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Technology in low socio-economic K-12 schools: Examining student access and implementation

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Technology in Low Socio-Economic K-12 Schools:

Examining Student Access and Implementation

by

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TECHNOLOGY IN LOW SOCIO-ECONOMIC K-12 SCHOOLS: EXAMINING STUDENT ACCESS AND IMPLEMENTATION

Katherine J. Kemker

ABSTRACT

Over the past twenty years, there has been an enormous financial investment in technology for K-12 schools to help bridge the digital divide between high and low socioeconomic (SES) students. These investments have included hardware, software, professional development, and research studies on the effectiveness of technology in the classroom.

This dissertation explored the essential conditions for the integration of technology, access, student-centered learning environment, and teacher use in the curriculum. Florida's elementary schools were divided into quartiles based on free and reduced lunch to investigate differences between the top quartile of high SES schools (n=400) and the lower quartile of low SES (schools n=396). The first research question investigated students' access to technology by specifically concentrating on their access to computers in high and low SES schools. A statistically significant difference was found between students' access to modern computer labs and modern laptop computers. However, there were no significant differences in access to modern classroom computers. When looking at software on student computers, a statistically significant difference between high and low SES schools was found in the availability of both basic tool-based

software and robust tool-based software. These data mirrored the statistically significant difference for frequency of use for tool-based software at high and low SES schools. Data on the teacher use of technology in the curricular framework of the classroom showed a statistically significant difference in the curriculum-focused use of technology, between high and low SES schools.

This study is a building block for further examination of the digital divide that exists between high and low SES schools. This divide appears to include low expectations for students in low SES schools through regular exposure to drill and practice software, while students in schools with high-SES populations have more opportunities to utilize tool-based software.

CHAPTER ONE

INTRODUCTION

In a speech to the Commonwealth Club of California, former United States Secretary of Education, Rod Paige, remarked on the "soft bigotry of low expectations" for low socioeconomic students. He stated that educators must "let go of the myths and perceptions about who can learn and who can't" to ensure that all students despite their level of poverty can reach high academic standards (U.S. Department of Education [USDOE], March 12, 2003, p. 2). The passage of the federal *No Child Left Behind (NCLB) Act of 2001* legislation reinforced the belief that all children can learn through the achievement of high academic standards (USDOE, 2002). This movement in the field of education emphasizes the use of rigorous curriculum for all students with the expectation of a shift in the type of curriculum being offered to students of poverty in low socioeconomic schools (Borman, 2003).

Research is revealing a pedagogical gap between schools in low and high socioeconomic status (SES) neighborhoods. Grading standards have been found to be lower in low SES schools because less curriculum material has been covered (Biddle & Berliner, 2002). In low SES schools, curriculum has been implemented that aims at the "basic" elements of the content to be learned on the assumption that no more can be managed and that mastery of the basics is the important accomplishment (Knapp, 1995).

A "pedagogy of poverty" has emerged in which students are given direct instruction in order for the teacher to maintain control in the classroom (Haberman, 1991).

An analysis of Title I schools conducted for the U. S. Department of Education found that students performed better in reading when teachers spent less time on basic instruction, followed by students filling out worksheets, and more time in exploration activities, such as problem solving (USDOE, 2001). Educational researchers concur inequities exist in the curriculum offered to low income students, in that cognitively rich tasks that require critical thinking are often missing (Darling-Hammond, 1997; Haycock, 2001; Wenglinsky, 2005). A curriculum must be developed for low socioeconomic schools that helps students to draw upon their strengths, skills, and prior knowledge in the learning environment (Marlowe & Page, 1999).

Newmann (1996) developed a curriculum called authentic pedagogy that requires students to construct meaning or knowledge, engage in disciplined inquiry, and work on products that have value beyond school. Students are given challenging academic lessons that involve the development of higher-order cognitive skills rather than merely responding to lower-order skills found in the pedagogy of poverty (Newmann, Wehlage, & Lamborn, 1992). Research has shown positive outcomes when this curriculum approach has been implemented in the classroom (Avery, 1999; Newmann, 1996).

Role of Technology

A technology enriched learning environment has the potential to deepen classroom instruction to make it more meaningful and assist in the development of higher-order thinking skills (Niemiec & Walberg, 1992). This type of environment entails a teacher and students' seamless access to technology in the classroom. When technology is used in this manner, it empowers students to develop thinking skills that allow them to help themselves (Kelley & Ringstaff, 2002; Mann, 1999). Students in a technology rich classroom tend to become more engaged and more active learners because of greater emphasis on inquiry and less on drill and practice (Bozeman & Baumbach, 1995; Sandholtz & Dwyer, 1997).

Since 1990, the United States has invested over forty billion dollars to provide technology for the K-12 classrooms. These federal dollars have come in various forms, such as E-Rate funding, *Technology Literacy Challenge Funds (TLCF*), and *Preparing Tomorrow's Teachers to Use Technology (PT3)*. Each source of funding had a specific purpose for the use of technology (McMillan-Culp, Honey, & Mandinach, 2003). For example, E-Rate supplies funding to schools with the expectation that every student will have access to the Internet. The goal of the *TLCF* program was to provide computers in the classroom, and funding has been provided through *PT3* to train pre-service teachers on the use of technology in the classroom (Dickard, 2003).

NCLB mandates the effective integration of technology into the curriculum of public schools for all students in the United States. This landmark legislation provides federal dollars through Title II Part D, *Enhancing Education Through Technology (EETT)* with the stipulation that both state and local educational agencies develop a comprehensive plan for the integrated use of educational technology into instruction and curricula to improve teaching and student achievement. The deadline placed on educators is "that technology will be fully integrated into the curricula and instruction of the schools by December 31, 2006" (USDOE, 2002, p.1676).

Defining Technology Integration

Unfortunately, a consistent definition for the integration of technology in the curriculum has never been adopted. Even the term "technology" can have varied interpretations. For example, administrators, teachers and policymakers often make the assumption that technology refers simply to a computer. However, Kelley and Ringstaff (2002) define technology as a variety of digital devices, from computers to digital cameras to software. For the purpose of this study, the term "technology" will include computers, application software, and digital devices, such as digital cameras, digital microscopes, and digital video cameras.

The integration of technology in the classroom is a process that involves change in an educational system and occurs over a period of time (National Center for Education Statistics [NCES], 2002). The attainment of this goal entails a reform in the teachers' method for the delivery of instruction with students. The National School Boards Association stated that the integration of technology is as much about change as it is about technology because educators must reform their teaching to integrate technology (Tiene & Luft, 2002). Researchers have concluded, "The magic lay not exclusively in the technology, but in the interweaving of a systematic program of education reform with the judicious use of technology-based resources" (Chang, Henriquez, Honey, Light, Moeller, & Ross, 1998, p. 43).

This process of change takes time, as a culture must be developed in the classroom that embraces technology as a “natural” part of the everyday work routine (NCES, 2003). According to Sandholtz, Ringstaff, and Dwyer (1997), there is an evolution of thought and practice that occurs with teachers during the process of change that teachers undergo with the integration of technology. At each stage of the process, the teacher adopts and implements technology in the curriculum (Dooley, 1999; Hall & Hord, 2001; Painter, 2001; Sandholtz, Ringstaff, & Dwyer, 1997). The integration of technology in the educational system is a time-consuming process in which teachers must change their beliefs about teaching and learning.

Regrettably, the pedagogical divide is also reflected in the use of technology. Low SES schools frequently use technology for drill and practice, while high SES schools use technology for higher-order thinking skills (Becker & Ravitz, 1998; Becker, Ravitz, & Wong, 1999; Wenglinsky, 2005). For example, students in low SES schools most commonly use technology for lower-order tasks, such as drill, practice, and test taking, whereas students in affluent, high SES schools have more opportunity to create web sites and multimedia presentations (Reid, 2001). Wenglinsky (1998) found that students of poverty use computers for “drill-n-skill” purposes. Likewise, when Herbert Kohl examined the use of computers with inner city students, he found a “covert” racism in the limits to the types of activities being done with students of poverty (Reid, 2001).

