewer and interviewee to fully explore the topics. Interviews were recorded with a digital voice recorder and the researcher took key-word notes during the interviews that were converted to themes after the interviews were completed. These notes were later compared to the transcribed interviews when analyzing the data. This ongoing analysis was continued throughout the interviewing phase to document and organize major categories in the data.

The qualitative interview questions in this study were based on a review of qualitative questionnaires from various research studies on educational technology and from a review of the literature that yielded several significant topics that can be explored. According to Creswell (1998), the central question of the qualitative interview should be as broad as possible, and then followed by several sub-category questions designed to extract as much information as possible from the subjects. The central question in this study involved educational technology and how it affects student achievement, specifically students with learning disabilities. The central question drove the selection of the interview question categories. These were educational technology and math achievement of students with learning disabilities; implementing technology in the classroom, learning theories and attitudes; teacher’s technology skill level; and financial issues. Each of these categories had only one question, with the option of follow up questions based on responses.
The interview questions were created to facilitate an open and frank discussion of the central question. Care was taken to word the questions in a way that would not lead the interviewee to a particular outcome. The purpose of this type of qualitative interview is to allow the ideas and themes to emerge from the data collected from the various subjects, not to seek a particular outcome or attempt to prove a theory (Denzin & Lincoln, 2008; Patton, 2001).

**Ethical Standards**

All interviews were recorded with the subject’s consent. Each subject was assigned a number that matched their recording. No names were used that could identify the subjects in the study, their school or their school district. All subjects were assured confidentiality. Only the researcher knows the names of the subjects. All information associated with this study that can identify subjects was locked in an office and protected, then destroyed once the study was completed.

This research was reviewed by The University of Southern Mississippi’s Human Subject Institutional Review Board (IRB) before the study began. This research study easily met all ethical guidelines because all participation was voluntary, all subjects were adults, subjects could stop at any time, the possibility of harm to subjects was minimal, and no personal data from any subject was shared.

All communication with subjects was honest and non-deceptive and there was no hidden procedures employed in the study. None of the subjects know any of the other subjects that participated in the study.
Limitations

As with all research models, there are limitations when using the concurrent mixed methods triangulation design. When using this model, challenges can arise from using data that is collected in such different forms. One possibility is that the qualitative data set may introduce a bias that confounds the quantitative data. This may lead to unequal evidence in the final results of the study (Creswell & Plano Clark, 2007).

Data Analysis

Quantitative Data Analysis

The quantitative data collected during this study was analyzed using multiple regression analysis. This statistical model was chosen because this research is concerned with relationships between three independent (predictor) variables and a dependent (criterion) variable. Multiple regression is a powerful tool for this type of correlational research (Kutner, Nachtsheim & Neter, 2004). In the field of educational research, multiple regression analysis is a popular and very widely used statistical model (Weisberg, 2005). Through the use of multiple regression, researchers can ask: what is the best predictor of a certain phenomena? Multiple regressions is, however, not deigned to prove causal connections between variables, but to ascertain possible relationships that may exist (Kutner, Nachtsheim & Neter, 2004).

After the data was downloaded from publically available sources, it was organized into an Excel spread sheet in logical rows and columns. The data was then imported into SPSS and the regression analysis was conducted. Descriptive statistics and frequencies were run first on all variables in the model. The mean values of the interval variables were used for centering purposes, and frequency data was used to determine
which categorical values remained in the constant after recoding. If any missing values are noted in the data, they will be identified as well as any other potential problems in the data.

Before running the regression analysis with SPSS, the interval variables was centered. This included students per computer, level of internet access, and 8th grade math scores. The categorical independent variable, teacher certification level, was re-coded.

Qualitative Data Analysis

The basic idea of grounded theory analysis is to use the transcripts and notes from qualitative interviews to discover and label variables, which in this case are major categories and concepts (Strauss & Corbin, 1998). This is accomplished through the process of coding the data in three distinct, but overlapping stages: open coding, axial coding and selective coding. The analysis of the qualitative data gathered in this research study followed this procedure.

With grounded theory research, some data analysis occurs during data collection, as described earlier, and does not require the researcher to complete all qualitative interviews. Some of the data analysis procedures occurred during interviews with subjects through key-word note taking and comparing themes as they emerge. After interviews were completed and the data transcribed, the process of data coding began.

In open coding, each discrete concept is identified and given a name (Creswell, 2002). As the interviews progress, these coded concepts are compared and categorized. Axial coding of the data was also performed. In axial coding, the categories and themes are related to each other through inductive and deductive processes. Categories were also
related to sub-categories. The relationships between themes that are emerging are
explained and linked during the axial phase of coding (Strauss & Corbin, 1998). The final
coding stage of the grounded theory process that was implemented is selective coding.
Selective coding is the process where all categories of the data are organized around the
central theme or category. This central category was the core phenomena of this study.

During the data collection processes, emerging categories and sub-categories were
analyzed to eliminate invalid categories during the process. Ongoing analysis of the data
during interviews was conducted to determine when a category reached saturation.
According to Strauss and Corbin (1998), data should be collected up to the point where
no new or unique data appears that is related to an established category. In contrast to the
quantitative component of this research study where data is collected then analyzed,
qualitative research requires analysis of the data throughout the study.

When coding was complete the results were taken to a coding review panel made
up of mathematics teachers who have taught students with learning disabilities, and who
use various levels of instructional technology. After agreement was reached on the
appropriateness of the categories of the coded data, results were ready to be reported.
CHAPTER IV
RESULTS

This evaluation of the research results will begin with a review of the purpose of the study and the research questions. In this concurrent triangulation mixed-method study, each qualitative and quantitative research question was analyzed individually and concurrently. These individual results were then merged and interpreted. To accomplish this goal, a concurrent triangulation mixed-method research model was used. The purpose of this study was to examine the relationships between instructional technology and mathematics achievement of students with learning disabilities. This chapter concludes with a summary of the research findings.

Data collection for the quantitative portion of the study was gathered from public sources and represented 67 school districts in the state selected for this study. A regression analysis was used to analyze the data and answer the quantitative research question:

1. Which independent factors (students per computer, level of internet access per student, and teacher’s certification level) can help predict 8th grade standardized mathematics scores of students with learning disabilities?

Data collection for the quantitative portion of the study was gathered from interviews of teachers from across the state selected for this study. The purpose of the qualitative interviews was to answer the following research questions:

2. Are 8th grade math teachers integrating appropriate technology into instruction?

3. Is the use of instructional technology by 8th grade math teachers improving mathematics achievement of students with learning disabilities?
4. Is the skill level of 8th grade math teachers sufficient to utilize technology for student engagement?

5. Are sufficient technology resources available for teachers to use during mathematics instruction?

Results of the Quantitative Study

Data were gathered for the quantitative portion of the study from publically available data located on the state department of education’s web site of the state selected for this study. To answer research question 5, data from 67 school districts (n = 67) were compiled and sorted by three independent variables: student per computer, internet access per student, and teacher certification level (percent of teachers in the district with advanced certifications) The dependent variable for this study was 8th grade standardized mathematics scores of students with learning disabilities. These scores represent the percentage of students with learning disabilities in each district that met or exceed the minimum passing score. The data was examined using descriptive statistics and multiple regression analysis. The following is a detailed summary of the results of this data analysis where each research question is addressed independently.

Research Question 1

To answer research question 1, the aforementioned data from state sources was used in a regression analysis to look for correlations between the independent and dependent variables. Descriptive statistics (see Table 1) were used to look for any problems in the data, such as variables that were highly collinear.
Table 1

**Descriptive Statistics**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>8thGradeScores</td>
<td>30.36</td>
<td>13.76</td>
<td>67</td>
</tr>
<tr>
<td>StudentPerComputer</td>
<td>3.4</td>
<td>.85</td>
<td>67</td>
</tr>
<tr>
<td>NetAccessPerStd</td>
<td>3.5</td>
<td>.86</td>
<td>67</td>
</tr>
<tr>
<td>TeacherWithAdvCert</td>
<td>58.57</td>
<td>6.65</td>
<td>67</td>
</tr>
</tbody>
</table>

The regression analysis was run (see Table 2) using all independent variables originally intended for this study. However, two variables, student per computer and internet access per student were highly collinear.

