Impact of Technology Integration in Public Schools on Academic Performance of Texas School Children

by

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An Applied Research Project
(Political Science 5397)
Submitted to the Department of Political Science
Texas State University
In Partial Fulfillment for the Requirements for the Degree of
Masters of Public Administration

Spring 2008

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Abstract

Purpose: The purpose of this study is to examine the impact technology integration in public schools has on the academic performance of public school students. *Method:* Data for this study were obtained from the Texas Education Agency. The study uses data measuring the level of technology integration in over 6,654 Texas public school campuses as well as TAKS scores of 4th, 8th, and 11th graders in the subject areas of reading, math, and science. Four areas of technology integration are identified and examined for their possible impact on the academic performance of public school students. A multiple regression analysis was used to assess the impact of the four areas of technology integration on academic performance. *Results:* The results show that overall the integration of technology in the classroom impacts the academic performance of students in the subject areas reading, math, and science. *Conclusion:* This research study provides valuable information regarding the necessity of integrating technology into public schools. While this field of research is still in its infancy, this study conveys the impact technology has on academic performance and the importance of further research in examining its effects.

About the Author

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Chapter 1: Introduction

Introduction

The number of Americans who use technology to enhance their lives increases daily. Most Americans either own or have access to a computer. Technology dramatically shapes our society and is an integral part of the business, medical, media and entertainment fields. In the workforce, computer technology assists individuals in the completion of daily tasks as well as provides support for more complex job duties. Presentations use PowerPoint and video projectors. Individuals communicate through email and blackberry telephones. People bank, shop, and purchase groceries online. People even use technology to check the news and weather.

In the 21st century, technology is by far the most powerful means of communication. Information can be obtained rapidly, even instantaneously. Shields and Behrman (2000, 23) support the claim that computer technology is rapidly transforming our society. In today's technologically enhanced society, children are our computer generation. "They are growing up with technology all around them and from an early age have an understanding of how to use computers" (Shields and Behrman 2000). Despite such technological advancements in almost every aspect of our society, technology is only now being used to transform education.

Over the last decade, efforts to implement technology into the classroom have increased and schools have experienced a parallel increase in state and federal funding. Congress has allocated billions of dollars in funding through various programs for technology integration. By providing monetary support to those schools that integrate technology into the classroom and incorporate it into daily curricula, officials believe that students will be well equipped to survive in the 21st century. The focus of this research is the integration of technology in public schools and the impact that technology has on the academic performance of public school children.

Research Purpose

This research study will examine the test scores of public school students enrolled in 4th, 8th, and 11th grades, in the areas of reading, math, and science. The purpose of this research is to assess the impact of technology integration on the academic performance of public school children. Key factors effecting academic performance are socioeconomic status, ethnicity, and geographic location.

This study is important because researchers have yet to fully explore this area. The integration of technology in public schools is in its infancy. While literature exists on the integration of computer technology in the classroom and its possible impact on academic success, there is a lack of evidence confirming the overall effect technology has on increasing academic success. The goal of this empirical research is to assess the impact technology has on the academic performance of public school children.

Chapter Summaries

Chapter two provides supporting literature concerning the impact technology has on the academic performance of public school children. This chapter also discusses the "digital divide" and its effect on society and in education, as well as factors that contribute to this divide, along with the integration of technological resources. This research will explore potential advantages to integrating technology into the classroom. In this chapter the conceptual framework is introduced and a link to the scholarly literature is provided.

Chapter three introduces the methodology used in conducting the research which includes secondary analysis of existing data, a discussion of how the data was obtained, as well as the dependent variables, independent variables and covariates. This report also presents operationalization of the hypotheses, and how each hypothesis was tested using multiple regression analysis.

The fourth chapter presents the results of the multiple regression analysis. Tables representing tests that were run are accompanied by text that explains the findings of the study. In-depth analyses of the results of the hypotheses discuss at length whether or not these hypotheses were accurate.

Chapter five provides summaries of the findings as well as conclusions based on the findings. This chapter also suggests criteria for future research, in order for educators to successfully equip children with the skills they will need to succeed in the 21^{st} century.

Chapter 2: Literature Review

Introduction

This chapter examines scholarly literature pertaining to the impact technology integration has on the academic performance of public school children. The literature examines the digital divide and the digital divide in education, as well as key areas of technology integration that promote student academic performance. The literature also outlines the role that the federal government plays in providing funding and discusses existing studies that explore the impact technology has on the academic performance of public school children.

Technology in the 21st century

The 21st century requires that individuals be technologically literate. Technology invades every aspect of daily life. According to the Web-based Education Commission (2000, 1) "the Internet is perhaps the most transformative technology in history, reshaping business, media, entertainment, and society in astonishing ways." The role and impact the Internet has on society is not merely a fad. Its effect on society is unprecedented.

"If this era of globalization has proven anything, it is that a growing world economy can create strong and lasting demand for technologically skilled workers and a technologically savvy workforce" (Web-based Education Commission (2000, 6). Eighty-five percent of all jobs in the workforce now require some degree of technological skill. Between 1998 and 2008, the demand for individuals who were skilled in information technology increased. More than two million jobs needed to be filled to replace individuals leaving the workforce. "In 2006, nearly half of all the workers that were employed in industries produced or intensively used information technology products and services” (Department of Commerce 1999). Despite this demand for individuals who are technologically skilled, this same requirement has not yet been made in education. For all the power technology holds, it has just recently been used to transform education. A discussion of the digital divide and the digital divide that exists in education follows.

Digital Divide

Technology use in society and education is not new. Dating back to the 1970's, technology was used in business to assist with daily tasks and routine functions. Administrators in education used computers to keep track of records and student information. In the 1980's computers were available to consumers at a lower cost and were able to store large amounts of information faster (Shields and Behrman 2000). In the 1990's the internet was introduced and access to vast amounts of information was readily accessible. Because of this influx of information technology and its prevalent use in society, users split into two groups. The digital divide was a term created as a means of describing these two groups. Jones (2004, 9) defines the digital divide as "those that have access to technology and those that do not." Individuals that do not have access risk being left behind in this technology rich society. Initially, access to technology was reserved for the upper class. While the disparities that existed in access were expected, the quick response from the government and private sectors in addressing this problem were not (Attewell, 2001). One of the ways in which the government and corporate business sought to address this issue was through the integration of technology in public schools. However, despite these efforts a second digital divide was created that pertained to use. Natriello (2001) suggests that “committing resources to address the access divide, whether from governmental or private sources, may have lead to a speedier solution to the more visible divide, the problem of disparities in access, at the cost of intensifying the less visible problem of disparities in use." The disparities that exist between the haves and the have-nots are easily delineated along the lines of socioeconomic status and ethnicity. Poor and minority families typically have less access to technological resources in society (Natriello, 260).

The digital divide does not merely refer to how many computers are in a classroom. It is how and in what way the technology is being used. Valadez and Duran (2007, 33) state, that in an effort to close the gap between the haves and the have-nots, the disparities between the two groups were exacerbated. "Merely providing resources for schools to purchase computers does not address the more important issues regarding poverty, inequality, and differential opportunities made available to low and high socioeconomic status (SES) students" (Valadez and Duran 2007, 34).

Socioeconomic Status (SES)

According to Kalyanpur and Kirmani (2005), the gap in access to technology has closed. Now the problem is how the technology is being used. The SES of students attending schools affects the quality of access that children have at their schools as well as the frequency and types of use. Becker (2000, 44) asserts children's experiences using computers is dependent on the type of subject being taught and the teachers' objectives. Data suggests that children of lower socioeconomic status tend to use computers for drill based and repetitive practice, while children of higher socioeconomic status use computers to enhance and develop critical thinking skills. Schools that have children from higher SES backgrounds were found to use technology to promote computer programming and higher order thinking skills. Children from lower SES backgrounds were found to use technology for basic remediation of skills that have been previously taught. Shields and Behrman (2000) also support the claim that "children who have a better SES status are more likely than less advantaged children to be provided opportunities to learn to use computers effectively as tools in their lives and are more likely to experience an enriched learning environment in the classroom." By promoting what is called equality of digital opportunity, schools can ensure funding is provided to purchase up to date technology and proper training for teachers. When integrating technology into daily classroom activities, proper professional development is critical. Schools with children from higher SES backgrounds were found to have adequate funding for educators to pursue technology literacy in professional development classes. Schools with children from lower SES backgrounds did not incorporate computer training into their professional development. According to Swain and Pearson (2003), "as a result of this lack of training in low-income schools, many educators did not feel comfortable using the technology and chose to use it for remediation of skills, rather than making it an integral part of daily classroom activities." Ethnicity is also a contributing factor in the disparities that exist in computer access and computer usage, which directly correlate to socioeconomic status. Jones (2004) states African American and Hispanics continue to experience lower Internet access and use when compared to non-minorities. "Studies show that children who were of Caucasian background used the computer for learning higher order thinking skills while children of minority backgrounds used the computer as drills and for practice" (Swain and Pearson 2003). While ethnicity is a contributing factor in the second digital divide, Attewell (2001) states that disparities exist mainly because of the inequality in income or in the differences of education, rather than by race. While children have different experiences using computer technology in school, the primary purpose of technology integration in public schools is to increase academic performance.

Power of the Internet

Today educators face many challenges. The number of students enrolling in schools is increasing, at the same time the number of teachers available to teach is decreasing. Schools continue to deteriorate while academic standards rise. Technology can help alleviate many of these problems. "The Internet enables society to address these educational challenges by bringing learning to students instead of bringing students to learning" (Web-based Education Commission 2000, 1). The Internet allows for the development and creation of learning communities that provide access to knowledge that was once difficult to obtain. Technological resources are making access to knowledge easily assessable for individuals to learn in a variety of different ways.