Recent studies suggest that research should move beyond a focus on the technology to an interest in designing an environment that fosters the disposition for critical thinking (Kelley & Ringstaff, 2002; Wenglinsky, 2005). The restructuring of the classroom should include the use of technology to provide active learning, authentic tasks, challenging work, problem solving, and higher-order thinking skills (Dalton & Goodrum, 1991; David, 1993).

Purpose

In the last four years, the state of Florida has received over $175 million dollars of federal funds through the *EETT* program for an average of 2.5 million students per year. However, research on the use of technology with low socioeconomic students has been very limited. The legislation of "No Child Left Behind" demands more resources for students in low socioeconomic classrooms. With more technology funds being provided to the schools, it is important to recognize and understand how effectively technology is being integrated that promotes higher-order thinking skills.

The purpose of this study is to examine the use of technology with low and high socioeconomic students in the state of Florida. In response to the *NCLB* legislation, the Florida Department of Education significantly revised its annual technology survey to provide more meaningful information about technology integration and capacity in Florida's schools. The implementation of the survey is an iterative process that entails a variety of individuals from the district level personnel to the school based technology specialist. During this process, the district and schools are able to be in constant communication to verify the accuracy of the data.

In 2002, the technology resource survey was piloted with schools in Florida based on benchmarks to provide schools with a tool for use in goal setting and technology planning. Revisions to the survey were based upon these benchmarks and the pilot study.

Historical data from the 2005-06 Florida Technology Resource Survey (TRS) were analyzed to examine the use of technology with low SES students in Florida. The TRS is divided in five sections, *Digital Learning Environment, Instructional Leadership, Florida's Digital Educators,* and *Access to Technology* with 78 survey items.

Research Questions

This study used data from the last three years of the Technology Resource Survey to examine the following questions in elementary schools:

1. Is there a significant difference between students' access to computers in high and low socioeconomic schools?
   a. Is there a significant difference in the total number (desktops and laptops) of modern and non-modern computers?
   b. Is there a significant difference in the locations of the computers for student use?
2. Is there a significant difference in the types of software available on computers between high and low SES schools?
3. Is there a relationship between the socioeconomic status of an elementary school and the frequency of student use by software type?
4. Is there a relationship between socioeconomic status of an elementary school and the teacher use of technology in the classroom?

Significance of the Study

Findings from this study expand our knowledge about the use of technology in high and low SES schools. Data from this study informs policy makers and state/district level administrators on how to plan for the high level integration of technology in all public schools. In addition, the data provide guidance on professional development for teachers on the use of technology with low SES students.

Limitations

A limitation of this study is the use of survey data in which the purpose is to provide information on the accessibility, use, and accountability of technology in schools. These data represent one moment in time from the individual who submits the survey and do not represent the actual classroom implementation by the teacher. The data collected reflects the interpretation of an individual who reports the data based on their perception of the use of the technology in the classroom.

Another limitation is a clear definition for the types of software programs being reported on the computers and the pedagogical use with students in the classroom. The data on the software programs is a generic representation for types of software programs being purchased for the computers. This data does not reflect how the software is actually being integrated into curriculum by the teachers. In addition, these data are reported by individuals, such as principals, technology coordinators, and media specialists that are not in the actual classroom.

Definitions

Authentic instruction. A model for high quality instruction that incorporates five main components of higher order thinking, depth of knowledge, connectedness to the world beyond the classroom, substantive conversation, and social support for student achievement.

Authentic standards. The five standards for authentic instruction: higher-order thinking; 2) depth of knowledge; 3) substantive conversation; 4) connections to the world beyond the classroom; and 5) social support for student achievement.

Curriculum-based software. Program based software that focuses specifically on curriculum and content areas.

High socioeconomic status. The top quartile of schools in which less than 40% of the students qualify for free and reduced lunch.

Low socioeconomic status. The bottom quartile of schools in which more than 75% of the students qualify for free and reduced lunch.

National Educational Technology Standards. The technology standards established for teachers and students. The six standards are premised on the use of technology to develop students: basic operations and concepts; social, ethical, and human issues; productivity tools; communication tools; research tools; and problem-solving and decision-making tools.

Pedagogy of poverty. A series of basic traditional core functions, such as teachers giving information, assigning homework, and monitoring seatwork that constitutes an instructional method.

Project-based learning. An instructional method organized around projects that allow students to encounter and learn the central concepts of the subject through real-world projects.

Technology integration. The seamless use of technology as a tool to accomplish a given task in a disciplined study that promotes higher order thinking skills.

Tool-based software. Application based software that provides opportunity for teachers and students to perform a task.

21st century skills. Those skills that have been identified as information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills.

CHAPTER TWO

LITERATURE REVIEW

The review of the literature is organized into three sections. The first section provides a theoretical understanding for defining technology integration technology in the classroom. The second section examines research on the essential conditions for integrating technology in the classroom. The final section provides an overview of research related to technology use with students from low socioeconomic status.

Defining Effective Technology Integration

Technology integration entails the students' seamless use of technology as a productivity tool to accomplish a given task in a disciplined study that promotes higher-order thinking skills. Integration is the assimilation of technology resources and technology enabled practices as a routine and seamless element of the day, so that students are prepared to use technology for the workforce (NCES, 2002). Technology is a tool to be employed by students in all curriculum areas to acquire new knowledge and skills, analyze and synthesize data, then construct a product that demonstrates their knowledge (NCES, 2003; Partnership for 21st Century Skills, 2002). This definition of technology integration in the classroom is based on NETS (the National Technology Standards for Students that were developed by ISTE in 2004), authentic instruction (Newmann & Wehlage, 1995), and Stages of Instructional Evolution (Sandholtz, Ringstaff & Dwyer, 1997).

National Educational Technology Standards

In the last century, there has been a move toward identifying and implementing state and national technology standards for students and teachers. In 1998, the International Society for Technology in Education (ISTE) published their National Educational Technology Standards (NETS) for Students. Two years later, ISTE published standards for teachers, which was followed in 2001 by standards for administrators. As of May 19, 2004, 33 states had adopted, adapted, or aligned with the ISTE standards for students. In addition, 34 states were using the ISTE standards for teachers and 29 states were implementing the ISTE standards for administrators (International Society for Technology in Education [ISTE], 2004).

In addition to basic computer operations and social/ethical issues, the NETS standards for students focus on using technology as a classroom tool for productivity, communication, research, and problem-solving/decision-making. Specifically, the NETS for students categorize technology competencies into six areas:

1. Basic operations and concepts
2. Social, ethical, and human issues
3. Technology productivity tools
4. Technology communication tools
5. Technology research tools
6. Technology problem-solving and decision-making tools

The categories provide a framework for linking performance indicators to the standards for Grades PreK-2; 3-5; 6-8; and 9-12. It is recommended that the skills be integrated into a student's personal learning and social framework, by being introduced in the classroom, reinforced, and finally mastered. The intent of the standards is for technology to be an integral component or tool for learning within the context of academic subject areas (ISTE, 2000).

In the first category, *basic operations and concepts*, students should be able to demonstrate a basic understanding of technology, such as computers, television, digital cameras and additional peripherals. Performance indicators at various grade levels might include being proficient in the use of computer terminology, proper care of the monitor, and selection of a printer (ISTE, 2004).

The second category, *social, ethical and human issues*, pertains to various issues involving the use of technology. Students should demonstrate technology literacy (in areas such as legal and ethical behaviors). A sample performance indicator would include students being able to evaluate the media images that surround them to make responsible choices about what they see and hear (ISTE, 2004).