Table 2

**Correlations**

<table>
<thead>
<tr>
<th></th>
<th>8thGradeScores</th>
<th>Student Per Computer</th>
<th>Net Access Per Std</th>
<th>Teacher With Adv Cert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8thGradeScores</td>
<td>1.0</td>
<td>.091</td>
<td>.093</td>
<td>.296</td>
</tr>
<tr>
<td>StudentPerComputer</td>
<td>.091</td>
<td>1.0</td>
<td>.999</td>
<td>.108</td>
</tr>
<tr>
<td>NetAccessPerStd</td>
<td>.093</td>
<td>.999</td>
<td>1.0</td>
<td>.108</td>
</tr>
<tr>
<td>TeacherWithAdvCert</td>
<td>.296</td>
<td>.108</td>
<td>.108</td>
<td>1.0</td>
</tr>
</tbody>
</table>

| Sig. (1-tailed)         |                |                      |                   |                       |
| 8thGradeScores          |               | .231                 | .227              | .008                  |
| StudentPerComputer      | .231           | 1.0                  | .000              | .192                  |
| NetAccessPerStd         | .227           | .000                 | 1.0               | .208                  |
Table 2 (continued).

<table>
<thead>
<tr>
<th></th>
<th>8th Grade Scores</th>
<th>Student Per Computer</th>
<th>Net Access Per Std</th>
<th>Teacher With Adv Cert</th>
</tr>
</thead>
<tbody>
<tr>
<td>TeacherWithAdvCert</td>
<td>.008</td>
<td>.192</td>
<td>.208</td>
<td>-</td>
</tr>
</tbody>
</table>

*p < .05

With all variables included in the model, the regression analysis was used to test if student per computer, internet access per student and teacher’s level of certification significantly predicted 8th grade mathematics scores of students with learning disabilities. The results of the regression analysis (See Table 3) indicated the three predictors explained 9.7% of the variance ($R^2 = .097$) and the overall model was not significant ($F(3,67) = 2.248, p > .05$).

Table 3

*Coefficients of First Analysis*

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std Error</td>
<td>Beta</td>
</tr>
<tr>
<td>Constant</td>
<td>-8.59</td>
<td>15.53</td>
<td>-</td>
</tr>
<tr>
<td>StudentPer Computer</td>
<td>-22.82</td>
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<td>-1.41</td>
</tr>
<tr>
<td>NetAccess PerStd</td>
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</tr>
<tr>
<td>TeacherWithAdvCert</td>
<td>58.57</td>
<td>.251</td>
<td>.299</td>
</tr>
</tbody>
</table>

*p < .05

In this model, it was found that teachers certification level significantly predicted 8th grade standardized mathematics scores (Beta = .299, p < .05), but student per computer
(Beta= -1.41, p>.05) and internet access per student (Beta= 1.47, p>.05) did not significantly predict 8th grade standardized mathematics scores.

Because two of the independent variables in the model were highly collinear (students per computer and internet access per student) one was chosen to be removed from the model and the analysis was run again (see Table 4). The regression analysis was conducted this time using two independent variables: internet access per student and teacher’s level of certification. With two variables included in the model, the regression analysis was used to test if internet access per student and teacher’s level of certification significantly predicted 8th grade mathematics scores of students with learning disabilities. The results of the regression analysis indicated the two predictors explained 9.2% of the variance (R²=.092) and the overall model was significant (F(2,67)=3.224, p<.05).

Table 4

*Coefficients of Second Analysis*

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std Error</td>
<td>Beta</td>
</tr>
<tr>
<td>Constant</td>
<td>-8.27</td>
<td>15.43</td>
<td>-</td>
</tr>
<tr>
<td>NetAccess PerStd</td>
<td>1.02</td>
<td>1.91</td>
<td>.064</td>
</tr>
<tr>
<td>TeacherWith AdvCert</td>
<td>.599</td>
<td>.248</td>
<td>.289</td>
</tr>
</tbody>
</table>

*p< .05*

It was found that teachers certification level significantly predicted 8th grade standardized mathematics scores (Beta= .289, p<.05). In this model, internet access per student (Beta= .064, p>.05) did not significantly predict 8th grade standardized
mathematics scores. For example, in the school district with the highest ratio of students to computers (5.5 students to each computer) 34.4% of the students with learning disabilities met or exceeded the mathematics standards on the state standardized test. In the district with the lowest ratio of students to computers (1.9 students to each computer) only 30.8% of the students with learning disabilities met or exceeded the mathematics standards on the state standardized test.

Results of the Qualitative Study

To answer research questions #2, #3, #4 and #5, participants were selected from across the state for interviews. Twelve participants agreed to be interviewed for this study. There were three participants from each region of the state (n = 12). The regions were defined as region 1 (South); region 2 (South Central); region 3 (North Central); region 4 (North). In each region there were three participants, one from an urban school, one from a suburban school and one from a rural school. This sampling was designed to get input from a diverse group of teachers. Many teachers who were chosen and contacted would not consent to recorded interviews, so others were contacted until a willing subject could be found in each area of the state. Table 5 provides information about each participant interviewed in this study.

Table 5

<table>
<thead>
<tr>
<th>Participant #</th>
<th>Years Teaching</th>
<th>Certification</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>3</td>
<td>B</td>
<td>South/Suburban</td>
</tr>
<tr>
<td>1.2</td>
<td>7</td>
<td>B</td>
<td>South/Rural</td>
</tr>
<tr>
<td>1.3</td>
<td>23</td>
<td>A</td>
<td>South/Urban</td>
</tr>
<tr>
<td>2.1</td>
<td>5</td>
<td>A</td>
<td>SouthCent / Suburban</td>
</tr>
</tbody>
</table>
Table 5 (continued).

<table>
<thead>
<tr>
<th>Participant #</th>
<th>Years Teaching</th>
<th>Certification</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2</td>
<td>8</td>
<td>AA</td>
<td>SouthCent/Rural</td>
</tr>
<tr>
<td>2.3</td>
<td>18</td>
<td>A</td>
<td>SouthCent /Urban</td>
</tr>
<tr>
<td>3.1</td>
<td>7mos</td>
<td>B</td>
<td>NorthCent / Suburban</td>
</tr>
<tr>
<td>3.2</td>
<td>5</td>
<td>A</td>
<td>NorthCent/Rural</td>
</tr>
<tr>
<td>3.3</td>
<td>5</td>
<td>A</td>
<td>NorthCent / Urban</td>
</tr>
<tr>
<td>4.1</td>
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<td>A</td>
<td>North / Suburban</td>
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<tr>
<td>4.2</td>
<td>11</td>
<td>A</td>
<td>North / Rural</td>
</tr>
<tr>
<td>4.3</td>
<td>8</td>
<td>A</td>
<td>North / Urban</td>
</tr>
</tbody>
</table>

Teaching experience ranged from seven months to 23 years. All teachers were involved in teaching mathematics to students with learning disabilities. Eight of the teachers were general education mathematics teachers who have students with learning disabilities included in their classrooms and four were special education math teachers. Teachers with advanced certification (A or AA certification) had an average of 10.6 years of teaching experience and a medium of eight years of teaching experience. Teachers interviewed who did not have advanced certification (B level) had an average of 3.5 years of teaching experience and a medium of three years of teaching experience.

Responses to Interview Questions

In the following section each participant’s responses to the interview questions were transcribed in their entirety. Very little editing was necessary to remove identifying information and to clarify statements or remove redundant or repeated statements by the same participant.
How do you use technology in the classroom when teaching students with learning disabilities?

(1.1) I try to use technology to reach student’s individual learning styles. I use a lot of charts, graphs, video clips and images to cover visual learners. I allow students to use computers so they can get hands-on experience; some students need that more than others. I use software on the school laptops to teach lessons. I have a program that adapts to students learning speed. When they get a problem wrong, the program gives them an easier or equally difficult problem. When they are working problems correctly, the program challenges them by raising the difficulty level. I use a LCD projector and a SMART Board for teaching almost every day. With the SMART Board I’m able to project problems on the board and show step by step how they are solved. I can also have students come to the board and work out problems. Students also collaborate on problems using the SMART Board. On the SMART Board they can interact with the screen by using the SMART Board pen to write and even move object around. Most of my students like doing that.

(1.2) Recently I got a SMART Board, which is really great for teaching students with learning disabilities, at least the students I’ve had. They tend to like more hands on stuff and they really enjoy coming up to the board and using the games and the interactive stuff and that has helped out a lot with their learning. We have a computer lab and we get to use it sometimes, but that is rare because it’s a really small computer lab and you have to schedule it and get there at the right time. My students have used computers, but I use the SMART Board more now than the
computer lab. I also have an Elmo in my room that I’ve had for 3 years. Students have enjoyed that because they can show their work to the class by coming up to my desk and putting their paper under the Elmo.

(1.3) Visually, through the LCD projector. I demonstrate using my computer which projects through the LCD projector to the screen and they follow along with me as I work problems. And then I would give them extra help personally if they falter with learning the objectives. My students with learning disabilities are required to meet the state objectives like all other students. We use computers every day, IBM Computers that have Microsoft software installed. I have a computer for every student.