The traditional model of teaching has been transformed. Teachers no longer lecture while students passively take notes. The traditional method of class instruction was the short term recall of facts, whereas the use of technology in the classroom provides greater opportunities for deeper foundations of knowledge. Technology creates and supports more effective learning environments. It allows students to find, recognize and evaluate content. Specifically, the Internet provides communication and discussion on a wide variety of topics with a broad range of people. The Internet is a tool that empowers students and encourages active participation in the classroom, through interaction.

The integration of technology in the classroom allows learning to take on new shapes and forms. Technology, specifically the Internet, allows students to research and access information from primary historical source material rather than from secondary source material. The Internet allows students to use resources and tools not found in their own schools. It can provide them with a global influence that reaches far beyond the classroom. The Internet also provides students the opportunity to share their knowledge with other students outside of their own school. "By sharing knowledge and ideas with others students outside their own classroom, clarity and accuracy take on new meaning" (Web-based Education Commission 2000, 58). Students produce higher quality projects and have greater comprehension of subject material.

Technology in the classroom

"Evidence indicates when technology applications are used effectively and efficiently; they can support higher-order thinking skills by engaging students in genuine, complex tasks within collaborative learning contexts" (Means 1993, 2). Cognitive research has shown that learning is most effective when four critical characteristics are present: (1) active participation (2) group participation (3) immediate feedback and interaction with educators and (4) real world connections. Technology allows all four characteristics to take place.

The traditional way to disseminate information to students was in a lecture and text format. This type of structure creates a passive learning environment, not conducive to deeper learning. "Some students who are taught in lecture and text format often do not develop deeper understanding of the subject material and have difficulty applying it in real world situations" (Roschelle et al. 2000, 79). Technology can be used in a variety of different ways to encourage active learning and participation. One of the first systems to add functionality to the basic classroom response system was a product called Classtalk. Classtalk allowed students to work individually or in groups, at their own pace using sets of questions. "This program was able to handle open-ended questions formats and was structured for group collaboration" (Wallace 2004, 171). Another example is a science lab in which students can conduct experiments and then plot results on a graph using the computer. This allows students to see their results immediately. “In widely replicated studies, researchers have noted significant improvements in students’ graphing skills, the interpretation and understanding of scientific concepts and an increase in motivation when using the computer software” (Roschelle et al. 2000, 79). Presenting classroom reports using PowerPoint also encourages active participation and creates a deeper understanding of content. Technology use in the classroom creates flexibility which provides for an environment that is fun and exciting for teachers and students. Instead of research papers students produce research based websites and “discuss points of literature in BLOGS instead of traditional handwritten journals” (Maninger 2006, 40).

The second characteristic technology fosters is group participation. Traditionally, teaching focused on individual learning. Experts see group work as one major place where computers can enhance traditional instructional practices. "The participation required when children are grouped around a computer, as opposed to working in isolation at individual computers, can have a positive effect on performance" (Ungerleider and Burns 2002, 22). Research has shown that when students work in groups, they develop complex critical thinking skills. Becker (2006) found that when students used computer supported intentional learning environments, students developed greater comprehension of subject matter, showed increased motivation and the ability to tackle difficult questions. By working in groups, students are able to hold informal discussions about the topics at hand. Roschelle et al. (2000, 80) assert "that much learning focuses on the meaning and correct use of ideas, symbols, and representations." Through informal social conversations, students and teachers can provide explicit advice, resolve misunderstandings and ensure mistakes are corrected. In one classroom the teacher had students answer a series of questions. The answers were put into a computer system and the results of student responses posted in a pie graph. After the students had used the communication system to register their responses to the question, the instructor would ask them to turn to their neighbor to discuss the reasons why they chose a particular answer. After discussion, the class would answer the same question again. When the question was posted a second time, the number of correct answers increased (Wallace, 2004, 172). Encouraging group participation through social interaction and discussion of current topics creates motivation and leads to more productive learning environments.

Immediate feedback and interaction with the educator is the third critical factor technology promotes in the classroom. In the traditional mode of teaching, there is very little interaction between the teacher and the student. Students complete work independently and hand it in to the teacher. Typically the teacher would return the assignment later. However, with technology implemented in the classroom, students can turn in homework assignments electronically and receive a grade instantly. Immediate feedback provides students the opportunity to "witness their mistakes and gives teachers the opportunity to reinforce learning" (Maninger 2006). Wallace (2004) examined how the internet in public schools affects teachers and students. When students were asked to use the Internet to research topics for discussion, interaction between the students and teachers increased. Because the students were researching the lesson themselves, the teacher had more time to answer individual questions concerning content and explain a process or a concept in more detail. "Research suggests that the learning process develops quicker when learners have frequent opportunities to apply the ideas they are learning and when feedback is provided immediately" (Roschelle et al. 81).

Finally learning is most effective when students have the ability to make connections to real world situations. The traditional model of teaching encourages learning facts and reciting them. However, when students go out in the real world they often have problems making connections and applying what they have learned in school to their real lives. Computer technology provides students with the opportunity to increase their knowledge on how to accomplish tasks, create critical thinking skills and provides the ability to improve learning strategies. Ungerleider and Burns (2002, 11) state that “the development and implementation of successful metacognitive skills can significantly influence learning and scholastic performance, which can be applied throughout life.” “Computer technology provides students with an excellent tool for applying concepts in a variety of contexts, thereby breaking the artificial isolation of school subject matter from real-world situations” (Roschelle et al. 82).

Impact of technology on academic performance

Research that has been conducted on the ways in which technology can improve what children learn focuses on programs that aide in students’ comprehension of core subjects like science, math, and reading, by presenting subject material in more easily understood formats. The largest volume of research on the impact of technology in core subject areas has been conducted on mathematics instruction. “Mathematics instruction also has the longest history of using technology for instructional purposes and boasts several impressive systems” (Ungerleider and Burns 2002, 15). Computer based applications can also be applied in science classrooms. Research has shown that students receive higher test scores and have greater understanding of the subject material. Roschelle et al. (2000,86) assert that “computer-based applications using visualization, modeling and simulation have proven powerful tools for teaching scientific concepts." When certain technology applications were used in the classroom, such as ThinkerTools, it was discovered that students’ understanding of subject matter increased well beyond their grade level. Researchers found that middle school students who used this computer assisted learning program had developed the knowledge to understand and explain concepts that were usually taught well above their grade level.

The impact technology has on the academic performance of public school children in the core subject area of mathematics is also positive. In the traditional teaching of mathematics, students were required to apply basic knowledge such as adding, subtracting, multiplying, and basic division. "However, in today’s society, people increasingly use mathematical skills to reason about uncertainty, change trends in data, and spatial relations" (Roschelle et al. 87). Using technology to check an equation can provide immediate feedback if the equation is incorrect instead of writing the equation out in pencil and waiting for a response from the teacher. A high school in Pittsburg implemented a computerized Cognitive Tutor in its mathematics classes. This program developed students higher order thinking skills by allowing them to use real world situations to solve problems (Ringstaff and Kelley 2002). Classrooms around the nation are expanding the mathematical literacy of students as more teachers are taking advantage of technology tools. “Algebra students who used computer assisted learning programs outperformed students in traditional classes, achieving gains of up to 25 percent in skill and up to 100 percent in problem solving” (Hubbard 2000).

While there are only a few studies that measure the effectiveness of technology in the area of language arts, the impact of technology can still be seen through the application of literacy programs and word processing systems. Computers may not be the best means to read complete books; however they are helpful in examining small sections of text and material (Ringstaff and Kelley 2002, 6). When typing a report, students are able to instantly see incorrect spelling and grammar. Technology also provides students with a wider array of resources; they can access virtual libraries and have access to information that their school does not have. Students who use email see an increase in their reading and writing skills. “Communicating and interacting through email, has proven to be a motivating factor in the improvement of language skills” (Ringstaff and Kelley 2002, 6).

A study was conducted in rural West Virginia at Hundred High School, on the impact of technology on academic success and showed favorable results. The school took advantage of a program called NETSchools and received funding from the E-rate program. NETSchools provided every student and teacher with a laptop. Once ports were installed, all the students and teachers connected to a Local Area Network. The results were astonishing. The desire to learn increased and students who had previously been disinterested in school became more active participants. After only six months, eighty percent of the students were accessing the Internet daily to gain supplemental instruction. In the past, their only source of information had been from the school library which contained out of date texts. "Over the course of that first year the 144 students at Hundred High scored higher and ranked above the national mean in every subject, as well as in total basic skills on the SAT" (Web-based Education Commission 2001, 12).

Another study called Project Child (Computers Helping Instruction and Learning Development), examined the impact computer integrated instructional programs had on student achievement. "Students showed positive results at both high and low achieving schools, having higher grade point averages and on average scoring higher on standardized tests" (Ringstaff and Kelley 2002, 4). In addition to these studies, other research studies examine the impact of drill-based remedial software on academic performance. "Students who used drill and practice technology to contribute to already learned skill sets, improved their academic performance on standardized tests" (Attewell 2001). Despite the positive impact of technology on enhancing learning environments, barriers do exist that limit the effectiveness of technology in the classroom. Technology in the classroom is only one piece of the puzzle. In order to be effective and have impact, school reform must happen at all levels; in the classroom, at the school, and in the school district.

Barriers limiting technology in the classroom

Lack of proper access is one contributing factor limiting the use of technology in the classroom. Educator preparation and proper professional development is another barrier to effective use of technology in the classroom. Obtaining adequate and proper access is critical to effectiveness of technology in the classroom. Without proper access, students may fall behind.