In the third category, *technology productivity tools*, students use various forms of technology to create different types of media such as documents, movies, pictures, and spreadsheets. In addition to using the computer, students demonstrate proper use of an assortment of hardware such as probes, scanners, and digital cameras to construct their knowledge (ISTE, 2004).

The fourth category, *technology communication tools*, focuses on students' use of various media to converse and interact with their peers, experts, and other audiences. Performance indicators include being able to collaborate, communicate, and interact effectively with a range of audiences for both direct and independent learning (ISTE, 2004).

In the fifth category, *technology research tools*, students use diverse forms of technology as a tool to locate, evaluate, and collect information from a variety of sources. Performance indicators include the ability to evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of online information (ISTE, 2004).

In the sixth category, *technology problem solving and decision-making*, students use technology to develop strategies for recognizing and solving real world problems. They should be able to identify a problem, ascertain if technology is useful in solving the problem, and, if so, select and implement the appropriate tools (ISTE, 2004).

Authentic Instruction

The NETS for students provide a basic framework for the use of technology in the classroom, while the theory of authentic instruction aims to engage students in authentic activities (Newmann & Wehlage, 1995). In 1990, the Office of Educational Research and Improvement of the U.S. Department of Education funded the University of Wisconsin's Center on Instructional and Restructuring of Schools to conduct a five-year program of research on School Restructuring to support authentic learning (Newmann & Wehlage, 1995; Newmann, 1996). Researchers visited over 60 schools across the country that were involved in restructuring efforts, and observed instructional activities, assessments, and student work in mathematics and social studies in 24 of those schools (Newmann & Wehlage, 1993).

Because of the dynamic and social nature of the activities, researchers noticed in the schools a widespread use of instructional techniques that resembled both social and psychological constructivism. Students were engaged in activities to create projects, compile portfolios, produce performances, complete experiments, and analyze data from surveys. The researchers recognized and appreciated the active learning in the classrooms but were concerned:

> Assuming the central purpose of teaching is to help students to use their minds well, then education reform must involve more than innovation in teaching technique, method, or procedure. The merit of any technique, whether conventional or innovative must be judged on its capacity to improve the intellectual quality of student performance (Newmann, Secada, & Wehlage, 1995, p.3).

Authentic Pedagogy. The theory of authentic pedagogy is based on the premise that students' work in the classroom should prepare them for the intellectual work that will be demanded of them as adults (Newmann & Wehlage, 1995). Newmann (1996) states that authentic pedagogy "stands for intellectual accomplishments that are worthwhile, significant, and meaningful, such as those undertaken by successful adults" (p. 23). He goes on to elaborate this theory with three criteria for authentic intellectual work: student construction of knowledge, discipline inquiry, and value beyond the classroom (Newmann, 1996).

First, students need to be constructors of knowledge, built on what they already know. The goal of instruction should be deep understanding of concept development through cognitive development or knowledge building rather than the development of behaviors or skills (Fosnot, 1996). From this perspective, learning is viewed as an active process and teaching as a means of facilitating active student mental processing (Gagne, 1985). When students construct knowledge it involves “organizing, interpreting, evaluating, or synthesizing prior knowledge to solve new problems” (Newmann, Bryk, & Nagaoka, 2001, p. 19).

The second criterion for significant authentic pedagogy requires disciplined inquiry that involves the use of a prior knowledge base, in-depth understanding, and elaborated communication. Students must acquire the knowledge base of facts, vocabularies, concepts and theories necessary for their inquiry. Knowledge becomes most powerful when students can use information to gain a deeper understanding of specific problems. Students must rely upon complex forms of communication, both to conduct their work and to present their ideas (Newmann, Bryk, & Nagaoka, 2001).

The final criterion of authentic pedagogy is for the task to “have meaning or value apart from documenting the competence of the learner” (Newman, Secada, & Wehlage, 1995, p.11). Instructional activities might include allowing students’ experiences outside of school to be integrated into those activities in the classroom. The concept of value beyond school involves the transfer of knowledge to an area that has personal significance for the students. When students are involved in an activity that has no value beyond measuring their success in school, “success in these tasks often carries no adaptive value, because large numbers of students consider school to only be a restricted, even an insignificant, arena of personal experience" (Newmann, Marks, & Gamoran, 1996, p. 286).

Authentic Standards. The standards for authentic instruction describe the cognitive connections that authentic tasks promote. For example, Wiggins (1998) defines authentic instruction as "the situational or contextual realism of the proposed tasks" (p. 21). Similarly, Darling-Hammond (1995) contends that authentic tasks should be set in a "meaningful context that provides connections between real-world experiences and school-based ideas" (p. 4). Authentic instruction involves tasks that generally engage students in "ill structured" challenges and roles that guide students for real world situations (Wiggins, 1989).

Authentic instruction is meaningful instruction. Teachers are able to move students beyond memorization of facts by creating experiences that demand sustained, disciplined, and critical thinking on topics that have relevance to life beyond school. The scale for the five standards of authentic instruction is shown in Figure 1.

Higher-order Thinking
Lower-order thinking only …2…………..3………4…… Higher-order thinking is central
Depth Knowledge
Knowledge is shallow …….2……………3…………….4……………Knowledge is deep
Substantive Conversation
None ………………………2…………..……3………..…..4…………………… High level
Connections to the world beyond the classroom
No connection …………….2……………..3…………...4……………………. Connected
Social Support for Student Achievement
Negative social support ……2……………3…………....4….…….. Positive social support

Figure 1. Scale levels of authentic instruction

The standards of authentic instruction are continuous constructs of quality from "less" to "more" rather than categorical variables (Newmann & Wehlage, 1995). Each of the constructs uses a five-point scale to measure the extent of authentic instruction in a particular lesson in the classroom. For example, the first construct measures the degree of higher-order thinking in a task given to students. In lower-order thinking, students are recipients of information; in this role, students simply recite information. However, at higher-order thinking, students are manipulating information and are involved in tasks that require problem solving and decision-making skills (Newmann, Marks, & Gamoran, 1996).

The framework for the five standards of authentic instruction can be used as a research tool or a reflective critique of teaching. In the role of research, the framework has been utilized to estimate the levels of authentic instruction in social studies and mathematics in K – 12 schools. Researchers were able to examine the conditions under which "restructuring" improves instruction in teachers instructional skills. The framework also allows teachers, either alone or with peers, to reflect upon their teaching. The standards provide criteria for examining the extent to which certain lessons and activities provide for authentic learning (Newmann & Wehlage, 1995).

Stages of Instructional Evolution

Over a decade ago, the Apple Classrooms of Tomorrow (ACOT) project began with the assumption that computers and technology would impact the classrooms (Office of Technology Assessment [OTA], 1995). The ACOT project trained teachers on the integration of computer technology in the classroom. This project was a collaboration among public schools, universities, research agencies and Apple Computer. Over one hundred schools around the United States were selected to begin integrating computer technology in the classroom (Fouts, 2000). The majority of the research was qualitative in nature.

In the ACOT classrooms, students and teachers had immediate access to a wide range of technologies including computers, videodisc players, video cameras, scanners, CD-ROM drives, modems and online communication services. Technology in the ACOT classroom was viewed as a tool for learning and a medium for thinking, collaborating, and communicating (Sandholtz, Ringstaff, & Dwyer, 1997). The teachers were trained on basic troubleshooting and tool-based software such as spreadsheets, databases, and graphic programs (Kelley & Ringstaff, 2002).

Using technology in this context changed the role of the teacher (Ringstaff, Sandholtz, & Dwyer, 1997). The teachers involved in the study began to reexamine their instructional strategies, and began to see themselves as facilitators. Teachers began to take a constructivist approach, realizing that teaching is more than transferring ideas from one who is knowledgeable to one who is not. Instead, learning was perceived as a personal, reflective, and transformative process (Sandholtz, Ringstaff, & Dwyer, 1997).