(2.1) We have finally been able to integrate the SMART Board into the classroom in the last year. Other than that I try to get my hands on graphing calculators and things that I can put in the hands of students. Really, I wish we could ease up the system policy on the use of Ipods and stuff like that because they all have those. A student may not go spend one hundred dollars on a graphing calculator but they will bring an Iphone or Ipod to class. From that sense, I am limited in what I can put in the students’ hands but we do get a good deal of work on the SMART Board in this class. We have not used the computer lab yet. I’m looking at a few projects this semester that we can do using a computer lab. I may try to check out the rolling lab, I have not looked into that yet, but I know we have one that is available.

(2.2) Of the students I teach, about half have learning disabilities and are getting support from the special education department here at the school. Other than the
few accommodations they are receiving, I treat them about the same as the other
students. They get extra time on tests and they get to go to the resource room and
take tests and get it read to them or whatever help they get in there. Of course,
none of that has anything to do with technology, so I will address that. The way I
use technology in the classroom, as least with my nicest device, is to teach math
using a document camera that is connected to a LCD projector. When I’m
working out math problems I can write on a piece of paper while facing the
students and my work is projected onto the screen. Sometimes I use a small dry
eraser board to write on and that is projected onto the screen. This works really
well because I can do this while facing the students, and I’m not standing in the
way of what I’m writing on the board like I was before I got this equipment. I
think the students like it also. I also have the LCD projector connected to a laptop
so I can use PowerPoint in a lesson. I can also show a video from my computer
and project it on the screen. I also have a computer in my classroom that I use to
create tests and worksheets. I have software on the computer that I use to do this.
Its real fast, all I have to do is click on the state objectives that we are working on
that week and the computer creates a worksheet or test for me. It can create
several different versions so that each student does not have the same thing. It
makes my job a lot easier.

(2.3) Usually they are mixed in with a regular class so I use it like I would with a
regular student. I do PowerPoint, which I think is helpful because it puts the
information up on the big screen, and it’s bright and colorful where they can see
it. In that regard I think the technology is helpful. I use my SMART Board for
PowerPoint and for showing step by step examples. Students can come up to the SMART Board and work problems for the class to see. Some students really like doing that because it seems to really spark their interest and keep them focused. There are still a lot of things I don’t do yet with the SMART Board because I don’t know how. I’m waiting on additional training. We do not ever use the computer lab. I developed a few lessons that we could do in the computer lab, but they just took the computer lab away and I don’t have that available anymore, so I haven’t done anything with the computer lab this year. We did have a geometry sketch pad program and I created a couple of lesson using that program, but now we have no computer lab access so we don’t use that now. I think we have a new rolling lab that had a set of laptops for the class, but I’m not sure where that is located. I plan to check into that soon.

(3.1) I have a SMART Board in my class and I use that to teach every day. With the SMART Board, students are able to see what I’m doing and that helps a lot. Also, I find that students with learning disabilities like the hands on aspects of learning, and the SMART Board helps with that. For example, when we are learning about probability, they have dice on the SMART Board that they can roll and a coin they can flip by touching the screen. This helps them grasp the concept of how ‘a one out of six chance of landing on a two’ works. It really helps then connect the abstract to the concrete. Also, I have found that with all students it is easier for them to understand what’s going on when it’s not just me up there talking, so I use videos from other sites and I can even use captions for students who are ESL or for students who have hearing loss.
(3.2) We bought SMART technology for the classrooms that allow us to work interactivity with students, and we also have the ability to take students to the computer labs. In the computer lab we have math software that students use to do assignments and take tests. In the next week, students in my class are going to be getting their own laptops.

(3.3) One of the things that I do, which is old school, is use an overhead projector to blow up text and images for kids that have visions problems. Another thing I do is use audio when teaching, such as accompanying music in the background that seems to hold their attention and I will actually use a narrative on the computer so they can hear someone speaking on a certain topic. That way, they don’t have to listen to my voice all the time, and I think they appreciate that. I use the computer lab that is available here at school. I have been put on a list to get a SMART Board, but I don’t have one yet and I don’t know when I’m getting one.

(4.1) I use the old standby, an overhead projector. I use that for most lessons. My students have laptops and we use them to do lessons and take tests. We have software for the kind of math we do in this class. I’m going to training soon for SMART Board because I’m supposed to be getting one soon.

(4.2) I have a few students in my classes that have learning disabilities and they get the same type of instruction that all students get. Sometimes I take them to the computer lab so they can look up things to complete assignments. You can see on my board that I have recommended web sites that they can go to. One of those web sites has a live tutor there. I also have a SMART Board and I still have an overhead projector, which used to be new technology but is old now. I have my
own computer that the students do not use, but I use it to create worksheets and look up things on the internet to use in class, so it’s used indirectly by students. Another technology I use is the TV, which is really outdated now. I use it for videos and other instructional materials that are on DVD.

(4.3) In one of my math classes, we use computers and a web based program called NovaNet. The computer class is only for students who are remediating in math and have failed the regular class. All the assignments and tests are on the computer, everything they need for the class is on the NovaNet web site. I have several special education students in that class and they are doing well using this system. In my other classes I use an overhead projector for lessons, but I don’t use very much technology in those classes. In the NovaNet math class, every student has their own computer, so it’s a technology intensive class.

In regards to students with learning disabilities, is using instructional technology improving student achievement and motivation?

(1.1) That’s really hard for me to answer. I would think so because I’m a very pro technology person. My gut feeling on that is that if I appeal to the students’ individual learning styles, then I will be able to teach the concepts with or without technology. I think that is the most important thing. I think if I have a new technology, like a SMART Board, it does seem to get their attention and that helps them to learn more if you have their attention. These kinds of things grab their attention for a while, but I predict that after we have SMART Boards in every classroom for a while the kids will get use to it and not pay as much attention any more. It’s like a long time ago when they first used a TV in a
classroom. It was a big deal for a while but not anymore. It’s not that TV’s are not useful, they are, but they are not a big deal to teachers or students now. It’s just another video. I assume that eventually we will say, oh, it’s just another SMART Board lesson.

(1.2) Yes I do, I think it is. I think that if it were taken away it would be detrimental for some of my students because the technology is the only way I get their attention when they come in. They are really more active and they participate more in the lesson if they can use technology than if they are just sitting there writing notes on a piece of paper, especially the ones who are lower level and have difficulty keeping up with notes and the pace of class.

(1.3) Anytime they are in a classroom with lots of technology bombarding them with every form of multi-media, then I think they probably are increasing their learning. I think they are able to transfer their learning from one type of problem to another because of the software we use that is supposed to help with that skill. Real-time feedback helps students know what they are doing right and wrong and I think that helps a lot. A single teacher with 25 students cannot give that much instant feedback like the software can. But then again, do I really think this is about the technology or the curriculum? I don’t know. Many students are motivated by the use of technology. Some students work harder because they are interested in computers and want to do their work using a computer.

(2.1) What interaction I’ve been able to see, I definitely think it does. You have so many different types of learners and technology gives them a whole new way to interact with the lesson. Its very hands on, which I think a lot of students respond
to, and definitely students with learning disabilities. I think it’s a lot more rewarding for them when using technology, and I think, from my experience, that it seems to sink in a little better. So yes, I have seen an improved result from using any type of technology, or any form of manipulatives for that matter, with students with learning disabilities.

(2.2) I think that sometimes it helps students. I would not say that it directly improves student achievement, the way you put it. But I think that students like it, they like looking at the work on the projector because it’s easier sometimes for them to see than me writing it on the board. The software I use to create classroom materials, worksheets and tests, saves me a lot of time. I used to do this by cutting and pasting and running around from book to book pulling materials together. Now it only takes a second. That saves time and frees me up to spend more time teaching. If I’m spending more time teaching, then I think students are learning more and achievement goes up. This is an indirect way technology is helping them achieve more. I think that overall, technology is helping teachers be more efficient and that helps students. I do not think that technology by itself helps anyone.

(2.3) I think so. Students are so computer game and TV screen oriented. They are so use to looking at screens and lights, so when they come to school and are only looking at the teacher they get board quick. I don’t think that is good, but it seems to be what’s happening. We should not have to entertain them and struggle to keep their attention, but we do and the things we use to do that seem to help.
(3.1) I think it’s a case by case basic. Some students that come in here are already so discouraged that no matter what I do or what I show them it feels like they have a wall because they have been told they can’t do it. I try to integrate things in there that will engage their interest, and all the students’ interest, because they are different than when we were in school and different things attract them and get them motivated. So it’s up to the particulate students. There are times when the technology gets some students attention and times when it does not seem to work at all. Overall, I think that a lack of technology would have a negative impact on student achievement. The SMART Board gives me the ability to address different learning styles better. If you take that away, it will be harder to reach all the different types of learners.