Schools that do not have adequate access to technology will fail to move research into practice and practice into research. Access to technology is fundamental. In education having adequate broadband access is extremely important. Broadband access is defined as the transmission of large amounts of data electronically, whether through wire or wirelessly. “The more powerful the capability to transmit data, the richer the online experience” (Web-based Commission 2000, 22). While having adequate access to technology at school is imperative, so is having access at home and at work; wherever learning opportunities can be found. The gap between the number of individuals who have access at home and those who do not is narrowing. In the past few years those individuals who have access at home has increased dramatically. Even rural households are catching up to those in urban areas. However for those students that do not have computer access at home, it is critical that schools provide that access in the classroom. "School computers are the only link to the Internet for many socioeconomically disadvantaged and minority children" (Swain and Pearson 2003). Not only must the access be convenient and affordable, but administrators, educators, and others who work with the technology must have the skill, knowledge and comprehension to apply it accordingly in the classroom.

According to the Web-based Commission (2000, 39) “teachers are the key to effective use of web-based tools and applications, but first they must become skilled at using them." Professional development is the critical ingredient for effective use of technology in the classroom. The educational community should approach the implementation of technology into the classroom in a manner similar to that employed by the business sector. The business world approaches technology implementation in a focused, goal oriented, well conceived manner. Educators take a generic approach of one size fits all. The business sector provides incentives, bonuses, and paid time off for their employees to take advantage of new training techniques, while educators are required to take classes on their own time and often at their own expense. According to the CEO Forum on Education and Technology (2001, 9), “studies continue to demonstrate that educators’ access to professional development remains the single most critical factor as to whether or not technology improves student achievement." Educators must have time to attend professional development classes of high quality if they are to receive the full benefits of instructional technologies. It is important to “provide opportunities for professional development that meets teachers learning needs in 21st century areas, such as project management, information literacy, and interdisciplinary instructional design” (Boss and Krauss 2007). Roschelle et al. (2000, 92), states that “to maximize the effectiveness of computer technology as a tool and to enhance learning in the classroom, education policymakers must incorporate technology selectively into educational reform as part of an overall program for improvement and continue to study its progress and results to improve efforts over time."

Federal programs supporting Educational technology

While policymakers have continued to emphasize traditional subjects such as reading, math, and science, they must also focus on the role that information technologies play in preparing students for life and work in the 21st century (CEO Forum 2000, 6). In this day and age of technology, it is imperative that students are well equipped in order to function not only in school, but at work and in life. For this reason and because of the visible impact technology has on the academic performance of public school children, over the last decade the government has allocated billions of dollars in public funds to provide schools with computers and access to the internet (Roschelle et al. 2000, 77).

Federal programs that work strategically with state and local level partners in both the public and private sectors offer the best chance of success. "Through such cooperative efforts, all our nation's children can gain access to educational technology and the computer skills they need to become productive citizens" (Roberts 2000, 184). A discussion of programs which support the integration of technology in the public school system follows.

The Education-rate (E-rate) program was developed to provide discounts on the cost of telecommunications services and equipment to public schools, private schools and to school libraries. The program was enacted as part of the Universal Service Program of the Telecommunications Act of 1996. The goal of this program is to ensure that schools are not left behind in a technology-rich society. The Federal Communications Commission administers this program, which provides 2.25 billion dollars annually in discounts on telecommunication services. The E-rate program primarily supports the technology funding in schools and libraries (U.S. Department of Education 2001).

The U.S. Department of Education provides grants for communities' technology centers. These grants bring the power of computers, technology and information resources to those students and adults living in low-income communities. Specifically these grants build community centers and provide Internet access to individuals living in rural and economically distressed areas. Internet access is provided and made available through community centers, libraries, and other educational facilities (U.S. Department of Education 2001).

For the last decade, the U.S. Department of Education's Star Schools program has provided support for distance learning projects. The purpose of this program is to promote skills and provide knowledge needed to implement technology in the classroom. The program has successfully improved reading, math, science, and foreign language skills in disadvantaged areas. "Over the past decade, this program has provided 50 million dollars to support distance learning projects with more than one million students and educators participating in the program across 50 states" (U.S. Department of Education 2001).

Other federally funded programs that have contributed significantly to the expansion of educational technology are the Preparing Tomorrow's Teachers to Use Technology program and the Technology Literacy Challenge Fund. The Preparing Tomorrow's Teachers to Use Technology program is administered by the U.S. Department of Education. The program supports the development of continuing education classes, by providing grants to facilitate the planning and implementation of ways to effectively integrate technology into educational curricula. The Technology Literacy Challenge Fund was created in 1996 under the U.S. Department of Education. "This program provides monetary support for schools and districts to lay the foundation to implement technology in their schools and alleviate the stress that comes with such implementation" (U.S. Department of Education 2001).

The Enhancing Education through Technology Act of 2001 has also played a critical role in the integration of technology in the classroom. There are two primary purposes of this act. The first purpose of this act is to assist states and localities in implementing a comprehensive technological system that will allow elementary and secondary schools to effectively use technology to improve academic achievement. The second purpose is to evaluate schools that do receive funding and determine if monetary resources are being used in an efficient manner (U.S. Department of Education 2001).

Through the development, creation and implementation of these federally funded programs it is clear that effective implementation of technology into education is important. “Several billion dollars in public and private funds have been dedicated to equipping schools with computers and connections to the Internet, with promises of even more funds in the future” (Roschelle 2000, 77). "In order for schools to take full advantage of the power of technology, educators must have a better understanding of how to efficiently use technology in the classroom in ways that will improve student achievement" (CEO Forum Education and Technology 2001).

Conceptual Framework

The research and literary findings suggest that technology integration does impact academic performance of public school children. It also suggests that despite differences in levels of technology integration, the impact on academic performance occurs at various levels.

This section develops the conceptual framework of this study providing direct links to the literature. This study is explanatory research using formal hypotheses to explain the impact technology has on academic performance. Explanatory research is used in all impact program evaluations (Shields and Tajalli 2005). This research uses formal hypothesis to address the “why” question. “Explanatory and formal hypothesis are the mainstay of social and policy sciences" (Shields 1998). "The "why" question answers the question if X then Y, and uses dependent and independent variables to test this causation" (Shields 1998).

This study tests 12 hypotheses that claim various areas of technology integration have a positive impact on the performance of public school students in the subject areas of reading, mathematics, and science. Four areas of technology integration are identified and tested for their impact. The four areas were identified from the Texas Education Agency website and are critical components of the Texas STaR Chart. These areas include: teaching and learning; educator preparation and development; leadership, administration, and instructional support; and infrastructure for technology. A combination of the four areas of technology integration and the three performance subject areas has generated 12 hypotheses for this study. The hypotheses of this study and their supporting literature are listed in the conceptual framework table below:

Table 2.1: Conceptual Framework of the Study

Hypotheses	Supporting Literature
H_{1a}: Integration of technology that is related to *teaching and learning* will improve *reading ability* of public school students.	Becker 2000, Roschelle et al. 2000, Ringstaff and Kelley 2002, U.S. Department of Education 2001, Angrist and Lavy 2002
H_{1b}: Integration of technology that is related to *teaching and learning* will improve *mathematics ability* of public school students.	Hubbard 2000, Roschelle et al. 2000, Ringstaff and Kelley 2002, U.S. Department of Education 2001
H_{1c}: Integration of technology that is related to *teaching and learning* will improve the ability of public school students in the subject area of *science*.	Attewell and Belkis 2003, Angrist and Lavy 2002, Nartiello 2001, Ringstaff and Kelley 2002, Becker 2000, Roschelle et al. 2000
H_{2a}: Integration of technology that is related to *educators' preparation and development* will improve *reading ability* of public school students.	Shields and Behrman 2000, Means et al. 2003, Becker 2000, Roschelle et al. 2000, U.S. Department of Education 2001
H_{2b}: Integration of technology that is related to *educators' preparation and development* will improve *mathematics ability* of public school students.	CEO Forum and Education Technology 2001, Becker 2000, Shields and Behrman 2000, Web-based Education Commission 2001
H_{2c}: Integration of technology that is related to *educators' preparation and development* will improve the ability of public school students in the subject area of *science*.	Swain and Pearson 2003, Web-based Education Commission 2001, Roschelle 2000, U.S. Department of Education 2001
H_{3a}: Integration of technology that is related to *leadership, administration, and instructional support* will improve *reading ability* of public school students.	Roschelle 2000, Becker 2000, CEO Forum Education and Technology 2001, U.S. Department of Education 2001
H_{3b}: Integration of technology that is related to *leadership, administration, and instructional support* will improve *mathematics ability* of public school students.	Shields and Behrman 2000, Means et al. 2003, Hubbard 2000, Roschelle et al. 2000, Web-based Education Commission 2001
H_{3c}: Integration of technology that is related to *leadership, administration, and instructional support* will improve the ability of public school students in the subject area of *science*.	CEO Forum and Education Technology 2001, Shields and Behrman 2000, Kalynampur and Kirmani 2005, Attewell 2001
H_{4a}: Integration of technology that is related to *infrastructure for technology* will improve *reading ability* of public school students.	Hubbard 2000, Roschelle et al. 2000, U.S. Department of Education 2001, Shields and Behrman 2000
H_{4b}: Integration of technology that is related to *infrastructure for technology* will improve *mathematics ability* of public school students.	Roschelle 2000, Becker 2000, CEO Forum Education and Technology 2001, U.S. Department of Education 2001, Web-based Education Commission 2001
H_{4c}: Integration of technology that is related to *infrastructure for technology* will improve the ability of public school students in the subject area of *science*.	Becker 2006, CEO Forum on School Technology Readiness 2001, Ringstaff and Kelley 2002

Chapter Summary

"When properly used, computers serve as important tools for improving proficiency in core academic subjects and the overall learning environment of the school" (Wenglinsky 1998). Due to federal programs providing the means to implement computer based technology into daily curriculum, schools throughout the nation are making great strides. Angrist and Lavy (2002, 736) claim that "although computer-aided instruction has been around for decades, there are few empirical studies that meet a rigorous methodological standard." Many studies are qualitative, assessing the attitudes of participants from particular studies, or quantitative, lacking real comparison groups.