As the role of the teacher changed, the role of the student also changed, moving from a passive role to an active role in learning. Students were provided with the opportunity to collaborate with other students on projects and given tasks. Teachers in the study observed numerous changes in student engagement with the introduction of technology in the classroom. Students became empowered when they were able to take responsibility for their learning as they interacted with the computer, designing and using their own instructional materials (Dixon-Krauss, 1996). Often, students displayed increased initiative by going beyond the requirements of assignments to independently explore new applications (Sandholtz, Ringstaff, & Dwyer, 1994).

Research from the ACOT project demonstrated that the introduction of technology to the classroom could increase the power for learning. (Sandholtz, Ringstaff, & Dwyer, 1990). However, the mere placement of the computer in the classroom did not change the learning environment; computer-based activities had to be related closely to those activities already taking place in the classroom for change to happen (Reilly, 1992).

Even when classrooms were drastically altered and teachers were willingly immersed in innovation, the change was slow, and often filled with temporary regression.

The ACOT study focused on both the process of the integration technology in the curriculum, as well as the adoption of the innovation, access to computers at the classroom level (Coley, Cradler, & Engel, 2000). This ten-year study produced an adoption model for the use of computer technology in the classroom known as the Stages of Instructional Evolution. This model states that educators go through five stages when adopting technology in the classroom: (a) entry, (b) adoption, (c) adaptation, (d) appropriation, and (e) invention (Sandhotz, Ringstaff, & Dwyer, 1997).

Researchers found that at each phase during this model, teachers varied their utilization of technology both personally and pedagogically. For example, at the entry stage, teachers were still not comfortable using technology and tended to use direct instruction and whole class activities. However, at the adaptation stage, teachers began to make the transition to using technology within the context of the curriculum. Finally, at the innovation stage, teachers and students were engaged in activities where technology was used to construct knowledge in a meaningful context (Sandholtz, Ringstaff & Dwyer, 1997).

Summary

The Stages of Instructional Evolution (Sandholtz, Ringstaff, & Dwyer, 1997), the NETS (ISTE, 2004) and authentic instruction (Newmann & Wehlage, 1995) provide the framework for defining the levels of technology integration in the classroom. The NETS for students (ISTE, 2004) establishes the role of technology in the classroom, while the standards for authentic instruction define the instructional methods for engaging students in authentic tasks (Newmann & Wehlage, 1995). Finally, the Evolution of Thought and

Practice establishes the stages of teachers use of technology in the classroom (Sandholtz, Ringstaff, & Dwyer, 1997). Hence, the optimal integration of technology in the classroom entails students' seamless use of technology as a productivity tool to accomplish a given task in a disciplined study that promotes higher-order thinking skills.

Essential Conditions

The integration of technology in the classroom requires a reformation of instructional practice by all individuals in the educational system. Three essential conditions have consistently emerged from the research on technology integration in the classroom (Glennan & Melmed, 1996; Kelley & Ringstaff, 2002; Sandholtz, Ringstaff, & Dwyer, 1997). First, teachers must have access to technology, such as laptop computers and tool-based software, in the classroom (Fisher, Dwyer, & Yocam, 1996; Mann, 1999; and Stratham & Torell, 1999). Second, teachers must develop a student-centered learning environment in which technology can be utilized for a higher level of integration (Means, Blando, Olson, & Middleton, 1993; Penuel & Means, 1999; Silverstein, Frechtling, & Miyoaka, 2000; Statham & Torell, 1999). Finally, technology tasks must be embedded in the curriculum framework (Coley, Cradler, & Engle, 1997; Sandholtz, Ringstaff, & Dwyer, 1997; Silverstein, Frechtling, & Miyoaka, 2000).

Access to Technology

In the last 20 years, there has been a major transformation in the access to computers for students in the classroom (NCES, 2005; Trotter, 2005). Since the early 1980's, the primary intent of federal funding has been to reduce the student to computer ratio. Nationally and locally there has been a significant progress toward this goal. In

1983, the ratio was 92 students per computer (at school); five years later, the ratio decreased to 27 students per computer, and ten years later, the ratio was just under 6 students for each computer (Technology Counts, 2005).

While studies have shown a decrease in the student/computer ratio, teachers continue to report that the lack of access to computers in the classroom is a significant barrier to technology integration. The location of the computers affects the accessibility for teachers in the classroom (Livingston & Wirt, 2005; Statham & Torrell, 1999). Computers maybe distributed among the classrooms, centralized in one area of the school, or a combination of the two approaches (Mann, 1999). However, computers in the classroom rather than in a separate computer lab are more likely to facilitate positive social interactions and students' use of technology a tool in the curricula (Clements, 2002; Knapp & Glenn, 1996).

Laptop computers. Almost a decade ago, education reformers began implementing initiatives in which both students and teachers were provided their own laptop computer. In 1996, the Learning with Laptops program began in Beaufort County School District in South Carolina when 300 sixth grade students were given laptop computers (Stevenson, 1999). That same year, Microsoft and Toshiba began the Anytime Anywhere Learning project with 19 pioneer schools in the United States receiving laptop computers (Rockman et al., 1998). Large-scale initiatives, such as those in Henrico County, Virginia, and the state of Maine, have placed 24/7 accesses to laptop computers in the hand of tens of thousands of teachers and students (Rockman, 2003; Zucker, 2004).

Another strategy has been to obtain a classroom set of laptop computers that is stored on a recharging cart, allowing access for any classroom in a school (Rockman, 2003). These class sets serve as portable labs that provide access to laptop computers for classroom use to complete a given task that utilizes technology in the curricula. While access is limited to the availability of the laptop cart in this strategy, this approach does overcome one barrier to the integration of technology by providing all students access to laptop computers.

The emergence of laptop computers in the classroom has enabled a shift in the focus of research for technology. Rather than focusing on the adoption of technology in the classroom, researchers have begun to examine the integration of laptops in the school infrastructure, the unique advantages of laptops in the classrooms, and student motivation with laptop computers (Rockman, 1998; Fouts & Stuen, 1997; Stevenson, 1998). Unfortunately, the majority of this research has been limited to those universities and districts implementing laptop computers in classrooms of students with high achievement and high socioeconomic status.

For three years, Rockman and an independent research organization evaluated Microsoft's Anytime, Anywhere Learning Program. This three-year study included eight school sites with three of the schools matched and five of the schools unmatched. A total of four hundred sixty students from grades 7 through 11 and 47 teachers from both public and private schools were involved in the study (Rockman, 1998).

The first year of the study examined the challenges and success of the implementation of laptops in the classroom. The second and third year focused on the impact of teaching and learning in the laptop classroom and how it supported the constructivist pedagogy. The data collected for this study included student and teacher questionnaires, test scores, student and teacher computer usage logs, interviews with administrators, and the analysis of standardized test scores (Rockman, 1998).

The study found that students who had access to technology increased their use of technology. In addition, more opportunities existed for individual access; laptop students used the Internet more frequently and for longer periods of time than non-laptop students. The laptop users spent more time doing their homework and used the computer at home for a variety of tasks (Rockman, 1998). Finally, researchers noted a move toward constructivist ideals and pedagogy. The ubiquitous technology was a catalyst for the change to more independent efforts and less direct instruction (Fouts, 2000; Rockman, 1998; Rockman, 2000).

In another study that focused on Title I schools, Ross studied the effectiveness of providing fifth and sixth grade students in Walled Lake Consolidated schools with access to laptop computers. This study concentrated on the use of laptop computers with regard to learning activities, technology usage, and writing achievement. The district had been part of the Anytime Anywhere Learning program since 1996. The laptop computers were available for a lease of fifty dollars a month. The training of teachers was based on framework to develop problem-based lessons that utilize real-world resources, student collaboration, and the use of computer tools to reach solutions. The lessons were structured around projects which engage students in examining community and global issues (Lowther, Ross, & Morrison, 2001).