(3.2) I believe that it motivates them because they don’t have the skills to do a lot of the grade level work that they should be doing at their age. Students with learning disabilities, like all students, have phones and MP3 players and know a lot about technology and are comfortable with it, so the technology we use in school does interest them and get their attention. But some students, when we go to the computer lab, do not have very good computer skills. We are a title 1 school in a rural area and many of the kids are from lower income families and they don’t have a computer at home to practice with, so they don’t have the skills necessary to actually do the activities we have planned. In addition to that, I also find that students in special education have a difficult time using the technology because they have to read instructions, and many of them have lower level reading skills. Because of this they will breeze through the material and not really
know what they are doing. For example, if we are working through math problems and they have to read the instructions that tell them to simplify or solve, they will sit there like they are reading it, and they will say they understand it, but they do not understand what they are reading. So I think that when teachers use technology to teach it is improving achievement, but when students are using the technology themselves to work alone, it is not improving their learning or increasing scores.

(3.3) I don’t know that it’s improving their achievement. I don’t have any indication that is happening. I think students will learn what we are teaching them, but the way we teach is always changing. If you go back in time when there was only pencil, paper, book and nothing else students were learning at that time, even students with special needs. In today’s world we are using computers more and more along with digital images and software. In the future all students will probably have a computer on their desk 100% of the time and they will still be learning and achieving. Whether they will be achieving more, or just achieving in a different way, I can’t say. A lot of kids are motivated by the use of technology, especially when it’s new. If it’s a new type of technology they have not seen before, then they are interested because it’s new and different. We use the computers in the computer lab. I hate to say it but computers are old hat now. The desktop is not something that’s new and innovative anymore, it’s been around too long. If you put them in front of the computer they are not as excited about using the computer to do school work as they are to look up cars or tennis shoes on the internet. I know that some kids, when introduced to the SMART Board for the
first time see it and are very interested in looking at it and touching it. But I think that many students have access to technology outside the school, like smart phones and game systems, that far surpasses what we use to teach them, so it’s hard to make what we have a motivational tool.

(4.1) I think it does help because it keeps the students interested. They want to be like their non-disables peers who are very technology oriented, so the more technology we bring to them the more they will be interested to use it. Whether or not it improves their achievement may depend on their learning disability. But it does give them a better connection to the social aspects of modern life. If students are paying more attention and are more interested, then I think it does improvement achievement.

(4.2) I co-taught a class where students use the internet to retake algebra and geometry and I think in that case student achievement was increased because of the technology we had available. We just got the SMART Boards in our math classes this school year, and I do not claim to be proficient on it, but what I’ve noticed is that is does get the attention of the students. I don’t know if it’s because it’s technology or because it’s new and different. But it does get their attention and engage students more and improve their participation. Some students even seem to have more courage to come to the board and work a problem since I started using the SMART Board.

(4.3) I think most of the students, including the special education students, are excelling in the computer based class, they get to work on their own pace and they all seem to really like it. I think they like it more than the regular math class and
achieve better because it’s one-on-one and they don’t have to worry what the kid beside them is doing because they are all on their own pace. They don’t know if they are ahead or behind. So I think that technology is helping these students succeed.

Describe your skill level with computers and related instructional technology?

(1.1) I would think my skills are above average for an educator. My career started with a technical degree working in a high tech company around computers and software everyday for about 20 years, so I would say that my skills are well above average.

(1.2) I think I’m pretty good with computers and technology. I’ve been working with them way over 10 years. With all of the workshops and professional development that we go to with the different types of programs, that helps out a lot.

(1.3) If I were ranked on a technology skill level, it would be high. There are others who have a lot more skills with technology in certain areas than me, certainly. But for what I do I would say my skill level is high compared to other teacher at this school.

(2.1) I would say that I’m probably still learning a lot. If it’s just me at home on my computer, I would say that I know a whole lot, but tying that into educational aspects is something I’m still trying to get the hang of. I’m trying to get more interactive presentations and that sort of thing. But I would say that I’m a tad bit above average level.
(2.2) I would not say that I’m an expert. I can do what I need to do, that is about all. Sometimes I need to know how to do something and we have a teacher here that is really good with technology so I go ask him. I’ve been using computers for a while, but not to do anything complicated. I’m able to find answer when I need them. I’ve had training from the school system and when I was in education classes at college.

(2.3) I would not call me advanced. I have a working knowledge of the computer and SMART Board. I would like to become more proficient, but time is the problem. It takes time to go to training and then practice and plan using something new, especially something high tech. You have to really know what you are doing before you can try it with the students. I’ve had some professional development classes, and I even went to a class on the SMART Board, but that was before I got the SMART Board, so I forgot most of what I learned because I could not apply it. I need to go to a SMART Board training class again. In the summer I try to go to technology workshops.

(3.1) I would say average. I’m not a computer guru that knows all about teaching with technology in all situations, but I know how to take advantage of my technology. I’m going to a workshop on Saturday, so if you ask me after that I may be able to tell you that I know a lot more.

(3.2) I would say I’m highly proficient. In my masters program I had to take computer classes and I’ve been to professional development classes on technology for different software programs and for SMART technology.
(3.3) I consider myself to be moderately skilled. I have a basic knowledge of all
the programs we use here. I know how to find things on the internet and I’ve
taken several online technology courses to get more familiar with the internet and
how to use it in the classroom. So at this point I would consider myself to be
moderately technology aware.

(4.1) My skill with computers is basic. I can do the basics with the Microsoft
software and I can search the internet. We have done technology training but I
have not been to very much of that kind of training. I plan to go to Smart
technology training soon.

(4.2) I did not grow up with technology like my daughter did, so I don’t think I
can attend enough computer classes to ever be on the same level as she is, so I
would say that my skill level is very modest, maybe it’s modest, it’s certainly not
great. I’ve had a pretty good bit of professional development training on
technology. The thing about that kind of training is that if you do not immediately
come back and start using the technology, you lose the knowledge. I went to
SMART Board training before I got the SMART Board and now that I’m using it
I have a lot of questions. I plan on attending something in March for SMART
Board training.

(4.3) I’m probably middle of the road, I would not say I’m super advanced or
anything like that. I’ve been taking Professional development courses to keep up
my administration certificate and a lot of that is technology related. I’m probably
a little better than average skill with technology.
What are your thoughts on the amount of resources spent on educational technology at your school?

(1.1) I have a unique perspective because for several years I was at a school where we had a really bad building and facilities situation. This was a really old run down school. I think that the central office, to make up for that, gave us any technology you can think of that a school would have. I really did like that. Here at my new school, the technology level is a lot lower, but the kids are still learning and their achievement level is higher than my last school. That, to me, brings into question how much technology really helps. I think there is a minimum level of technology, and we have that here. I think every teacher needs a laptop to prepare for a lesson; they need a computer and internet access for the ease and convenience of doing their work. But you can throw as many dollars as you want at it, but if you don’t have motivated students, if they don’t come to school motivated to learn and get an education, then you can’t unscrew the top of their heads and pour in the information any better with technology than you can with chalk and a chalk board. Students must value education and it must be valued at their home in order for them to come to school and treat it like something of value.

(1.2) Being in a small school with the amount of money we get, I would say a lot goes to technology. There are SMART Boards in almost every class now so I would say it’s really good. Technology is the world we live in now so I think we are doing pretty good at our school keeping up with technology.
I think the resources spent on the technology is probably adequate; the resources spent maintaining the technology is poor. Maintaining quality use is poor. Service and support are terrible. I think the resources are there. Of course you could pour more and more money into it, but does it do any good? I don’t know. In the right hands it might.

I feel like there is always room to spend more. There are so many classrooms here that do not have the technology they need. I don’t think I have all the technology I need for this room, yet mine is better equipped than others. There is so much more out there that we could use, but in a world where everything is being cut, you cannot go dumping a whole lot of money in one particular area. But I feel like it’s adequate and I know that it’s something we have been addressing in the last couple of years that I’ve been here trying to get every dollar of funding to furnish the classroom with everything they need. I know we are doing all that we can right now. I think everyone would like for it to be more, but we are getting by.

I think at our school we don’t have as much money for technology as, maybe, a school in a large city. We get money from the state and federal grants, and that money is spent on technology, but we could use more. A lot of teachers don’t have any of the nice equipment like I have. Some teachers have come in my room and seen the document camera and mentioned that they would like to have one for their room. There is a lot of technology in the school, but there is a lot missing, so we need to devote more resources to technology in our school.
(2.3) I think we should have more labs available. Even when we had a computer lab available, I would try to schedule the lab and there would be some teacher in there scheduled for the whole week and that makes it hard. I think we need a couple of labs and a couple of rolling labs so that each student in the school can get more computer time when needed. What we need is resource available when we need them and have the right amount for a class, not 30 computers for a class of 30 students and 6 of the computers don’t work. That has been a problem in the past.