When comparing the amount of funding spent on the integration of technology into classrooms and the amount of funding spent on gauging technology's effectiveness in increasing academic performance, the research is non-existent (Wenglinksy 1998). While it is important to implement technology into education, it is equally important to examine the impact technology has on academic performance. "Evidence indicates that when technology is used effectively and efficiently, it can help support learning, and that it is especially useful in developing the higher order skills of critical thinking, analysis and scientific inquiry" (Means et al. 2003). Research and development should link to areas of academic performance and support a clear case for using technology in education. "There is growing evidence of a direct link between use of technology and increased academic performance" (CEO Forum 2001).

Chapter 3: Methodology

Chapter Purpose

This chapter explains the steps used to test the hypotheses of this research, and describes how the data was obtained, as well as the methodology used to test the research purpose. In this chapter the hypotheses are operationalized and discussed.

Purpose of the Study

The purpose of this study is to assess the impact of technology integration on academic performance of public schools students. Administrators and educators can integrate technology into various areas of school operation such as teaching and learning, professional development of the educators, administration and support, and infrastructure. The goal of this research is to find out which area of technology integration, if any, produces desired outcomes of improving student academic performance. The twelve hypotheses were developed around the four key areas that are used in the Texas STaR Chart, and the three core subject areas that TAKS tests public school students on. The four key areas of the Texas STaR Chart are: teaching and learning; educator preparation and development; leadership, administration and instructional support; and infrastructure for technology. These key areas will be discussed in detail in the following pages. The three subject areas that Texas public school children are tested in are reading, math, and science. The twelve hypotheses are defined below.

H_{1a}: Integration of technology that is related to *teaching and learning* will improve *reading ability* of public school students.

H_{1b}: Integration of technology that is related to *teaching and learning* will improve *mathematics ability* of public school students.

H_{1c}: Integration of technology that is related to *teaching and learning* will improve the ability of public school students in the subject area of *science*.

H_{2a}: Integration of technology that is related to *educators' preparation and development* will improve *reading ability* of public school students.

H_{2b}: Integration of technology that is related to *educators' preparation and development* will improve *mathematics ability* of public school students.

H_{2c}: Integration of technology that is related to *educators' preparation and development* will improve the ability of public school students in the subject area of *science*.

H_{3a}: Integration of technology that is related to *leadership, administration, and instructional support* will improve *reading ability* of public school students.

H_{3b}: Integration of technology that is related to *leadership, administration, and instructional support* will improve *mathematics ability* of public school students.

H_{3c}: Integration of technology that is related to *leadership, administration, and instructional support* will improve the ability of public school students in the subject area of *science*.

H_{4a}: Integration of technology that is related to *infrastructure for technology* will improve *reading ability* of public school students.

H_{4b}: Integration of technology that is related to *infrastructure for technology* will improve *mathematics ability* of public school students.

H_{4c}: Integration of technology that is related to *infrastructure for technology* will improve the ability of public school students in the subject area of *science*.

Research Methodology

This study uses secondary analyses of data gathered by the Texas Education Agency (TEA). Different sets of data were collected from the TEA. One set involved data gathered through the Texas STaR Chart assessment survey, a tool designed for use in technology planning, budgeting resources and evaluation of progress in local technology projects (TEA 2006). The Texas STaR Chart Assessment Survey was administered to principals or individuals designated to take the survey. According to the Campus Statewide Summary, 7,990 campuses were administered the survey for the year 2006-2007, with 7,752 completed. This survey assessed the extent of technology integration into Texas public school campuses.

Another set of data was gathered from the Academic Excellence Indicator System (AEIS) by the Texas Education Agency. The Academic Excellence Indicator System contains a wide range of information on the performance of students on each public school campus and in each district in Texas for every school year. For the purpose of this study, secondary analyses of data retrieved from AEIS includes information from school campuses assessing performance levels of school children in 4^{th}, 8^{th}, and 11^{th} grade in the core subject areas of reading, math, and science. Data were also collected concerning enrollment levels, geographic location, ethnicity, percent of students receiving free lunch, and percent of funding spent per student.

The Texas Education Agency's collection of data from AEIS were also used to retrieve information about the finances and demographics of every public school campus in Texas. Finally data from the Texas Assessment of Knowledge and Skills test (TAKS) was gathered. The TAKS is a standardized test that is administered in the state of Texas to primary and secondary school children. This test assesses students' knowledge in reading, math, science, writing, and social studies to determine if Texas educational standards are being met. Table 3.1 shows how the hypotheses in this study were operationalized.

Table 3.1: Operationalization of Hypotheses

Variables	Unit of Measurement
Dependent Variables	
• 4^{th}, 8^{th}, 11^{th} grade reading scores	• % 4^{th}, 8^{th}, and 11^{th} grade students passing TAKS for Reading
• 4th, 8^{th}, 11^{th} grade math scores	• % 4^{th}, 8^{th}, and 11^{th} grade students passing TAKS for Math
• 8^{th} and 11^{th} grade science scores	• % 4^{th}, 8^{th}, and 11^{th} grade students passing TAKS for Science
Independent Variables	
• Key Area I: Teaching and Learning	• 6 items on a scale from1-4
• Key Area II: Educator Preparation and Development	• 6 items on a scale from1-4
• Key Area III: Leadership, Administration, and Instructional Support	• 6 items on a scale from1-4
• Key Area IV: Infrastructure for Technology	• 6 items on a scale from1-4
• Enrollment	• Number of students enrolled in each school campus
• % White	• % white students enrolled in each school campus
• % Free/Lunch	• Economically disadvantaged in each school campus
• Urban/Rural	• 0 = Rural / 1 = Urban
• % Expenditure/per student	• % expenditure per pupil for each school campus

Dependent Variables

There are eight dependent variables in this study. Dependent variables are based on the Texas Assessment of Knowledge and Skill (TAKS) scores that are retrieved from the Texas Education Agency's database. TAKS tests are standardized tests in the subject areas of reading, mathematics, and science that are given to public school students during the spring semester of each year. The *dependent variables* of this research are:

1. Percentage of 4^{th} grade students from each Texas public school campus that passed the TAKS test in the subject of *reading*.
2. Percentage of 4^{th} grade students from each Texas public school campus that passed the TAKS test in the subject of *math.*
3. Percentage of 8^{th} grade students from each Texas public school campus that passed the TAKS test in the subject of *reading*.
4. Percentage of 8^{th} grade students from each Texas public school campus that passed the TAKS test in the subject of *math*.
5. Percentage of 8^{th} grade students from each Texas public school campus that passed the TAKS test in the subject of *science.*.
6. Percentage of 11^{th} grade students from each Texas public school campus that passed the TAKS test in the subject of *reading*.
7. Percentage of 11^{th} grade students from each Texas public school campus that passed the TAKS test in the subject of *math*.
8. Percentage of 11^{th} grade students from each Texas public school campus that passed the TAKS test in the subject of *science*.

The unit of analysis for this study is Texas public school campuses. There are over 7,000 public school campuses in Texas. To protect the external validity of the research, this study eliminates Charter Schools from the list of public schools. Charter Schools are semi-independent schools that are not subject to many of the rules and regulations that bind regular public schools. Similarly, this research excludes school campuses with less than 100 students. In the judgment of this researcher, performance and technology integration of these schools are inconsistent with larger school campuses. After eliminating these two types of schools, 6,654 campuses remained as samples for use in this project. The TAKS scores were retrieved from Texas Education Agency's (TEA) databases. To comply with the federal Family Educational Rights and Privacy Act, TEA masks some campus scores. Table 3.2 shows how these scores were coded by TEA and how they were converted for the use of this study.

Table 3.2: Treatment/Conversion of Masked Scores

Condition	TEA's Masked Code	Treatment/Conversion for this study
5 or fewer students	-1	Eliminated from Study
Almost 100% of students pass the test	-4	Converted to 99.9%
Nearly, no one passed the test	-3	Converted to .1%
Value of student demographics are outside a reasonable range	-2	Eliminated from Study

Independent variables

This study uses four main independent variables and several covariates in running the multiple regression analysis. In response to strict federal requirements in education, the State of Texas has developed its own tool allowing schools to evaluate their efforts in the integration of technology into the classroom. Campuses and districts must complete the Texas Campus STaR Chart online each year and use the specific profiles to gauge their progress annually, in order to comply with federal and state requirements (TEA 2008). The Texas Campus STaR Chart centers around four key areas of the Long-Range Plan for Technology: 2006-2020. The four areas include: Teacher Learning; Educator Preparation and Development; Leadership, Administration, and Instructional Support; and Infrastructure for Technology. Each of the four key areas consists of complex sub-categories which assist administrators in determining levels of technology integration on their school campus. Each sub-category is scored on a scale of one to four. The sub-categories are then computed based on the sum of the scores, and the score for each Key Area is obtained. Below, each area is discussed and defined according to criteria developed by the Texas Education Agency Educational Advisory Committee (ETAC).

Key Area I. Teaching and Learning

The first independent variable is Key Area I: Teaching and Learning. This area consists of six sub-categories which suggest that teachers can influence the role technology plays in increasing the academic performance of school children.