The data collected included classroom observations, student writing test scores, student surveys and focus groups, teacher surveys and interviews, and parent surveys and interviews. Observation instruments included the *School Observation Measure (SOM)* and the *Survey of Computer Use (SCU)*. The *SOM* was based on 60 continuous minutes of observation, divided into four, fifteen-minute segments. The four observation periods were then summarized on one SOM Data Summary form. The *SCU* was completed as part of the 60-minute observation sessions, only if students were using technology during that time (Lowther, Ross, & Morrison, 2001).

Researchers found that teachers in the laptop classrooms tended to integrate technology more in their curriculum with student-centered strategies such as project-based learning, inquiry research, and cooperative learning. Observers found that laptop classrooms were engaged with the computer as an educational tool. The majority of teachers reported they were teaching differently than before by integrating technology into both existing lessons and newly developed lessons. The implication from the multiple data sources was as a consequence of all students having continual access to individual computers an active learning environment was created in the classroom (Lowther, Ross, & Morrison, 2001).

Student-Centered Learning Environment

The second condition for effective technology integration is the development of a student-centered learning environment. Kelley and Ringstaff (2002) stated that if technology is to be used in powerful ways, the role of the teacher in the classroom must change. The traditional model of instruction is the lecture-recitation-seat work model in which the teacher is the focus of the instruction and the only source of knowledge. In a student-centered environment, the teachers' role becomes one of a facilitator for learning as students were guided to take an active role in constructing their knowledge (Penuel & Means, 1999; Silverstein, Frechtling, & Miyoaka, 2000; Statham & Torell, 1999). Students become active learners because they are engaged in collaborative and project-based learning environments with an emphasis on higher-order thinking skills (Penuel, Golan, Means, & Korback, 2000).

In a 1995 report to the U.S Congress, the Office of Technology Assessment (1995) proposed that using computers could change the way teachers teach. This report stated that some teachers use computers in a traditional "teacher-centered" method, such as drill and practice for mastery of basic skills, or to supplement teacher-controlled activities. However, other teachers use technology to support more student-centered approaches to instruction, such as providing students with the opportunity to conduct their own scientific inquires and engage in collaborative activities while the teacher assumes the role of facilitator or coach. The learner-centered framework focuses on the learners and their perceptions, needs and motivations (McCombs, 2000). Teachers who fall into this second group are the more enthusiastic technology users, because technology is particularly well suited to support this style of instruction (OTA, 1995).

Ausubel (1963) contends that meaningful learning occurs when new experiences are relative to what a learner already knows. While developing expert systems, Jonassen, Wilson, Wang, and Grabigner (1993) found that the people who seem to learn the most from the design of instructional materials are the designers themselves. When students are provided the opportunity to produce their own knowledge, it becomes a powerful learning experience. The use of technology as a cognitive tool requires students to think in meaningful ways about the application's capabilities (Jonassen & Reeves, 1996).

The traditional use of the computer in the classroom has been to teach or tutor students. Thomas Reeves (1998) describes this process as learning "from" computers in which the primary goal is to increase student's basic skills and knowledge. Learning from computers takes on a variety of tutoring systems, such as computer-based instruction (CBI), computer assisted instruction (CAI), and integrated learning systems (ILS), in which content is provided from the computer (Ringstaff & Kelley, 2002).

The term learning "with" computers refers to students using technology as a tool for problem solving, conceptual development, and critical thinking (Culp, Hawkins, & Honey, 1999; Sandholtz, Ringstaff, & Dwyer, 1997; Means, 1994; Reeves, 1998). When the computer takes on the role of a cognitive tool, it is an intellectual partner to enable higher-order learning (Reeves, 1998). Rather than treating students as recipients of knowledge, Jonassen and Reeves (1996) proposed that computers be used as a cognitive tool allowing students to use the computer to interpret and organize their knowledge. The computer as a tool allows teachers and students flexibility to creatively enhance the curriculum and instruction. Examples of tool–based software include: spreadsheets, databases, and multimedia software (Ringstaff & Kelley, 2002).

The more advanced uses of the computer support the constructivist view of learning in which the teacher is a facilitator of learning rather than the classroom's only source of knowledge (Trilling & Hood, 1999; Penuel & Means, 1999; Statham & Torrell, 1999). In studies of students using the computer as a tool for instruction, teachers have reported it provides them the opportunity to create a student-centered environment. The teachers become more open to multiple perspectives on problems and are willing to experiment in their teaching (Knapp & Glenn, 1996). Table 1 illustrates the contrasting views of instruction with technology and construction with technology as a tool (Sandholtz, Ringstaff, and Dwyer, 1997):

Table 1.

Contrasting Views of Instruction and Construction

	Instruction	**Construction**
Classroom activity	teacher-centered didactic	learner-centered interactive
Teacher role	fact teller always expert	collaborative sometimes learner
Student role	listener always learner	collaborators sometimes expert
Instructional emphasis	facts memorization	relationships inquiry and investigation
Concept of knowledge	accumulation of facts	transformation of facts
Demonstration of success	quantity	quality of understanding
Assessment	norm-referenced	criterion-referenced portfolios and performances
Technology use	drill and practice	communication, collaborative, information, access, expression

Project-based learning. One method for integrating cognitive technology tools in a student-centered environment is to implement a project-based learning environment. Project-based learning is organized around projects that allow students to encounter and learn the central concepts of the subject. A project involves students in a constructive goal directed process that entails inquiry, knowledge building, and resolution. The most important aspect of project-based learning is that the projects are realistic and give the students a feeling of authenticity (Thomas, 2000). Project-based learning gives control to the learner to make decisions about the content, style and design.

Research on project-based learning has reported gains in student achievement, problem solving capabilities, understanding of the given subject matter, comprehension of specific skills and strategies in introduced in the project, and changes in problem solving skills (Thomas, 2000). The Challenge 2000: Multimedia Project is an example of project-based learning. The Multimedia Project was developed through a joint venture with the San Mateo County Office of Education and Silicon Valley, a partnership of area businesses focused on improving the quality of life in the Silicon Valley region in northern California. The projects were expected to include seven components:

- Be anchored in core, curriculum; multidisciplinary
- Involve students in sustained effort over time
- Involve student decision-making
- Be collaborative
- Have a clear real-world connection
- Use a systematic assessment: both along the way and end product

- Take advantage of multimedia as a communication tool (Penuel, & Means, 1999).

To accomplish the goals of the Multimedia Project, support was provided to teachers in learning how to implement projects by forming a peer community of learners. This community was comprised of veteran teachers, who could share their teaching experiences, and technology coordinators, who brought their technology related skills. Through the implementation of a peer learning community, student-centered projects, and the provision of support for teachers, the classroom processes were expected to change. The design called for classrooms in which:

- Students engage in longer-term, more complex assignments
- Teachers act as coaches and facilitators of student learning
- Students engage in more small group collaborative activities
- Greater involvement with external resources is emphasized, including heightened attention to external audiences for student work

These benchmarks were established to indicate that the project would meet its objectives for student learning (Penuel, & Means, 1999).

The *Stanford Research Institute (SRI)* used case studies, interviews, teacher surveys, classroom observations, and school-wide indicators of achievement and performance assessment to evaluate the Multimedia Project. In year three of the study, nineteen classrooms were chosen from among the Challenge 2000 classrooms across grade levels. Principals from these schools then nominated three technology classrooms engaged in the project and three non-technology classrooms. The results of the study established that technology had made a difference in the classroom (Penuel & Means, 1999).