(3.1) I think a lot of the technology money came from a grant, and we used some of that money to also buy a portable laptop lab, which is great. Now there are more computers so students do not have to wait so long to use a computer at school for research. I think we are getting better at spending on technology even in the short time I’ve been working at this school. But I do feel like there is some technology that is being bought that is not getting used, like the student clickers that sit and collect dust more days because we have not been trained on how to use them.

(3.2) I would say that it’s limited. We have two computer labs, but we do not have anyone to staff them so if you send a student to the computer lab for additional work to enrich their learning, there is no one to watch them or help them. You can take a class and manage them yourself, but because of the class sizes we do not have a computer for every student. But next week our 8th grade students will be getting a laptop each and that will improve things greatly, but only for 8th grade students. They will be able to take those computers home as well. That should
improve the 6th and 7th grade classes as well because they will not have not to share the computer labs with the 8th graders any longer. But we still don’t have enough technology or enough training in technology for teachers.

(3.3) I think it’s fantastic. I think that every time I turn around we are doing more and more at this school in technology. I see all these teachers getting new technology like SMART Boards and digital cameras and stuff to use in the classroom. Just because it has not made it to every classroom does not mean that we are not spending a lot of money right now on technology. In just the few years I’ve been at this school, I seen a big improvement in the level of technology spending. I don’t think you can ever spend too much money on technology because if we spend a million dollars today, in five years we will still need to spend more because our technology will be outdated. We will never spend enough to get ahead of the curve on technology, but I think we are doing good and spending enough to keep moving forward.

(4.1) In order to be a progressive school and keep up with society, I think we do spend a good bit on technology and the things that go with it, and I think that’s important. If we do not keep up with technology, then our students are learning obsolete skills, and they are not going to be successful or prepared. So I think we spend either enough, or maybe we should spend more, to try to get these kids prepared. Everything is technology oriented in his world, and these kids, especially with learning disabilities, are already one step behind everyone else. So if they don’t learn this stuff they will continue to fall behind. They need the academics and math skills, but they also need to know about technology to
survive, or to get a job because you have to use technology in almost any job. So I think we spend a good bit, but we should probably spend more.

(4.2) I don’t know exactly how much money that are spending or where it’s coming from. I don’t know where they got the SMART Board money from, but I think it’s great that the money was spent on this technology. I’m all for technology, but you can’t have total technology. I’m trying to tutor several students who are behind because they have missed classes and they need a teacher. I could put them on the computer or give him a video to watch, but the computer cannot understand their facial expressions and understand what they really comprehend. To a degree, technology is wonderful and in this day and age it’s very necessary because students are going out into a world where the economy is based on technology. They are going to have to be very technologically literate. The school is not spending too much money on technology, but I think I have what I need now based on what I’m able to do and what I’m trained to do, but in the future I’m sure there will be something else I can use in the classroom and we will need to continue spending on technology. So I think we are spending enough now and we need to keep spending if we can.

(4.3) Probably not enough. If we are going to go the route of technology in the education system then we need to spend more on technology and on training teachers. I don’t see how we have any other choice.

Central Themes

The following section will describe the themes that emerged during the qualitative interviews. In grounded theory, themes are allowed to present themselves during the
interview process. No hypothesis or central theme was decided on before the study began; these ideas and themes were allowed to emerge from the data and interviews naturally. Table 6 presents a list of the central themes that emerged from the interviews and the percentage of respondents who were in agreement with each theme. This is followed by an analysis of each theme.

Table 6

*Central Themes and Percentage of Respondents*

<table>
<thead>
<tr>
<th>Themes</th>
<th>Respondents in Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology is part of daily learning</td>
<td>92%</td>
</tr>
<tr>
<td>Technology is used for individualized instruction</td>
<td>58%</td>
</tr>
<tr>
<td>Modern technology motivates students</td>
<td>100%</td>
</tr>
<tr>
<td>Technology improves student achievement</td>
<td>75%</td>
</tr>
<tr>
<td>I have moderate to above average technology</td>
<td>75%</td>
</tr>
<tr>
<td>skills</td>
<td></td>
</tr>
<tr>
<td>Resources are adequate at my school</td>
<td>58%</td>
</tr>
<tr>
<td>More technology resources are needed</td>
<td>50%</td>
</tr>
<tr>
<td>I’m using SMART technology</td>
<td>58%</td>
</tr>
</tbody>
</table>

*Technology is Part of Daily Learning*

A large number of teachers interviewed reported using some form of modern technology in their daily classroom activities. Most of these teachers with a modern device have a SMART Board. Two reported having document cameras and three reported having a computer for each student in the class. One participant commented, “I have a
SMART Board in my class and I use that to teach every day. With the SMART Board, students are able to see what I’m doing and that helps a lot” (Participant 3.1). Another participant (4.3) who has a computer for each student in the class stated, “In one of my math classes, we use computers and a web based program called NovaNet. The computer class is only for students who are remediating in math and have failed the regular class. All the assignments and tests are on the computer, everything they need for the class is on the NovaNet web site."

Teachers, who instruct with technology almost daily, seemed to agree on the benefits of having technology available on a regular basis. When made available to the teachers, this technology seems to be enthusiastically put to use.

I use a LCD projector and a SMART Board for teaching almost every day. With the SMART Board I’m able to project problems on the board and show step by step how they are solved. (Participant 1.1)

Technology is Used for Individualized Instruction

Another theme that emerged from the interviews was teachers using technology to individualize instruction. Several teachers were very adamant about this aspect of using technology.

I try to use technology to reach student’s individual learning styles. I use a lot of charts, graphs, video clips and images to cover visual learners. I allow students to use computers so they can get hands-on experience; some students need that more than others. I use software on the school laptops to teach lessons. I have a program that adapts to students learning speed. When they get a problem wrong, the program gives them an easier or equally difficult problem. When they are
working problems correctly, the program challenges them by raising the
difficulty level. (Participant 1.1)

Others alluded to the fact that individualized instruction was occurring based on
their explanation of the classroom activities.

Recently I got a SMART Board, which is really great for teaching students with
learning disabilities, at least the students I’ve had. They tend to like more hands
on stuff and they really enjoy coming up to the board and using the games and the
interactive stuff and that has helped out a lot with their learning. (Participant 1.2)

*Modern Technology Motivates Students*

The only theme to emerge with 100% support from the participants was that
modern technology motivates and captures the attention of students. It is important to
specify here that participants were making the point that only new technology truly grabs
student’s attention.

We just got the SMART Board s in our math classes this school year…what I’ve
noticed is that is does get the attention of the students. I don’t know if it’s because
it’s technology or because it’s new and different. But it does get their attention
and engage students more and improve their participation. Some students even
seem to have more courage to come to the board and work a problem since I
started using the SMART Board. (Participant 4.2)

The point was made more than once that older technology that has been around
for many years does not garner the same interest level of a new device like a SMART
Board.
I think if I have a new technology, like a SMART Board, which does seem to get their attention, and that helps them to learn more if you have their attention. These kinds of things grab their attention for a while, but I predict that after we have SMART Boards in every classroom for a while the kids will get used to it and not pay as much attention any more. It’s like a long time ago when they first used a TV in a classroom. It was a big deal for a while but not anymore. It’s not that TV’s are not useful, they are, but they are not a big deal to teachers or students now. It’s just another video. I assume that eventually we will say, oh, it’s just another SMART Board lesson. (Participant 1.1)

The personal computer was even classed as old technology and unable to excite student’s interest as it once did not that long ago.

I hate to say it but computers are old hat now. The desktop is not something that’s new and innovative anymore, it’s been around too long. If you put them in front of the computer they are not as excited about using the computer to do school work as they are to look up cars or tennis shoes on the internet. (Participant 3.3)

*Technology Improves Student Achievement*

A large majority (75%) of participants believe, from their experience as classroom teachers, that the use of instructional technology improves student achievement.

What interaction I’ve been able to see, I definitely think it does. You have so many different types of learners and technology gives them a whole new way to interact with the lesson. (Participant 2.1)

In order to fully express the point, one participant indicated what would happen if all modern instructional technology was taken away.
Overall, I think that a lack of technology would have a negative impact on student achievement. The SMART Board gives me the ability to address different learning styles better. If you take that away, it will be harder to reach all the different types of learners. (Participant 3.1)

*I Have Moderate to Above Average Technology Skills*

Most participants did not believe they have an advanced skill level with technology (83%). Although there was no rating scale used in the interviews, teachers were reluctant to describe their skill level as high.

I would say that I’m probably still learning a lot. If it’s just me at home on my computer, I would say that I know a whole lot, but tying that into educational aspects is something I’m still trying to get the hang of. (Participant 2.1)

Some pointed to the need for more professional development to supplement their current knowledge and allow them to better utilize the new technology in their classroom.