With the role of technology changing in the world, so must teachers change how they teach and students how they learn. In the past, teachers served as the primary source of information, passing their knowledge to their students. In the 21st century, this traditional approach is changing. Students are required to become more active learners. In the Teaching and Learning section there are six sub-categories. The extent to which these six technology related means of teaching and learning are integrated in schools form our first independent variable. The sub-categories of our first independent variable are:

- Patterns of Classroom Use
- Frequency/Design of Instructional Setting Using Digital Content
- Content Area Connections
- Technology Applications/TEKS Implementation (Texas Essential Knowledge and Skills
- Student Mastery of Technology Applications
- Online Learning

Patterns of Classroom Use: Teachers use technology in classrooms in different ways. Some use technology to supplement their lectures with video or an overhead projector, and some incorporate technology into daily curriculum which forces students to perform higher order thinking skills, such as analyzing information and designing solutions, and effective communication (Shields and Behrman 2000).

Frequency/Design of Instructional Setting Using Digital Content: This area identifies where computers are used and how often they are used in an instructional setting. Frequency of use and setting may vary depending on where the computers are located, and how often students are able to use them. Schools at the highest level of technology integration promote more integrated use of technology with academic curricula. Shields and Behrman (2000, 22) assert that "schools may need to redistribute computers out of labs and into the classroom." Rather than placing computers in labs and in libraries, students may benefit by having computers in the classrooms themselves.

Content Area Connections refers to using technology for basic skills and incorporating technology into the classroom across all subject areas, which provides learning opportunities that would not be available if technology was not used. By providing a link to the classroom lesson and enhancing the learned content technology, educators encourage students to take a more active role in learning. In turn, students take a more proactive and motivated role in their own education. Schools in the highest levels of technology integration facilitate this type of learning environment.

Technology Application/TEKS Implementation as defined by Jones (2004, 27) involves technology application courses offered and taught within grade clusters such as grades K-8. In the early stages of technology integration, schools teach two technology related courses. Schools at the highest level of technology integration teach a minimum of four technology related courses.

Student Mastery of Technology Applications TEKS: In this category, educators direct their attention toward the proportion of students in each school who pass the mastery of essential technology skills test. For schools at early technology integration levels, essential skills are only mastered by twenty five percent of students. Schools that are at the highest levels of technology integration have students who measure at eighty six to one hundred percent in mastery of essential technological skills.

Online Learning: This category is defined as the amount of online learning activities teachers implement in daily classroom instruction. Schools that are in the early stages of technology integration use and develop, very little online learning activities. Schools at the highest level of technology integration create and implement web based lessons which are aligned with TEKS-based content (TEA 2008).

Key Area II. Educator Preparation and Development

The second independent variable is Key Area II: Educator Preparation and Development. This area also consists of six sub-categories which suggest that to effectively integrate technology into the classroom and increase academic performance of school children educators must be adequately trained.

Not only is the implementation of technology into education critical, it is imperative that teachers are adequately trained and prepared to incorporate technology into daily curriculum. State and local education agencies should ensure that all teachers receive pre-service and/or in-service training on how to integrate technology effectively into curricula. Within Educator Preparation and Development there are six-sub categories. The components of these sub-categories form the second independent variable.

- Content of Professional Development
- Models of Professional Development
- Capabilities of Educators
- Access to Professional Development
- Levels of Understanding and Patterns of Use
- Professional Development for Online Learning

Content of Professional Development: At the earliest stages of technology integration into schools, teachers receive basic training in computer literacy. This includes an introduction to basic software applications and to the Internet. In schools that are in the highest stages of technology integration the majority of teachers mentor each other and develop new learning methods that encourage students to use higher order thinking skills.

Models of Professional Development: The difference between schools in the early stages of technology integration and those in the highest stages are the number and frequency of professional development classes offered to educators. Schools in the highest stage of technology integration offer anytime, anywhere learning available through a variety of delivery systems, while those in the early stages only offer large learning in group settings (TES 2008). Professional development of educators can influence the impact of technology on academic performance of students. According to Swain and Pearson (2003, 330), “professional development in technology is important for all teachers, a fact that continues to be reflected in the data found in studies conducted in U.S. schools.”

Capabilities of Educators: The State Board for Educator Certification (SBEC) has set five clearly defined technology application standards for all teachers. The capabilities of educators range from those that demonstrate one standard, to educators that demonstrate all five standards. Teachers that demonstrate all five standards have a high level of technology literacy and incorporate technology use into daily curriculum.

Access to Professional Development: Professional development plays a critical role in influencing the impact technology has on academic performance. Valadez and Duran (2007) note, "the importance of educators feeling comfortable in using and incorporating technology into daily classroom activities." Educators who feel comfortable in using computer technology are more likely to assign their students computer and internet work than those teachers who had not received adequate training. Schools in the earliest levels of technology integration typically offer less than nine hours of professional development as compared to schools that have fully integrated technology by offering at least 30 hours of professional training.

Levels of Understanding and Patterns of Use: This category rates educator’s levels of technology literacy. Educators with only basic comprehension are more likely to use technology for remediation of basic skills while those with a more comprehensive understanding of technology are more likely to use technology in a way that promotes highly interactive learning environments. According to McCrory (2004, 449) "technology literacy is the key to successful teaching with technology."

Professional Development for Online Learning: This category defines educators in the early stages of technology integration as having taken part in professional development in the use of online learning, while educators in the highest levels of technology integration have taken courses in online learning and are teaching classes online.

Key Area III. Leadership, Administration, and Instructional Support

The third independent variable of this study is Key Area III: Leadership, Administration, and Instructional Support. This area consists of six sub-categories which suggest that, for technology to impact the academic performance of public school children, administrators must share common goals and visions for proper technology implementation.

Integrating technology into public schools is challenging. Because of the difficulties in implementation, individuals in leadership must share a common vision and goals for integrating technology into campus life. Within Leadership, Administration, and Instructional Support there are six sub-categories:

- Leadership and Vision
- Planning
- Instructional Support
- Communication and Collaboration
- Budget
- Leadership and Support for Online Learning

Leadership and Vision: Schools that are in the early stages of technology integration have leaders that are aware of the potential impact technology may have on student achievement. However, schools in the highest stages of technology integration have leaders who promote and encourage a unified vision among educators and administrators. These are leaders who encourage continuous innovation in teaching and learning thru the use of technology.

Planning: It is important that schools develop an effective plan for implementing technology. Schools in the earliest stages of technology implementation have very few goals and objectives incorporated into their campus plans, while schools in the highest levels of technology integration have clearly defined goals and objectives which are incorporated into their campus plans, with an emphasis placed on student success.

Instructional Support: If schools are to integrate technology in their learning environment they must provide educators with instructional support. Schools in the early stages of technology integration have limited support for the use of and integration of technology into their daily curriculum. Schools in the highest stages of integration, on the other hand, have leaders and educators who support the use of computer technology in the classroom. Schools that are in the highest stages of technology integration promote a more active learning environment and facilitate higher order thinking skills.

Communication and Collaboration: Campuses in the earliest stages of technology integration are limited in their uses of technology and lack the ability to use technology to communicate internally or to communicate with parents and the students. Schools operating on campuses with high levels of computer technology use a variety of ways to communicate and collaborate with staff, students, and parents. These schools use the web to inform students and parents of upcoming events, individual classroom teachers have assignments posted on their teacher web sites, and educators communicate with one another through email or blackberries.

Budget: Budgets should include an allocation of funds for hardware, software, professional development, minimal staffing support, and some continuing costs (Jones 2004). Schools with the highest level of technology integration incorporate all of the above in their budgets, even allowing for professional development needs. Wenglinksy (1998) asserts that "professional development plays a critical role for teachers who use computer technology on a daily basis." Therefore it is necessary that schools allocate funding in their budgets for educators to participate in professional development courses.

Leadership and Support for Online Learning: This is the final sub-category in the area of leadership, administration, and instructional support. Schools in the early stages of technology integration have only a basic comprehension of the value of online learning. Schools that are in the highest levels of technology integration, on the other hand, have an in-depth understanding of the potential use of online learning and offer online classes for credit.

Key Area IV. Infrastructure for Technology

The fourth independent variable is Key Area IV: Infrastructure for Technology. This area contains six sub-categories which suggest that, in order to positively impact the academic success of public school children, proper and adequate infrastructure must be present in schools.

The fourth key area defined by the Texas Campus STaR Chart is infrastructure for technology. TEA (2008) asserts that the technology infrastructure of a school is the most critical element of support for the three previous key areas. With the assistance of federal funding and the Texas State Legislature, a technology infrastructure has allowed more schools to become connected to the World Wide Web and other external resources.

Within the area of Infrastructure for Technology, there are six sub-categories:

- Students per Computer
- Internet Access Connectivity/Speed
- Other Classroom Technology
- Technical Support
- Local Area Network/Wide Area Network
- Distance Learning Capacity

Students per Computer: Over time the number of computers in public schools in Texas has dramatically increased. In schools that are in the early stages of technology integration, the ratio of students per computer is defined as ten or more students per Internet-connected computer. Schools that are in the most advanced stages of technology integration have a 1 to 1 ratio of students per computer.

Internet Access Connectivity/Speed: Schools in the early stages of technology integration only have connectivity in fifty percent of classrooms, while schools in the highest stages of integration have connectivity available in every classroom.

Other Classroom Technology: This category includes projectors, graphing calculators, digital cameras, and other digital devices. Schools that are still in the early stages of technology integration are forced to share these resources with other teachers and classrooms on campus, while schools in the highest levels of technology integration are fully equipped with recent technology and are not required to share.