In the fall, students in the technology classrooms were only slightly more likely than students in non-technology classrooms to be engaged in long-term projects. However, by spring the gap was very wide, with 67% of technology classrooms involved in extended projects compared to 14% in the non-technology using classrooms. Similarly, in the fall, only 56% of technologies using classrooms were involved in the constructing products, while 39% of non-technology using classrooms were involved in constructing products. In the spring, 73% of technology using classrooms engaged students in small group collaboration, compared to the 38% in the non-technology using classrooms (Penuel & Means, 1999).

The study determined that teachers in Multimedia Project classrooms assumed the role of coaches or facilitators. In the spring semester of the study, only 29% of time in the technology-classrooms was devoted to teacher led activities, versus 62% in non-technology classrooms. Teachers in the technology classrooms were more likely to spend time explaining concepts, providing information, or questioning students about their understanding of material. Finally, the study found that students in the Multimedia Project classrooms were more likely to spend time engaged in small group collaboration. In the spring portion of the study, only 3% of the time in the technology classrooms was devoted to instructional or known answer questions compared to 72% of the time in the non-technology classrooms. The study found that teachers had an eagerness to use collaborative learning as a tool to promote a greater mastery of content and skill in cooperating and working with others (Penuel & Means, 1999).

Technology in the Curricular Framework

The final condition for effective technology integration involves teachers' development of student tasks that make use of technology as a tool within the curriculum framework (Coley, Cradler, & Engle, 1997). Before technology can become a critical element of the curriculum process, teachers must move beyond using it to simply improve students' basic skills. Teachers need to understand and appreciate the role technology can perform within their curriculum. Hence, students will be given tasks that employ the use of technology to construct their knowledge on a given topic, rather than being an "add-on" to the curriculum (Sandholtz, Ringstaff, & Dwyer, 1997).

Researchers (Sandholtz, Ringstaff, & Dwyer, 1997) from ACOT recognized that as teachers transformed their instructional methods, they progressively changed their use of technology in the curriculum framework. For example, in the entry stage, technology was used sparingly in the curriculum. Teachers used computer-based or tutorial programs to reinforce concepts taught in the curriculum. However, in the appropriation stage, students used technology as a tool to complete interdisciplinary, project-based tasks. Students were provided access to tool-based programs, such as spreadsheets, presentation, and multimedia authoring programs to complete their projects (Ringstaff, Yocam, & Marsh, 1997).

Means and Olson (1995) anticipated that technology could expand learning opportunities for all students when teachers utilized it as a tool in the curriculum and instructional framework. As teachers develop an understanding for the impact technology can have on the curriculum, there tends to be a shift in learning "from" technology to learning "with" technology. In this manner, teachers and students have flexibility to creatively enhance the curriculum and instruction, as technology is used as a tool to gather, organize, and analyze that is used to solve problems and construct knowledge (Means, Blando, Olson, & Middleton, 1993). Effective integration of technology depends on the teachers' understanding and development of tasks for students in the curriculum framework (Baker, Herman, & Gerhart, 1996).

North Central Texas. When technology is implemented as a tool within the curriculum, students are encouraged to develop higher-order thinking skills. Hopson, Simms, and Knezek (2002) examined fifth and sixth grade students in a suburban school district to determine if students in technology enriched classrooms demonstrated better use of high-order thinking skills than students in a traditional classroom. The treatment group was composed of students enrolled in a technology-enriched magnet school in a North Central Texas school district during the 1996-97 and 1997-98 school years. The treatment group included students selected at random from the students who applied for the program. The comparison group included students not accepted to the magnet program, along with students from comparable campuses without a technology-enriched classroom (Hopson, Simms, & Knezek, 2002).

The research design for this study was a posttest and quasi-experimental design. The treatment and comparison groups were given the Ross Test of Higher Cognitive Process. The Ross Test is a 105-item test to determine the effectiveness of curricula or instructional methodology to teach the higher-order thinking skills of analysis, synthesis, and evaluation. Four distinct groups were identified for the study based on demographics and grade level (Hopson, Simms, & Knezek, 2002).

The treatment groups were provided access to the computer as a tool for learning, and instructed using the fifth grade curriculum for a technology-rich environment. Each of the treatment classrooms was equipped with one computer for every two students allowing the students to use spreadsheet, database, and word processing software as tools to take notes, produce assignments, and construct projects. In addition, the teachers were equipped with a multimedia teaching station and trained on the use of technology as a tool for learning (Hopson, Simms, & Knezek, 2002).

The comparison groups were instructed in a traditional classroom setting with the district's curriculum for fifth grade. The comparison classrooms had no access to computers in the classroom and only limited access to computers in the campus computer lab for computer literacy and remediation. The teachers did not have access to computer based teaching stations and received no training in the use of technology as a tool for learning (Hopson, Simms, & Knezek, 2002).

A univariate analysis of variance was used to establish initial equivalence for the treatment and comparison groups on the Ross Test. The results of the ANOVA indicated no significant difference between the fifth-grade treatment and comparison groups. A one-way ANOVA on the posttest data indicated differences between the sixth grade groups was significant, so an analysis of covariance was required. The fifth and sixth grade treatment group students exhibited a higher level of evaluation skill as measured by the Ross Test. No significance difference was noted in the performance of the two groups on the analysis and synthesis subtests. The technology-enriched classroom environment had a minimal but positive effect on student acquisition of higher-order thinking skills (Hopson, Simms, & Knezek, 2002).

This study adds to the limited research on the use of computers to enhance the development of higher-order thinking skills. The teachers reported that learning in the technology enriched classrooms was more student-centered and less teacher/textbook driven. An environment was created that facilitated the use of cooperative groups with students focused on knowledge construction rather than acquisition (Hopson, Simms, & Knezek, 2002).

Summary

Computers and technology can provide students with the opportunity to construct their own knowledge. However, computers in and of themselves do very little to aid in the learning process, and the presence of technology in the classroom does not automatically inspire teachers to rethink their teaching or students to adopt new modes of learning. In order for a change to occur, both teachers and learners need to learn how to take advantage of technology to enhance learning (Coley, Cradler, & Engel, 2000). It is the role of the teachers to implement and use technology as a tool for learning with their students.

Technology and Students of Low Socioeconomic Status

Research has found that poverty is one factor associated with student achievement and school dropout rates (Leroy & Symes, 2001). Other factors associated with low achievement include racial or ethnic background, single-parent family, mother with low education, limited proficiency in English, and low expectations for success (Miller, 1993; Huang & Waxman, 1996; Strahan, 2003). Often, students who are likely to fail in school or in life because of their life's social curriculum are generally termed "at-risk students" (Slavin & Madden, 1983). These students are at-risk of failure because of broken homes and a culture of poverty.

In the Conditions of Education (NCES, 2002), researchers stated that poverty has the potential to be a serious threat to students access to quality learning opportunities and their success in school. According to the 2000 Census, 15% of all children lived in households where the annual income in the previous year was below poverty level. Students from low SES can be found throughout the United States; the state of Florida has an average with 18% of students living at the poverty level (Kidscount Snapshot, 2004).

Title I Schools

In 1965, Congress established the Elementary and Secondary Education Act. The goals of the Title I program were to improve schooling in areas of high poverty areas and to advance the equality of education outcomes (Borman, 2003). Since that time, the federal government has appropriated nearly eight billion dollars each year for Title I programs designed to assist economically disadvantaged students (Citizen's Commission on Civil Rights, 1998). Recently, the largest funding in history was given to the Title I program calling for stronger accountability mandates and holding schools and districts responsible for the achievement of outcomes of minority students, low-income students, and English-language learners (Borman, 2003).