I’ve had some professional development classes, and I even went to a class on the SMART Board, but that was before I got the SMART Board, so I forgot most of what I learned because I could not apply it. I need to go to a SMART Board training class again. (Participant 2.3)

*Resources Are Adequate At My School*

Not surprisingly, most participants interviewed did not describe their technology resources as abundant, but adequate (58%).

Probably not enough. If we are going to go the route of technology in the education system then we need to spend more on technology and on training teachers. I don’t see how we have any other choice. (Participant 4.3)
Most teachers were satisfied with their level of technology resources, but stopped short of saying that an abundance of technology resources exist at their school.

I feel like there is always room to spend more. There are so many classrooms here that do not have the technology they need. I don’t think I have all the technology I need for this room, yet mine is better equipped than others. There is so much more out there that we could use, but in a world where everything is being cut, you cannot go dumping a whole lot of money in one particular area.

(Participant 2.2)

More Technology Resources are Needed

Half of the participants pointed to a need for more resources at their school. One teacher with abundant resources pointed to the fact that many others in the same school were doing without adequate technology resources for teaching.

A lot of teachers don’t have any of the nice equipment like I have. Some teachers have come in my room and seen the document camera and mentioned that they would like to have one for their room. There is a lot of technology in the school, but there is a lot missing, so we need to devote more resources to technology in our school. (Participant 2.1)

More than one teacher mentioned the fact that not enough computers are available for students to use on a regular bases because computer labs are overcrowded and difficult to schedule.

I think we should have more labs available. Even when we had a computer lab available, I would try to schedule the lab and there would be some teacher in there scheduled for the whole week and that makes it hard. I think we need a couple of
lads and a couple of rolling labs so that each student in the school can get more
computer time when needed. (Participant 2.3)

*I’m Using SMART Technology*

Many teachers reported having a SMART Board in their classroom and wanted to
discuss its benefits. For this reason, the use of a SMART Board is considered a major
theme that emerged from the interviews. SMART Boards are very modern, and
expensive, technology and many teachers in the state selected for this study had this
technology in their classrooms. These teachers believed this technology was allowing
them to motivate students, engage uninterested students, increase participation, teach to
different learning styles and offer real world simulations. One teacher stated, “On the
SMART Board they can interact with the screen by using the SMART Board pen to write
and even move objects around. Most of my students like doing that” (Participant 1.1).
Another made a point that demonstrates how the SMART Board, and other modern
instructional technology, may overshadow the personal computer in the classroom:

My students have used computers, but I use the SMART Board more now than
the computer lab. I also have an Elmo in my room that I’ve had for 3 years.
Students have enjoyed that because they can show their work to the class by
coming up to my desk and putting their paper under the Elmo. (Participant 1.2)
CHAPTER V
DISCUSSION

Introduction

This chapter begins with an overview of the study and how the various components of this mixed-method research were conducted. Findings from both data sources are reviewed and discussed and conclusions are offered based on the research questions asked by the study. The implications and limitations of this research are also discussed as well as future research opportunities in the area of instructional technology that were uncovered during the course of this study.

Summary of the Study

Computer-aided technology is a major factor in the classroom today (Ganesh & Middleton, 2006). Most schools have a wide range of technology for instruction, including computer labs with Internet access that can be utilized for instruction (Vale & Leder, 2004). A considerable number of studies that have been conducted to determine the benefits of using computer-based and Web-based instruction have indicated a positive relationship between using computer-based instruction and achievement and motivation (Cates, 2005; Connor, Moss & Grover, 2007; Deubel, 2001; Drickey, 2006; Hsieh & Lin, 2008; Stephens, & Konvalina, 1999). This body of literature continues to grow. Other studies have concluded that the use of instructional technology offers mixed results on student achievement (Martindale, Pearson, Curda, & Pilcher, 2005; Mouza, 2008). In either case, it is clear that teaching with technology will continue to be a part of education on all levels going forward. Utilizing this technology for effective instruction should be the goal of educational leaders.
Educators and researchers have argued that technology should be a key component for teaching mathematics to at-risk learners (Li & Edmonds, 2005). Many students find mathematics difficult and boring and this impedes their motivation to learn (Stephens & Konvalina, 1999). Since most young people today are comfortable using computers and the Internet, researchers argue that computer-assisted learning using instructional technology may increase student achievement (Baki & Guveli, 2008).

The use of instructional technology is on the rise in the state selected for this study. However, this researcher could not find published studies conducted to determine if instructional technology is improving student achievement in the aforementioned state. Therefore, the purpose of this concurrent triangulation mixed methods study was to investigate the relationships between the use of instructional technology and the mathematics achievement of students with learning disabilities. Five substantive research questions were posed by the researcher to explore this purpose. The following sections of this chapter will discuss the results from both the quantitative and qualitative components and offer an integrated summary of the results and discussion. As pointed out in the methodology section of this study, mixing results through discussions is an acceptable method of summarizing conclusions from quantitative and qualitative data (Creswell & Plano Clark, 2007).

As stated previously, the research questions that will be discussed in the following sections of this chapter as follows:

1. Which independent factors (students per computer, level of internet access per student, and teacher’s certification level) can help predict 8th grade standardized mathematics scores of students with learning disabilities?
2. Are 8th grade math teachers integrating appropriate technology into instruction?

3. Is the use of instructional technology by 8th grade math teachers improving mathematics achievement of students with learning disabilities?

4. Is the skill level of 8th grade math teachers sufficient to utilize technology for student engagement?

5. Are sufficient technology resources available for teachers to use during mathematics instruction?

Mixed-Method Findings

A discussion of the mixed method results will be presented in this section. It is important to note while all research questions were address with qualitative analysis methods to varying degrees, research question #1 was addressed primarily with quantitative analysis methods.

Research Question One

Research question #1 sought to use publically available data to link student achievement to the availability of instructional technology in the schools and the teachers’ level of certification, with the assumption that higher certification typically means more years of experience as a teacher. Data from sixty-seven school districts was collected and analyzed using multiple regression analysis.

The mere number of computers in schools is not an indication of how the technology is being applied for effective instruction. However, if more computers per student and more internet access per student can be linked to student achievement with empirical data, then it is a starting point for determining if simply more technology is the key to student success in mathematics. Two independent variables, students per computer
and internet access per student, were highly collinear. Therefore the IV student per computer was removed.

The results did not indicate that internet access per student (which was highly collinear with students per computer, the IV removed from the final results) was a predictor of standardized mathematics scores for 8th grade students with learning disabilities. To lower student to computer ratios, many schools have opted for 1 to 1 laptop programs, with some schools issuing a laptop to each student to take home. Studies have found that one-to-one student to computer ratios yielded excellent results (Dunleavy & Heinecke, 2007; Grimes & Warschauer, 2008; Penuel, 2006). Studies such as these have repeatedly found that increased access to computers increases student achievement and motivation.

The data in this study did not indicate that a lower student per computer ratio impacted standardized test scores. The district with the lowest student per computer ratio did not outperform the district with the highest student per computer ratio. This does not, however, indicate that lower ratios were not helpful in some other area, such as student motivation. According to the qualitative interviews conducted during this study, students are motivated by the use of technology, especially modern devices. These findings agree with some of the cited research in the literature review of this study on the subject of student motivation (Cates, 2005; Hazzan, 2002; Halat, 2008; Li, 2007).

According to the quantitative data, teacher’s certification level was a significant predictor of mathematics achievement for students with learning disabilities. Districts with a higher percentage of teachers who hold advanced certifications had higher standardized mathematics scores by students with learning disabilities. In this study it
was found that teachers with advanced certification had more years of teaching experience than teachers without advanced certification. This is significant because time of service has been found to affect teachers’ use of technology. A review of the literature by Russell, O’Dwyer, Bebell and Tao (2007) found that in 2003 new teachers with less than 6 years of service were not using technology for instruction as frequently as teachers who had more than six years experience. The same research was examined again in 2005. It was discovered that teachers with less than three years of teaching experience reported higher levels of comfort with technology, but lower levels of technology use during class time for instruction. Based on their own study of 2,864 teachers’ use of technology compared to time of service in 2007, Russell, O’Dwyer, Bebell and Tao reported that new teachers who are comfortable with a technology rich environment do not appear to use technology for instruction more than their counterparts with more than six years experience.