Technical Support: Technical support is a critical component of technology integration. If educators are required to develop and use computer technology in daily classroom activities, it is imperative that adequate technical support is in place. The area of technical support is defined by the number of technicians to computers ratio. In schools that are in the early stages of technology integration, there is one technical staffer to more than 750 computers. Schools in the higher levels of technology integration have at least one technical support staffer to 350 computers.

Local Area Networks and Wide Area Networks: According to Jones (2004, 43), "schools in the early stages of technology integration have limited print/file sharing networks and few shared resources are available on campus." Schools that are in the highest levels of technology integration have rooms that are all connected to local area networks and wide area networks with easy access for students and teachers.

Distance Learning Capacity: Distance learning involves web based online learning. This includes media streaming, pod casts, and animation. Schools in the early stages of technology integration will have access to online learning, however presentations will be text-based and lack animation. Schools in the highest levels of technology integration have simultaneous access to online learning that incorporates pod casts, media streaming, and the ability to store customized online instruction.

Covariates

The covariates of this study are contributing factors to the academic performance of public school children. There are a number of factors that influence the academic performance of public school children, and there is a vast amount of literature on each of these factors. This study uses five of the most salient factors frequently mentioned in the literature.

Enrollment is the first covariate this research examines. The number of school campuses containing less than 100 students was eliminated from the data as well as all charter schools. School campuses that contained less than 100 students were not included in this study because they do not provide a large enough sample size. Charter schools were exempt from the study because, in the state of Texas, they are not required to take the TAKS test.

Ethnicity represents the percentage of white students in each school campus. The number of minority students on each school campus was subtracted from the number of white students on each school campus.

Socioeconomic Status of Parents is the third covariate used in this study. The covariate represents the percentage of children receiving a free lunch. The percent of economically disadvantaged students is calculated as the sum of the students coded as eligible for free or reduced-priced lunches or eligible for other public assistance, divided by the total number of students.

School Campuses were categorized by geographic location. They were either rural campuses or urban campuses. For coding purposes rural = 0 and urban = 1.

Expenditure per Pupil is the final covariate used in this study. Expenditure per student is the percentage of funding each campus allocates per student.

Statistical Method

The statistical method used in this study is multiple regression analysis. "Multiple regression analysis is a form of statistical analysis that seeks the equation representing the impact of two or more independent variables on a single dependent variable" (Babbie 2004, 450).

Chapter Summary

This chapter explains the hypotheses and methodology used in this research study. Of the nearly 8,000 campuses from which data was originally obtained, only 6,654 met the standards of this study. All data for this study were collected from TEA's various databases and merged into a single file. The statistical method used in this study is multiple regression analysis. The next chapter presents the findings of this study.

Human Subject Protection

This research study uses secondary analyses of data to examine the impact of technology on the academic performance of public school students. All data used in this study are from public records posted on the Texas Education Agency's website. In an effort to comply with the federal Family Educational Rights and Privacy Act, all data, where individual academic performance could be distinguished, were masked for the protection of individual participants. There are minimal risks in conducting this research, as there was no interaction or communication between the researcher and subjects. This research project was exempted for full or expedited review by the Texas State Intuitional Review Board (25-63475).

Chapter 4: Results

Chapter Purpose

This chapter presents the findings of this research. Multiple regression analyses were preformed to test whether the integration of technology into the school system positively impacts the academic performance of public school students in the core subject areas of reading, math, and science.

Multiple Regression Results

Multiple regression analyses was used to gauge the impact technology has on the academic performance of public school children in reading, math, and science. The use of multiple regression analysis allows a prediction of the impact of various aspects of technology integration on academic performance of students while controlling for intervening covariates. The covariates used in this study are enrollment, ethnicity, socioeconomic status of parents, expenditure per pupil, and school demographics. Tables 4.1, 4.2, and 4.3 are summaries of the regression results. It should be noted that the science scores of 4^{th} graders in Table 4.3 are not calculated, because 4^{th} grade students are not tested in this subject.

Key Area I: Teaching and Learning

This area of technology integration focuses on the way knowledge is disseminated in the classroom. Teaching and learning encourages students to become more active participants in their education, by promoting critical thinking skills and active participation in the classroom. Students are encouraged to incorporate technology in analyzing information and in presenting reports or projects. In the key area of teaching and learning, an increase in reading, math, and science scores was expected.

H_{1a} postulated that the integration of technology that is related to *teaching and learning* will improve the *reading ability* of public school students. The results support this hypothesis only for 11th graders (see **Table 4.1**). This hypothesis was not supported for 4th or 8th graders. 11th graders that showed improvement in reading ability when technology related to teaching and learning was integrated occurs for a variety of reasons. Patterns of classroom use and frequency are sub-categories of teaching and learning and have an impact on how students use technology in daily classroom activities. It is likely that 11th graders have more opportunities to take advantage of technology and use it in daily classroom activities. These students are older and have the ability to use technology in more advanced ways to enhance school projects and assist in research. Online learning, another sub-category of teaching and learning, incorporates websites for students to use as well as web based lessons. In this category it is more likely that 11th graders will have higher frequency of use than 4th and 8th graders, due to age.

The second hypothesis,**H_{1b}**, predicts that integration of technology that is related to *teaching and learning* will improve *mathematics ability* of public school students. Again only 11th graders showed improvement in mathematics when technology related to teaching and learning was integrated into daily classroom activities (see **Table 4.2**). One reason 11th graders showed improvement can again be attributed to age. These students are older and are more likely to use technology, such as graphing calculators, to assist them in solving complex problems. While 8th graders may use graphing calculators, the frequency of use does not equal that of 11th graders nor the complexity of functions used.

H_{1c} postulated that the integration of technology that is related to *teaching and learning* will improve the ability of public school students in the subject area of *science*.

This hypothesis was not supported for 8th graders. The hypothesis was supported for 11th graders only. **Table 4.3** presents the results of the analysis. The sub-categories that lie under the Key Area: Teaching and Learning, foster a more proactive learning environment. Therefore 11th graders, due to their age, succeed in this key area more so than 8th graders. More opportunities are available to 11th graders in frequency and patterns of use, and they are more likely to use the internet to research projects or use technology to present them.

Key Area II: Educator Preparation and Development

This key area is critical when integrating technology into daily classroom activities. Therefore, it is necessary to ensure that all teachers are adequately trained and prepared to effectively incorporate technology into daily curriculum. Teachers who are not properly educated or prepared are less likely to incorporate technology into daily lessons and assign computer homework to students. In the key area of educator preparation and development, an increase in reading, math, and science scores was expected.

The first hypothesis for Key Area II, $\mathbf{H_{2a}}$, predicts integration of technology that is related to *educators' preparation and development* will improve *reading ability* of public school students. This hypothesis was not supported for any grade level (see **Table 4.1**). This research theorizes that improved reading scores were not seen in this area because this key area focuses on improving the knowledge of the educators. The focus here is on the content of the professional development programs rather than showing teachers how to effectively integrate technology into daily classroom activities.

$\mathbf{H_{2b}}$ postulated that the integration of technology that is related to *educators' preparation and development* will improve *mathematics ability* of public school students.

Again this hypothesis was not supported for 4th, 8th or 11th graders (see **Table 4.2**). The reason for the lack of improvement in mathematics ability can be explained by the sub-categories found in Key Area II. It is possible that educators are not receiving adequate training. Professional development classes could only be providing basic training in computer literacy, or teachers may not have access to professional development classes relating to technology (Valadez and Duran 2007).

The third hypothesis $\mathbf{H_{2c}}$: theorizes that integration of technology that is related to *educators' preparation and development* will improve the ability of public school students in the subject area of *science*. This hypothesis was not supported at any grade level (see **Table 4.3**). While literature supports the claim that this area is critical in impacting scores of public school children, it is possible that educators do not have access to technological resources. School classrooms may also lack suitable technology with which teachers could be supplementing lessons (Valadez and Duran 2007).

Key Area III: Leadership, Administration and Instructional Support

Schools planning on integrating technology must have clearly defined goals, share a common vision, and allocate funds towards achieving these goals. Because of these difficulties and challenges, schools must have unified leadership, administration, and instructional support.

The first hypothesis $\mathbf{H_{3a}}$ developed is that integration of technology that is related to *leadership, administration, and instructional support* will improve *reading ability* of public school students. This hypothesis was supported for only 4th graders (see **Table 4.1**). A possible explanation for the improvement in reading ability may be through the enhanced communication and collaboration of teachers, parents and students. Parents of

4^{th} graders are still using a hands' on approach in educating their children. When schools use the web to inform parents and students of homework assignments, there is a unified goal of creating active roles for students and parents, which encourages learning (Web-based Education Commission 2000).

H_{3b} hypothesized that the integration of technology that is related to *leadership, administration, and instructional support* will improve *mathematics ability* of public school students. The results shown in **Table 4.2** support this hypothesis only for 4^{th} and 8^{th} graders. One explanation for the improvement in mathematics ability was evident in 4^{th} and 8^{th} graders could be explained by the role of leadership and instructional support. Administrators for 4^{th} and 8^{th} graders may feel that this is a critical age level among students in facilitating higher order thinking skills, and therefore support the use of computer technology in the classroom.

The third hypothesis developed was **H_{3c}** which states that integration of technology that is related to *leadership, administration, and instructional support* will improve the ability of public school students in the subject area of *science*. This hypothesis was supported only for 8^{th} graders (see **Table 4.3**). At this grade level students showed an improvement in science. The educators and administration on the school campuses may be the source of this improvement. Since 8th graders are not on the same campuses as 11^{th} graders, educators may have developed a more effective plan in integrating technology into the classroom. Schools that implement a plan with clearly defined goals and objectives generally experience an increase in academic performance of public school children. Another possible explanation for this improvement in science ability may be that the middle school campuses are providing funding for technology integration in their annual school budgets (Howley and Howley 2008).