Several critical issues have been associated with the low achievement of students from high-poverty Title I schools. While researchers realize the most serious concerns are basic funding and political beliefs, there are still several amendable issues with possible improvements for at-risk students (Melendez, 1993). Three critical issues are: shortage of qualified teachers; teachers' low expectations; and teaching practices that consist predominantly of basic skills (Waxman, Padron, & Arnold, 2001).

Frequently, the most under-prepared teachers are assigned to schools and classrooms in areas with the highest level of poverty (Darling-Hammond, 1992, 1997). Teachers from high poverty schools tend to have lower literacy skills on teacher certification tests than teachers from advantaged schools. Those differences in teacher qualities often have an impact on student achievement (Ferguson, 1998). Furthermore, teachers of at-risk students have been found less skilled at implementing more complex approaches to instruction and less capable of identifying students' needs (Darling-Hammond, 1992, 1997).

The second critical issue has to do with teacher expectations of students from high-poverty Title I schools. Lower teacher expectations result in an overemphasis on repetition of content through drill and practice (Knapp & Shields, 1990; Lehr & Harris, 1988). Often, at-risk students are not provided tasks to promote higher-order thinking skills because it is believed they must first demonstrate lower levels of knowledge before they can be taught higher level skills (Rivera & Zehler, 1991; Waxman, Padron, & Knight, 1991). When teachers underestimate the potential of students from high poverty schools, the achievement gap widens between minority and majority students (Ferguson, 1998).

The final issue is the teacher-centered model of instruction found in schools that serve at-risk students (Brookhart & Rusnak, 1993; Haberman, 1991, Waxman, Huang, & Padron, 1995). The teacher-centered model of instruction emphasizes lecture, drill and practice, remediation, and student seatwork, consisting mostly of worksheets (Stephen, Varble, & Taitt, 1993). Haberman (1991) calls this emphasis on teacher directed instruction in high poverty schools with at-risk students a "pedagogy of poverty." He went on to state that when teachers are "making" students learn, the students usually assume a passive role with low engagement in tasks that are not generally authentic (Haberman, 1991).

Characteristics of Students

Often, students living in poverty have different basic value and belief systems from the schools they attend, which operate within middle class norms. It becomes the role of teacher and school to mediate the student's belief system with the teacher's belief system. Payne (2001) describes poverty as "the extent to which an individual does without resources" (p. 16). These resources include financial, emotional, mental, spiritual, physical, support systems, relationships, and knowledge of hidden rules of class.

Schools become the only environment in which students of poverty have the opportunity to access a number of these resources (Payne, 2001).

Students of poverty often come to school with different expectations than their peers and teachers. Researchers have found that poverty affects a student's growth, cognitive development and academic achievement (Alaimo, Olson, & Frangillo, 2001). Often, students of poverty lack a motivation to learn, because they live in environments over which they have little control. When they are at school, they lack a vision for their future and see themselves remaining in this situation for the rest of their lives (Bandura, 2001; Brophy, 1998). The students are unable to make the connection between acquiring an education and creating an opportunity out of their situation.

In addition, a lack of readiness to learn exists because of their social situation. They are deficient in the social and cognitive skills that are needed to succeed in life because their social environment has affected their development (Renchler, 2000). Their home environment has limited opportunity to organize perceptions and to develop higher-order cognitive process. The students lack the ability to solve problems because of a lack of parental involvement, which supports the development of independent thinking (Benson, 1995; Bowman, 1994).

Student Achievement

Research has shown that poverty has a negative impact on student learning and future success (Payne, 1998). In a research study on students of poverty in inner cities, Renchler (1993) found those living in low socioeconomic areas were more likely to have educationally damaging circumstances as part of their life experiences than higher SES children. Poverty negatively effects a student's cognitive development, academic achievement, and physical and emotional health (Alaimo, Olson, & Frangillo, 2001).

Researchers conducted a two-year study in high poverty schools with a focus on instructional practices designed to promote children's understanding and build meaning into the learning experience. The study included three states (California, Maryland, and Ohio) and approximately 140 classrooms in 15 schools. During the first year, grades one, three, and five were studied; the second year included grades two, four, and six. The study focused on three subject areas (mathematics, reading, and writing) since these subjects accounted for the majority of instructional time in elementary grades (Knapp, Shields, & Turnbull, 1995).

After an analysis of instruction and student learning gains, the researchers concluded that meaning-oriented instruction produces superior learning to more traditional skills with both low performing and high performing students. Instruction that emphasizes reasoning and problem solving is more effective at teaching advanced skills, as effective at teaching basic skills, and better at engaging students in learning. Their research offered a three-pronged argument for teaching meaning in high-poverty classrooms. First, teachers construct and maintain a rich academic learning environment, which reflects the students' diverse cultural and SES backgrounds. Second, teachers approach instruction in a method that produces a higher level of thinking by constructing cognitively demanding tasks. Third, teachers are able to sustain this form of teaching because of the instructional leadership, peer support, and uninterrupted blocks of instructional time (Knapp, Shields, & Turnbull, 1995).

Technology in Schools with Low SES Student Population

Research examining the use of technology in high poverty, Title I elementary schools is very limited. Some studies reveal that although millions of dollars have been appropriated for technology in high poverty, Title I schools, it is not being utilized effectively as a tool for higher order thinking skills (Waxman & Huang, 1996; Wenglinsky, 1998; Waxman, Padron, & Arnold, 2001). Additional research findings concluded that teachers from high poverty schools were less prepared to use computers than teachers from economically advantaged schools (Wenglinsky, 1998).

Wenglinsky (1998) examined the relationship between educational technology and student achievement in mathematics. Data were gathered from the 1996 National Assessment of Education Progress in mathematics consisting of national samples of 6,227 fourth graders and 7,146 eighth graders. Data included the frequency of use for mathematics in schools, access to computers at home and in school, professional development of mathematics teachers in computer use, and the kinds of instructional use of computers in the schools.

Wenglinsky (1998) concluded that the impact of technology depended on how teachers used it and integrated in the curriculum with their students. The overall frequency of school computer use for simulation and higher order thinking skills had a positive impact to academic achievement. He concluded that “disadvantaged eighth-graders seem to be less likely to be exposed to higher order learning through computers” and that using “computers for drill and practice, the lower-order skills, is negatively related to academic achievement" (1999, paragraph 4).

In the spring of 1998, the *Teaching, Learning, and Computing (TLC*) survey was conducted with a national sample of principals, technology coordinators, and teachers (Ravitz, Becker & Wong, 2000). Altogether, over 4,000 teachers from grades 4 through 12 in over 1,100 schools from across the United States chose to participate in the survey. Between the fourth through sixth grade teachers in this sample who use computers for instruction, teachers in predominately minority, poorer schools (N=120) showed no real difference in the use of skill/game software than teachers in wealthier schools (N=189). The use of word processing, however, was much more prevalent in economically advantaged schools. Teachers in wealthier schools were also more likely to use simulations, reference materials, spreadsheets/databases, multimedia, and web browsers than were teachers who taught minority students in low SES schools (Becker, Ravitz, & Wong, 1999).

Students of poverty need to develop cognitive skills and become designers of their learning. Students learn and retain the most from thinking in meaningful ways. Using technology as a cognitive tool enables students to apply concepts in a variety of contexts. Those tools need to engage students in the cognitive strategies of learning such as construct, collaborate, interact, and contextualize process (Roschelle, Pea, Hoadley, Gordin, & Means, 2000). The more advanced uses of technology support the constructivist view of learning in which the teacher is a facilitator of learning rather than the classroom's only source of knowledge (Penuel & Means, 1999; Statham & Torrell, 1999; and Trilling & Hood, 1999). However, little research exists on the use of this type of technology with at-risk elementary students

In a recent study Page (2002) investigated the effects of technology on the academic accomplishments of elementary students of low SES, the sense of worth for those students, and the classroom among between students and with teachers, which resulted from the exposure. The purpose of the study was to compare elementary students' attainments, such as self-esteem, classroom interactions with peers, and academic achievement, in a technology-enriched environment with those of students in traditional elementary classrooms. This quasi-experimental study was designed to examine if the outcomes would be significantly different between the two groups (Page, 2002).