Research Question Two

According to the International Society for Technology in Education (ISTE, 2008), there are several critical factors that need to be considered when integrating technology into instruction. These include appropriate professional development, alignment of instruction with state curriculum standards, daily integration of technology, individualized feedback, student collaboration, and real world problem solving using technology. During the interviews, themes emerged that supported the implementation of these technology standards by the participants in this study. For example, 75% of the teachers interviewed reported average to above average technology skills. All of these teachers mentioned some form of professional developments that helped them acquire
these skills during their career. Was the professional development appropriate? Probably not for all teachers because some commented on the need for more professional development in order to effectively use the new technology they have been given for instruction. However, there is no doubt that the majority of these teachers are confident in their ability to effectively use technology for instruction.

Daily integration of technology was a theme supported by 92% of the participants. This is a surprisingly high number and indicates how the state selected for this study is aggressively moving toward more technology usage by teachers. Many of the teachers discussed their new technology devices, like SMART Boards, and how their school is allocating more resources to instructional technology.

Using technology for individualized instruction was a theme supported by 58% of the participants. How technology is used has become a more important question than the mere presence of technology resources in schools. For example there is abundant research on modern technology that only reports the difference in achievement of two groups, one with the new technology and one without (Marzano, 2009) However, this does not take into consideration how the devices are being used for instruction and if teachers are using effective practices as defined by ISTE. Other researchers have investigated the specific application of instructional technology (Samuelsson, 2007). This type of research is carried out to explore beyond technology merely being available to teachers. Intentionally using technology for individualized instruction and individualized feedback, as well as appealing to individual learning styles emerged as themes and sub-themes during the teacher interviews in this study. This emphasis on the individual student when teaching agrees with the literature presented in this study. According to
McCoog (2007), word processors can help teach writing and language skills (linguistic); computer programs can teach logic and critical thinking skills (logical-mathematical); Graphics intensive programs can develop visual skills (visual/spatial); there are programs that write and play music (musical); Computer learning games can help develop eye-hand coordination (body-kinesthetic); Students can work in groups using computers or students response systems (interpersonal); computers can help students work on personal skills while working alone. Many of these learning characteristics were discussed by the participants who supported the theme of individualized instruction and feedback.

Although not major themes, other ISTE critical factors for integrating technology into instruction discussed by participants were: alignment of instruction with state curriculum standards (Participant 2.2), student collaboration (Participant 1.1), and real world problem solving using technology (Participant 3.1). The ISTE critical factors seem to be in practice by teachers in the state selected for this study and therefore help establish that appropriate technology is being integrated into instruction.

Research Question Three

When considering the quantitative data in this study, more access to technology did not significantly affect the 8th grade math scores of students with learning disabilities. This may be explained by considering how this technology is used for effective instruction. According to Marzano (1998), effective instructional strategies can utilize technology to expose students to new knowledge, reinforce previous learning activities, and teach students to apply knowledge. Other research supports the use of technology coupled with proven instructional strategies. Technology and effective instructional strategies can be a powerful approach to improving student achievement (Marzano,
Pickering & Pollock, 2001). Based on the results of this dissertation, the availability of more computers does not guarantee success for students with learning disabilities.

There is no doubt, based on the qualitative data collection, that teachers in the state selected for this study believe that the use of instructional technology improves student achievement (75% supports) and is a factor in motivating students (100% supports). There is ample literature that supports this finding. For example, research supports the use of technology driven educational activities to improve students’ achievement scores, time on task, engagement and satisfaction (Cates, 2005; Connor, Moss & Grover, 2007; Deubel, 2001; Drickey, 2006; Hsieh & Lin, 2008; Stephens, & Konvalina, 1999). Although in some cases research results are mixed, some experimental research with technology-based instruction has shown that students in the experimental group outperform students in the control group (Frye & Dornisch, 2008; Funkhouser, 2003; Hakkarainen, 2003; Watson & Hempenstall, 2008). The argument, by these and other researchers, that the use of instructional technology increases student achievement (general population and students with learning disabilities) is accepted by virtually all state departments of education, the U.S. Department of Education (USDE, 2010) and other creditable organization such as the International Society for Technology in Education (ISTE, 2008). There are professional organizations that recommend the use of technology specifically when teaching mathematics, such as the National Council of Teachers of Mathematics (NCTM). Teachers interviewed in this study appear to agree.

There were, however, some teachers interviewed during this study who either do not accept that instructional technology is making a different in student achievement (17% supports), or cannot say for sure (8% supports). There is support for the argument
that the use of instructional technology does not affect student achievement (Grimes & Warschauer, 2008). Other research results pointed out in this dissertation were slightly positive, mixed or inconclusive (Martindale, Pearson, Curda, & Pilcher, 2005; Mouza, 2008). Nevertheless, as cited previously in this dissertation, the positive support for the hypothesis that technology improves achievement outweighs the negative.

Research Question Four

From the quantitative data presented in this study, it appears that having more computers per student does not impact student achievement as measured by standardized mathematics test scores. Therefore, it is likely that increases in student achievement may only be obtained through a combination of the right technology placed in the hands of the right teachers with sufficient technical skills and years of experience.

The quantitative data revealed that in districts where teachers have higher certification levels, which are typically teachers with more years of experience, the students with learning disabilities in those school districts tend to score higher on standardized mathematics exams. The qualitative data in this study revealed that teachers with advanced certification (A or AA certification) had an average of 10.6 years of teaching experience and a median of eight years of teaching experience. Teachers interviewed who did not have advanced certification (B level) had an average of 3.5 years of teaching experience and a median of three years of teaching experience. Does this mean that teachers with more years experience and high certification levels use more technology? That variable was not measured in this study. Nonetheless, when considering related research that compares teachers’ years of service and technology use, there is support for the argument that teachers with more years of experience implement more
technology into their instruction (Russell, O’Dwyer, Bebell & Tao, 2007). The findings from this dissertation were consistent with previous findings from research where teacher experience and technology use were correlated.

From the qualitative data emerged several themes and subthemes that help clarify how well teachers are prepared to implement appropriate technology into the classroom. The majority of participants (75%) in this study described their technology skills as moderate to above average. Most teachers were satisfied with their ability to use instructional technology, but regarded professional development an ongoing necessity.

As previously stated, teachers reported the type of technology implementation defined as appropriated by ISTE (2009) during the course of the interviews. Only one teacher reported having basic technology skills.

*Research Question Five*

The quantitative data gathered during this study did not help to answer research question #5 since the only information available about technology was the number of computers per students in each school district. This snapshot of computers in the schools and internet availability is not a complete picture of the technology available to teachers. Furthermore, a simple count of desktop or laptop computers is an inventory, in the opinions of some, of old technology and does represent the most modern and exciting technology available to teachers and students. The state selected for this study does not offer any public data on the specific types of modern technology, hardware or software, used in the various school districts other than computer units. Consequently, it is not possible to obtain an accurate picture of this information without a more through
collection of data. The qualitative interviews conducted during this dissertation served, in part, to collect data on specific modern technology currently in use across the state.

Just over half of the teachers interviewed in the qualitative portion of this study indicated that their school had adequate technology resources (58%). Half the teachers stated that more technology is needed. Only one teacher claimed to have abundant technology resources. There was not a single overarching theme to emerge as a result of research question #5, but a definite theme was the need to continue keeping current with modern technology through acquiring more resources. Not surprisingly, none of the teachers supported abandoning technology and returning to old style chalkboards. On the contrary, when discussing technology resources with teachers it was discovered that many teachers (58%) in the state selected for this study have interactive whiteboards, called by their brand name - SMART Board. Others without SMART Boards were expecting to receive one soon. The discussion of SMART Boards emerged as a major theme in the qualitative portion of this study.

SMART Board technology is highly regarded by the teachers who reported using it for mathematics instruction. It was reported to be especially useful for teaching students with learning disabilities. More importantly, the teachers using the SMART Board seemed to believe that it was helping to increase student achievement. There is research to support the effectiveness of this technology. For example, researchers have found that students and teachers like using the technology (Smith, Higgins, Wall & Miller, 2006) and that interactive whiteboards increase student engagement, motivation and achievement (Marzano, 2009). Smith, Higgins, Wall and Miller (2005) conducted a literature review on interactive whiteboards in educational settings and found the tone of
the literature to be overwhelming positive. Although all research on interactive whiteboards is not positive, much of the literature is supported by the findings in this dissertation. Based on the availability of technology, such as SMART Boards, and the number of teachers who reported having adequate technology, it appears that resources are available in the state selected for this study to implement effective instructional technology.

Conclusions

This study was designed to investigate the relationships between the use of instructional technology and the mathematics achievement of students with learning disabilities. This was accomplished using a mixed-method concurrent triangulation model that utilized quantitative and qualitative data. Regression analysis and grounded theory were used to analyze the data.

The results of this study were mixed. The regression analysis revealed that more computers per student and more access to the internet per student did not significantly affect student achievement in the 67 school districts selected for this study (Beta= .064, p>.05). During the interviews with teachers, however, a theme emerged that more technology is good and student achievement is increased when teachers have access to modern technology. For some teachers modern technology included desktop computers, for others it did not. Since only desktop computers and laptops were counted in the quantitative data, and no other forms of modern technology, this may account for the apparent discrepancy in results.