Key Area IV: Infrastructure for Technology

This area of technology integration focuses on how schools acquire technological resources and how they connect to the web. Infrastructure for technology is the critical element that supports the three previous key areas. Schools equipped with computers and other technological resources which aide in integrating technology into the classroom should experience an improvement in reading, mathematics, and science ability.

H_{4a} postulated that the integration of technology that is related to *infrastructure for technology* will improve *reading ability* of public school students. This hypothesis was only supported for 8th graders (see **Table 4.1**). The improvement in reading ability among 8th graders may be due to the availability of technological resources on school campuses. Schools that allowed students to use email or type reports showed an increase in the reading ability among students. It is also possible that middle school campuses have budgeted accordingly and are not subjected to sharing resources between classrooms and teachers. One reason 4th and 11th graders lacked improvement could be that, while the technological infrastructure may exist on the campus, it is not being utilized in the classroom (Maninger 2006).

The second hypothesis **H_{4b}** expected that the integration of technology that is related to *infrastructure for technology* would improve *mathematics ability* of public school students. This hypothesis was not supported for any grade level (see **Table 4.2**). The lack of improvement in mathematics ability may be attributed to a variety of reasons. It is possible that in this area of technology integration, educators are forced to share resources, such as graphing calculators, and projectors, and are not fully equipped with recent technology in the classroom. Another possibility could be that a comprehensive infrastructure does not exist.

H_{4c} hypothesizes that the integration of technology that is related to *infrastructure for technology* would improve the ability of public school students in the subject area of *science*. Again, this hypothesis was not supported for any grade level (see **Table 4.3**). Possible explanations include that, in the subject area of science, technology is not being incorporated into lesson plans. Another explanation for the lack of improvement in science scores is schools may be lacking resources to give each student a computer on which to conduct experiments. “Research has determined that a 1:1 ratio of computers to students is a desirable setting for increased student achievement” (Maninger 2006). Schools may also lack internet access connectivity.

Table 4.1: Relative Impact of the Integration of Technology on Reading Ability of Public School Students

	4^{th} Grade	8^{th} Grade	11^{th} Grade
Key Area I: Teaching and Learning	.042	.125	.301*
Key Area II: Educator Preparation and Development	- .121	-.063	-.006
Key Area III: Leadership, Administration and Instructional Support	.267**	.090	-.053
Key Area IV: Infrastructure For Technology	.066	.121*	-.119
Enrollment	.000	.000**	.001**
% Minority	- .041**	-.044**	-.089**
% Free Lunch	- .207**	-.135**	-.101**
% Expenditure/per student	.001**	.000*	.000
Urban/Rural	2.830**	-1.244**	-3.144
Constant	88.88**	97.91**	100.98*
R-square	.37	.40	.35
F	246.09**	114.51**	74.36**

Cells in the body of the Table represent unstandardized coefficients.
* Significant at $\alpha < .05$ **Significant at $\alpha < .01$

Table 4.2: Relative Impact of the Integration of Technology on Mathematics Ability of Public School Students

	4^{th} Grade	8^{th} Grade	11^{th} Grade
Key Area I: Teaching and Learning	.056	.198	.506**
Key Area II: Educator Preparation and Development	-.128	-.102	-.181
Key Area III: Leadership, Administration, and Instructional Support	.294**	.467**	.085
Key Area IV: Infrastructure For Technology	.088	.178	-.142
Enrollment	.003**	.001	.001**
% Minority	-.047**	-.037	-.110**
% Free Lunch	-.158**	-.292**	-.183**
% Expenditure/per student	.001**	.000	-.001**
Urban/Rural	3.444**	.731	-6.039**
Constant	86.16**	80.40**	98.94**
R-square	.24	.32	.32
F	129.51**	81.97**	62.77**

Cells in the body of the Table represent unstandardized coefficients.
* Significant at $\alpha < .05$ **Significant at $\alpha < .01$

Table 4.3: Relative Impact of the Integration of Technology on the Ability of Public School Students in the subject of Science

	8th Grade	**11th Grade**
Key Area I: Teaching and Learning	.269	.427*
Key Area II: Educator Preparation and Development	-.122	-.204
Key Area III: Leadership, Administration, and Instructional Support	.264**	.093
Key Area IV: Infrastructure For Technology	.107	-.036
Enrollment	.000	.001*
% Minority	-.103**	-.126**
% Free Lunch	-.333**	-.251**
% Expenditure/per student	.000	-.001**
Urban/Rural	-1.934*	-.473**
Constant	91.23**	97.94**
R-square	.51	.41
F	177.40**	94.97**

Cells in the body of the Table represent unstandardized coefficients.
* Significant at $\alpha < .05$
**Significant at $\alpha < .01$

Chapter Summary

The research confirms that, the integration of technology into the classroom positively impacts the academic performance of public school students in different subject areas and in different grade levels. While the academic performance of public school children varies with regard to subject matter and grade level the impact of technology on test scores is clearly evident. **Table 4.4** presents a summary of findings. The impact of technology on academic performance varies depending on the subject and grade level of the student. This study confirmed three hypotheses stipulating that there is a relationship between technology and academic performance.

Table 4.4: Results Summary

Hypotheses	Findings
H_{1a}: Integration of technology that is related to *teaching and learning* will improve *reading ability* of public school students.	**Supported only for 11th graders**
H_{1b}: Integration of technology that is related to *teaching and learning* will improve *mathematics ability* of public school students.	**Supported only for 11th graders**
H_{1c}: Integration of technology that is related to *teaching and learning* will improve the ability of public school students in the subject area of *science*.	**Supported only for 11th graders**
H_{2a}: Integration of technology that is related to *educators' preparation and development* will improve *reading ability* of public school students.	**Not Supported**
H_{2b}: Integration of technology that is related to *educators' preparation and development* will improve *mathematics ability* of public school students.	**Not Supported**
H_{2c}: Integration of technology that is related to *educators' preparation and development* will improve the ability of public school students in the subject area of *science*.	**Not Supported**
H_{3a}: Integration of technology that is related to *leadership, administration, and instructional support* will improve *reading ability* of public school students.	**Supported only for 4th graders**
H_{3b}: Integration of technology that is related to *leadership, administration, and instructional support* will improve *mathematics ability* of public school students.	**Supported only for 4th & 8th graders**
H_{3c}: Integration of technology that is related to *leadership, administration, and instructional support* will improve the ability of public school students in the subject area of *science*.	**Supported only for 8th graders**
H_{4a}: Integration of technology that is related to *infrastructure for technology* will improve *reading ability* of public school students.	**Supported only for 8th graders**
H_{4b}: Integration of technology that is related to *infrastructure for technology* will improve *mathematics ability* of public school students.	**Not Supported**
H_{4c}: Integration of technology that is related to *infrastructure for technology* will improve the ability of public school students in the subject area of *science*.	**Not Supported**

Chapter 5: Conclusion

Research Summary

The purpose of this study is to examine the impact technology integration has on the academic performance of public school children. The first chapter provides an introduction of the topic and explains the importance of the research.

The second chapter discusses recent literature concerning the integration of technology into public schools. The literature revealed that, when technology was integrated into daily classroom activities, academic performance increased in the core subject areas of reading, mathematics, and science. The conceptual framework and hypotheses were presented in this chapter and were supported through direct links to the literature.

Chapter three articulated the methodology used in conducting this research. This chapter outlines how the data was obtained and the study developed. The eight dependent variables along with the four independent variables and five covariates are explained in both text and tabular format.

Chapter four presents the results of the multiple regression analysis. The results were analyzed and discussed in text format and through the use of tables. After analyzing the result, each hypothesis was either supported or not supported, along with possible reasons explaining the outcome.

Summary of Findings

Key Area I: Teaching and Learning. This research found that the integration of technology, as it pertains to teaching and learning, only significantly impacted 11^{th} graders. For 11^{th} graders, technology impacted academic performance in all three subject areas; reading, mathematics, and science. Theoretically, 11th graders may benefit more from technology because of their age. In this key area, active teaching role shifts from the teacher to the students, who are encouraged to take a proactive role in their education. Due to their age, 11th graders easily acclimate to this style of teaching, more so than 4th or 8th graders. Students in the 4th and 8th grades still need more hands on instruction and benefit from traditional classroom activities. It is also possible that 11th graders have a higher level of understanding of technological resources and better incorporate them into research presentations and projects.

Key Area II: Educator Preparation and Development. This research determined that the integration of technology, as it relates to educator preparation and development, had no significant impact on the academic success of school children in any grade or subject. This result was unexpected. The literature review indicated that educator preparation and development was a critical element in effective technology integration, which greatly impacted academic performance. The literature supported the view that educators should participate in professional development classes and learn how to effectively integrate technology into daily curriculum (Valadez and Duran 2007). There may be a variety of reasons why this technology related area showed no impact on improving academic performance. The content of professional development could be insufficient. Continuing education classes may not be training educators in basic computer literacy. It is also possible that technology related professional development classes are not part of school budgets and therefore educators do not have the financial resources to attend these classes. Another deterrent for teachers may be the infrequency in which these classes are offered. If classes are only offered once a year, many educators may not have the opportunity to participate. If educators feel inadequately prepared to implement technology into daily curriculum, it is unlikely that they will assign computer homework (Valadez and Duran 2007).