The quantitative data showed that mathematics scores are higher in school districts where teachers have higher levels of certification, and therefore more years of
experience (Beta= .289, p<.05). The qualitative data revealed that all teachers, regardless of years of experience, were implementing technology in their classrooms. The distinction between these teachers was how they viewed their own technology skill level. Therefore, according to quantitative data, the only independent factor that may predict mathematics achievement of students with learning disabilities was teacher level of certification. On the other hand, qualitative data suggested that technology is critical for the achievement of all students, including students with learning disabilities.

The qualitative results also indicated that teachers are implementing appropriate technology into instruction as defined by ISTE. The majority of these teachers feel they have the necessary skills and training to implement technology for effective instruction, and they have the resources to carry out the task. These teachers see their students improving as a result of their implementation of technology into their instructional activities. As can be expected, a small number of teachers were not convinced that using technology as part of instruction was helping students achieve. On the other hand, these teachers never once suggested that technology use should be decreased in the classroom.

All of the aforementioned findings of this study may be used to conclude that the appropriate application of technology should be the focus of school leaders and the research community. Simply raising the number of computers in schools may not be the best practice going forward. This may explain why increased mathematics scores of students with learning disabilities were connected to teacher certification levels.

The use of instructional technology has been studied extensively and a rich history of research exists. There are many variables, including human variables, which makes this research very challenging. This study was relevant because results
corresponded to current literature on instructional technology and student achievement. Positive aspects of using technology as part of classroom instruction could always be found in the research results cited; even when student achievement was not supported. Many of the current research studies cited in this dissertation produced mixed results, which seems to be encouraging modern research to focus on appropriate use of technology more than the presence of technology in the classroom. School leaders and instructional leaders should considering this when allocating instructional resources.

Limitations

Limitations of this study include the use of limited quantitative data, self-reported data, the participant selection process and number of subjects. As with all research models, there were limitations when using the concurrent mixed method triangulation design. During the use of this model, challenges arose from using data that was collected in such different forms. It is possible that the qualitative data set may include a bias that explains the conflicts with quantitative data. This may explain the mixed results in this study.

Since only the number of computers per student and internet access per student were represented in the quantitative data, and not all technology used in the various school districts, content validity could be affected. The state selected for this study did not have public data on modern technology such as SMART Boards, student response systems, and document cameras. The use of this data may have given more meaning to the final results of the study.

Self-reported data may have affected both content and construct validity in this study. Such as, the potential difference between how teachers discussed their technology
skill levels and the actual measurement of said levels. To the best of the investigator’s knowledge these validity problems were not severe. Nonetheless, care should be used when interpreting results.

It was not possible to randomly select the participants for the qualitative interviews during this study. Convenience sampling was use with care and participants were selected from across the state in varying demographic regions. The number of subjects that agreed to participate was less than the number that declined to participate. Because of this, the teachers who agreed to participate in this study may have been biased toward the subject matter.

As with all qualitative data using small numbers of participants, it is possible that generalizability and transferability may be limited when considering other states. However, the data should be highly relevant to the state selected for this study.

Implications for Policy and Practice

School leaders are faced with the challenging role of allocating resources to support classroom instruction. Technology is an expensive and limited resource that is currently in high demand by teachers. Research such as this study and others can help guide school districts in decision making when dealing with the issue of instructional technology.

As pointed out, limited quantitative data and a small sample of teachers posed limitations and challenges for this study. Nevertheless, important information was gleaned from this mixed method investigation that may help guide some educational leaders. Therefore, the following recommendations are offered for consideration:
School leaders should have knowledge of what constitutes the proper use of instructional technology. There needs to be an understanding that more is not always better, but correct implementation is the key to successful use of technology for instruction.

Teachers need regular professional development to insure that technology is being used to full potential. Teachers with lower certification levels and less time of service should be especially encouraged to increase their skills with implementing technology.

When teaching students with learning disabilities, instructional technology must be used to teach to individual learning styles and provide individualized feedback.

When teaching students with learning disabilities, instructional technology can be used to motivate students who are lacking confidence, especially in mathematics skills.

Technology should be use to allow students to collaborate on activities where possible rather than exclusively individual use.

Technology should be use to simulate real-world activities to help students with learning disabilities increase their ability to transfer skills.

Recommendations for Future Research

This dissertation made a broad investigation of technology and student achievement in the state selected for the study. Based on the findings, a closer look at specific techniques for implementing technology for instruction should be considered. For example, more internet access and computers per student did not impact student
achievement in this study, even though teachers claim to experience success when using these same technologies. The specific implementation of technology should be studied more closely using the guidelines set forth by the International Society for Technology in Education (ISTE). Research should be considered to investigate if schools and school districts are involved in the correct implementation and use of education technology based on the seven principles if ISTE. These principles are: appropriate professional development, alignment of instruction with state curriculum standards, daily integration of technology, individualized feedback, student collaboration, and real world problem solving using technology (ISTE 2009). The application of these principles can be researched in a variety of methods using quantitative and qualitative data. Studies should be conducted involving all seven principles at once or individually for a more focused investigation. This research must include how teachers are using technology to engage students with learning disabilities in meaningful instruction aimed at transfer of knowledge.

Since most teachers in this students report having access to technology, it may be necessary to investigate whether or not their self-described access to resources is connected to their professional development training. If teachers with more access to technology who are implementing technology correctly are doing so as a result of more professional development training, then this connection should be examined.

Research into SMART technology use in the state selected for this study should also be considered. SMART technology is obviously on the rise and considerable resources are being dedicated to equip all mathematics classrooms with this hardware and
software. Experimental research that compares classes with and without this technology should be conducted to explore the benefits to students with learning disabilities.
APPENDIX A

IRB APPROVAL

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board
115 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE
NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 21, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form.
- If approved, the maximum period of approval is limited to twelve months.

Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: 10111801
PROPOSED PROJECT DATES: 12/01/2010 to 02/28/2011
PROJECT TYPE: Dissertation
PRINCIPAL INVESTIGATORS: Kenneth G. McLeod
COLLEGE/DIVISION: College of Education & Psychology
DEPARTMENT: Educational Leadership
FUNDING AGENCY: N/A
HSPRC COMMITTEE ACTION: Expedited Review Approval
PERIOD OF APPROVAL: 12/06/2010 to 12/05/2011

Lawrence A. Hosman, Ph.D.
HSPRC Chair

12-07-2010
APPENDIX B
CONSENT TO PARTICIPATE

Hello, my name is Ken McLeod and I am a special education mathematics teacher at Baker High School in Mobile, Al. I am currently in the process of fulfilling requirements for a doctorate degree from the University of Southern Mississippi. To carry out my dissertation research project, I need to interview several middle school mathematics teachers in your state. I would greatly appreciate your help in this matter.

This research study is titled: A mixed method investigation of the relationships between instructional technology and mathematics achievement of students with learning disabilities.

Your school meets the criteria for this research study. If you consent to participate in this study I will call you at a time that is convenient and conduct the interview on the phone. If you school is in a reasonable distance from my location, I will come to your school and meet with you for a face-to-face interview. In either case, the interview will be approximately 20 to 30 minutes. If you request, I will send you a copy of the interview questions in advance.

Your participation in this study will not result in you or your school, or school district being identified in any way. The interview will be recorded, but all recordings will be destroyed after they have been transcribed and no names will be associated with the interview. Participation in this study is voluntary and you may end participation at any time during the course of the study without penalty, prejudice.

This project has been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research subject should be directed to the chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820

If you agree to participate, please sign the attached form and return to me.

Thank You
Ken McLeod
251-591-4369
To whom it may concern,

This letter serves to confirm that I am willing to participate in the study conducted by Ken McLeod entitled: A mixed method investigation of the relationships between instructional technology and mathematics achievement of students with learning disabilities.

I understand that my participation in this study is voluntary and I may end my participation at any time during the course of the study without penalty, prejudice.

NAME___________________________________

SIGNATURE_____________________________

DATE__________________________________
APPENDIX C

QUALITATIVE INTERVIEW QUESTIONS

Demographics

How long have you been teaching ________________
Urban, suburban or rural school ________________
Certification Level______________

Implementing technology in the classroom, learning theories and attitudes.

How do you use technology in the classroom when teaching students with learning disabilities?

Educational technology and student achievement

In regards to students with learning disabilities, is using instructional technology improving student achievement and motivation?

Teacher’s technology skill level

Describe your skill level with computers and related instructional technology?

Financial issues and resources

What are your thoughts on the amount of resources spent on educational technology at your school?
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