This research determined that technology integration, as it pertains to Leadership, Administration, and Instructional Support; significantly impacted the academic performance of 4th graders in reading and math, and impacted 8th graders in the areas of math and science. Such positive findings suggest that it is necessary for campuses to develop clearly defined goals and plans in properly implementing technology into the classroom. The impact on 4th in reading and math, and 8th graders in mathematics and science may be due to the fact that the leaders and administrative staff on these campuses feel this is a critical age to establish a strong foundation for higher order thinking skills. Therefore, educators may have developed a unified vision as to how to effectively implement technology into the classroom. However, it should be noted that while impact was evident in reading and mathematics for 4th graders, they were not tested in the subject area of science. It is possible that while leaders and administrative staff have clearly planned goals and objectives, adequate funding is available. Science classrooms typically require more advanced and recent technological resources, so the integration of technology may have already taken place, explaining why impact in 8th grade science scores was seen.

Key Area IV: Infrastructure for Technology. This research determined that technology integration as it pertains to infrastructure for technology showed significant impact on the academic performance of 8th graders in reading. There may be a correlation between these results and student access to the internet (Web-based

Commission 2001). As discussed in the literature, those students who used the internet daily to communicate and do research had increased vocabulary and literacy skills. It is unlikely that 4th graders use the internet and other classroom technology when compared to the frequency of use by 8th graders. However, 11th graders also did not improve their academic performance. Theoretically, the lack of improvement may either be due to lack of access or having to share resources between classrooms (Howley and Howley 2008). While the students per computer ratio have increased in recent years, this is still a problem which may explain why impact was not evident in every subject area.

Recommendations for the future

Researchers may have yet to fully explore the impact computer technology has on academic success. There is still much that is unknown about how technology impacts the learning process. While present research suggests the implementation of technology on academic performance produces a positive effect, the research base is often limited in both scope and methodology. "Hundreds of studies have been attempted to link computer applications to improved academic performance" (Attewell and Belkis et al. 2003, 280). These studies measure the effectiveness of technology in the classroom and often have mixed results, making it difficult to generalize about technology's overall impact in improving learning. At times, mixed results occur due to the differences in software and hardware used from school to school. "Due to the differences in the way technology is used, it may be difficult to obtain uniform and consistent results" (Roschelle et al. 2000, 78). Although this study provides results regarding the impact of technology on academic performance supports limited conclusions, overall it shows that certain technological applications may impact the academic performance of students at various grade levels. By further researching the impact of technology integration on academic performance, researchers may play an active role in helping prepare students for the challenges they will face in a world dominated by technology. In the words of Andrew Trotter (2001), “technology offers tremendous potential for improving the delivery of education and we should not squander this opportunity."

Bibliography

Angrist, Joshua and Lavy, Victor.2002. New Evidence on Classroom Computers and Pupil Learning. *The Economic Journal*. 112 (482): 735-765.

Attewell, Paul. 2001. Comment: The First and Second Digital Divides. *Sociology of Education*. 74

Attewell, Paul., Belkis, Suazo-Garcia, and Juan Battle.2003. Computers and Young Children: Social Benefit or Social Problem. *Social Forces*. 82 (1): 277-296.

Babbie, Earl.2004. *The practice of social research*. California: Thompson Wadsworth.

Becker, Jay H. 2000. Who's Wired and Who's Not: Children's Access to and Use of Computer Technology. *Children and Computer Technology*. 10 (2): 44-75.

Becker, Jonathan D. 2006. Digital Equity in Education: A Multilevel Examination of Differences in and Relationships between Computer Access, Computer Use and State-level Technology Policies. *Education Policy Analysis Archives*. 15 (3) 2-36.

Boss, Suzie and Krauss Jane.2007. Real Projects in a Digital World. *Principal Leadership*. 8 (4): 22-26.

Carvin, A. 2000. Mind the gap: The digital divide as the civil rights issue of the new millennium. *Multimedia Schools*. 7 (1): 56-59.

CEO Forum on Education and Technology.2001. Education Technology Must Be Included in Comprehensive Education Legislation. 3-11. www.ceoforum.org

CEO Forum on School Technology Readiness.2001. Key Building Blocks for Student Achievement in the 21st century. 1-32/ www.ceoforum.org

Howley, Aimee and Howley, Craig.2008. Planning for Technology Integration: Is the Agenda Overrated or Underappreciated? *Educational Planning*. 17 (1) 1-17.

Hubbard, L. 200. Technology-based math curriculums, custom build for today's classroom. *Technology Horizons in Education Journal*. 28(3).

Jones, Ammy. 2004. Exploring the Facts of the Digital Divide in Texas Public Schools Grades K-12. http://www.ecommons.txstate.edu/arp/19

Kalyanpur, Maya and Kirmani, Mubina H. 2005. Diversity and Technology: Classroom Implications of the Digital Divide. *Journal of Special Education Technology*. 20(4): 9-18.

Kosma, Robert B.2003. Technology and Classroom Practices: An International Study. *Journal of Research on Technology in Education*. 36(1) 1-14.

Maninger, Robert M.2006. Successful Technology Integration: Student Test Scores Improved in an English Literature Course through the Use of Supportive Devices. *TechTrends*. 50(5) 37-45.

Means, Barbara.; Roschelle, Jeremy.; Penuel, William.; Sabelli, Nora and Haetel, Geneva. 2003. Technology's Contribution to Teaching and Policy: Efficiency, Standardization, or Transformation. *Review of Research in Education*. 27: 159-181.

Means, B., J. Blando, K. Olson, T. Middleton, C. Morocco, A. Remz and J. Zorfass. 1993. *Using Technolgy to Support Education Reform* U.S. Department of Education, Washington D.C. www.ed.gov/pubs/EdReformStudies/TechReforms

Natriello, Gary. 2001. Comment: Bridging the Second Digital Divide: What Can Sociologists of Education Contribute? *Sociology of Education*. 74 (3): 260-265.

Riel, Margaret and Becker, Hank. 2000. The beliefs, practices, and computer use of teacher leaders. *Teaching, Learning and computing, special report*. Center for Research on Information Technology and Organizations http://wwwl.crito.uci.edu/TLC.

Ringstaff, Cathy and Kelley, Loretta. 2002. The Learning Return on Our Educational Technology Investment: A Review of Findings from Research. 1-30. WestEd RTEC.

Roberts, Linda G. 2000. Appendiz A: Federal Programs to Increase Children's Access to Educational Technology. *The Future of Children*. 10 (2): 181-185.

Roschelle, Jeremy; Pea, Roy D., Hoadley Christopher M., Gordin, Douglas N. and Barbara M. Means. 2000. Changing How and What Children Learn in School with Computer-Based Technologies. *The Future of Children.* 10 (2): 76-101.

Rouse, Cecilia E. and Lisa Barrow. 2006. U.S. Elementary and Secondary Schools: Equalizing Opportunity or Replicating the Status Quo? *Opportunity in America*. 16 (2): 99-123.

Schacter, John. 1999. The Impact of Education Technology on Student Achievement: What the Most Current Research Has To Say. *Milken Exchange on EducationTechnology*. http://www.milkenexchange.org

Shelley, M.C., Thrane, L.E. and Shulman, S.W. 2006. Lost in cyberspace: barriers to bridging the digital divide in e-politics. *Int.J. Internet and Enterprise Management*. 4(3): 228-243.

Shields, Margie K. and Richard E. Behrman. 2000. Children and Computer Technology: Analysis and Recommendations. *The Future of Children* 10 (2): 4-30.

Shields, Patricia M.1998. Pragmatism as philosophy of science: A tool for public administration. *Research in Public Administration*. 4: 195-225.

Shields and Tajalli.2005. Theory: The missing Link in successful student scholarship. http://ecommons.tx.state.edu/polsfacp/7

Sivin-Kachala, J.1998. Report on the Effectiveness of technology in schools. 1990-1997. Software Publisher's Association.

Swain, Colleen and Pearson. 2003. Educators and Technology Standards: Influencing the Digital Divide. *Journal of Research on Technology in Education*. 34 (3):326-335.

Texas Education Agency. Instructional Materials and Educational Technology Division. 2008. School technology and Readiness: A Teacher Tool for Planning and Self-Assessing aligned with the Long-Range Plan for Technology. http://www.tea.state.tx.us/starchart/search

Trotter, A.2001 Federal Study Details Major Barrier to Internet Learning. *Education Week*. 20(16):34.

United States. Department of Commerce (1999). *The Emerging Digital EconomyII.* http://www.ecomerce.gov/ede/ede2.pdf

Ungerleider, Charles S. and Tracey C. Burns (2002) Information and Communication Technologies in Elementary and Secodary Education: A State of the Art Review. *Information Technology and Learning* 2-28.

U.S. Department of Commerce. Economic and Statistics Administration National Telecommunications and Information Administration. 2000. Falling Through the Net: Toward Digital Inclusion. http://www..ntia.doc.gov/ntiahome/fttn02/falling.html

U.S. Department of Education. National Center for Education Statistics.2000.*Teachers Use of Computers and The Internet in Public Schools*. NECS 2000-090.

U.S. Department of Education. 2003. *Internet Access in Public Schools and Classrooms*: 1994-2002.

U.S. Department of Education 2001. Enhancing Education through Technology www.ed.gov/porgrams/edtech/index.html

Valadez, James and Richard Duran.2007. Redefining the Digital Divide: Beyond Access to Computers and the Internet. *The High School Journal*. 90 (3): 31-44.

Wallace, Raven McCrory. 2004. A Framework for Understanding Teaching with the Internet. *American Educational Research Journal*. 41 (2): 447-448.

Web-based Education Commission.2000. The Power of the Internet for Learning: Moving from Promise to Practice. 1-84.

Wenglinksy, H. 1998. Does it compute? The relationship between educational technology and student achievement in mathematics. *National Educational Testing Service.*

Yau, Ray. 1999. Technology in K-12 Public Schools: What are the Equity Issues? *Equity Review*. 1-10.