Participants in this study included 211 students from 10 classrooms (five technology enriched and five without technology) at five elementary schools in Louisiana. Two of the schools included third grade classes for the experimental and control groups, while three of the schools included fifth-grade classrooms for the experimental and control groups. Each of the classrooms involved in the study was a self-contained classroom, with the students in each class typical of other students at their particular schools. Most of the students were from lower-income families, and all were classified as being low SES (Page, 2002).

The experimental and control classrooms were selected by each school's principal based on their teaching performance. The teacher in each of the experimental group classrooms was fully trained in the use of technology and was made aware of innovative uses of technology through workshops, in-service days, and university coursework. Throughout the year, the experimental teachers began to integrate technology as a tool into the curriculum. Experimental teachers made an effort to integrate technology into every lesson, whether or not the learning opportunity appeared to be technology based. The teachers were provided assistance from staff members on the Louisiana Challenge with technical assistance, training in operational procedures, and technology integration (Page, 2002).

The hardware in each of the experimental group classrooms included at a minimum: a teacher computer; four student computers; five Internet connections; a network laser printer; an inkjet printer; a large TV monitor; a presentation device; a digital camera; a VCR; a classroom set of calculators; a laserdisc player with laserdiscs; and a mini computer camera for videoconferencing. The software package included: an integrated office-suite; a multimedia authoring tool; math curriculum programs; reference programs; and a portfolio assessment.

Teachers in both the experimental and control groups followed the same curriculum throughout the school year with different approaches (technology or traditional). The control group teachers conducted their classroom in the traditional manner. The majority of the classrooms contained a computer for teacher use, but with little or no access for students to technology (Page, 2002).

Data for this study were collected from standardized achievement scores. Four schools used the Iowa Tests of Basic Skills (ITBS) to measure student achievement in math and reading (Hoover, Hieronymus, Frisbie, & Dunbar, 1996; Page, 2002). Pretests were administered in April 1998 and posttests in March 1999. One school administered the California Achievement Test (CAT, 1996) for reading and mathematics achievement.

CAT pretests were administered to all students in September 1998 and posttests in April 1999. All schools completed the Coopersmith Self-Esteem Inventories (CSEI) during the two observation sessions for each school (Page, 2002).

Two additional observations in the experimental and control group classrooms utilized an adapted version of the Flanders Interaction Analysis System (FIAS) instrument to measure initiation/reaction patterns among students and teachers. A form was developed that allowed the researcher to record both classroom activities and the instances of classroom verbal exchange. The observation period was for an entire day in which the researcher listened and recorded for a three-minute time period, then took a three-minute rest from recording interactions. This process was repeated for the entire observation period (Page, 2002).

Data from the ITBS, the CAT, and CESL were analyzed to determine if significant differences existed between the adjusted posttest means of the experimental and control groups. The ANCOVA analyses related to reading showed mixed results, as there was no significant difference between the adjusted posttest means of the ITBS Reading Total. However, there was a statistically significant difference on the adjusted post means of the CAT Vocabulary, $p<.001$, and the CAT Comprehension, $p<.001$. In regards to the math, the ANCOVA analyses were much more consistent than the reading. There as a statistically significant difference, $p<.05$, with the ITBS Mathematical Total scores and the CAT Mathematical Concepts and Applications, $p<.001$, and the Analytical Mathematics, $p<.001$ (Page, 2002).

The researchers found a statistically significant difference, $p<.05$, with the ANCOVA analysis between the experimental and control groups on the composite self-esteem scores. The experimental group had a higher adjust pot means score with general self-esteem, $p<.001$, and school self-esteem, $p<.05$. A statistically significant difference was found in the analysis on classroom interactions, $p<.001$, between the experimental and control group. In particular, the differences were found between the types of classroom interactions. In the experimental group, the frequency of student to student interaction was observed 51% of the time with the teacher to student frequency 31% of the time. A contrast was seen in the control group, in which the student to student interaction frequency was 16% of the time and the frequency of the teacher to student interaction was 58% of the time.

The study concluded that when students of low SES have a technology enriched elementary classroom, levels of mathematics achievement, self-esteem, and student-centered learning environments. Students in technology-enriched classrooms scored higher on standardized tests in mathematics. In addition, those same classrooms, students were provided the opportunity to take control of their own learning environment, through computer work groups and student to student interactions. The researcher recognized that other variables were involved in the study, thus could not conclude that the computers and technologies caused these positive outcomes (Page, 2002).

Summary

Research has demonstrated that students of poverty are more likely than other students to attend schools with limited access to technology and receive only traditional instruction consisting of lecture and drill-and-practice activities. Much of the research involving students of poverty mirrors the “soft bigotry of low expectations” (U.S. Department of Education, 2002) and has therefore focused on learning from technology rather than learning with technology. A clear gap exists in the research on use of technology as a tool for learning with students of poverty.

The school must take on the role of creating a culture in which all students from various ethnicities and SES backgrounds can understand the vital role education plays in their lives and futures (Bowman, 1994; Marlowe & Page, 1999). A social environment must be created in which all students feel a part of the learning so they can take responsibility for their lives. The students must be educated to reach beyond their current poverty and given intellectual and social skills, to succeed more fully in life (Renchler, 2000). This goal will be achieved when school principal and instructional staff set high expectations that are attainable for all students.

Schools provide the opportunity to increase students’ academic achievement and allow them to reach their potential when students are viewed at-promise rather than at-risk (Slavin, 1998). A learning environment at the school must be created that allows for students to become more independent learners as they assume responsibility for their learning. In order for schools to be successful in student learning, a pattern of attitudes, beliefs and behaviors by the principal, teachers, and support staff needs to be developed for high expectations and commitment to bring about student achievement (Good & Brophy, 1996). In addition, schools with low SES students must have access to the same levels of hardware and software tools as high SES schools.

CHAPTER THREE

METHOD

This chapter is divided into three major sections. The first section outlines the research questions to be examined. The second section is background on the Technology Resource Survey instrument. The final section is the research method that was employed to answer the research questions.

Research Design

This study used secondary data to examine the use of technology in low and high socioeconomic in public elementary schools in the state of Florida. Data from statewide surveys related to technology were used to investigate differences in access and use of technology in low and high SES schools. Specifically, this study used data from the 2005–06 School Technology Resource Survey to examine the following questions:

1. Is there a significant difference between students' access to computers in high and low socioeconomic schools?
    a. Is there a significant difference in the total number (desktops and laptops) of modern and non-modern computers?
    b. Is there a significant difference in the locations of the computers for student use?
2. Is there a significant difference in the types of software available on computers between high and low SES schools?

3. Is there a relationship between the socioeconomic status of an elementary school and the frequency of student use by software type?
4. Is there a relationship between socioeconomic status of an elementary school and the teacher use of technology in the classroom?

Population

To answer the research questions, enrollment data for all elementary schools in Florida were tabulated then categorized according to poverty level. These data were provided from the Division of Accountability, Research and Measurement (ARM) in the Florida Department of Education. It is the role of ARM to assist school districts in the legislative requirement for reporting accurate information to the Master School Identification Database (MSID). This file contains information for all public school PK-12 schools such as school type, primary service, and Title I status.

The Title I status is designated by the school district based on the criteria in *No Child Left Behind* legislation based on the students who were eligible to receive free and reduced lunch. Under the National School Lunch and Breakfast Programs, students unable to pay the full price of meals served have the opportunity to apply for free or reduced price meals. Students eligible for this program come from households whose household income is at or below the poverty level. The data on the students that are eligible for the program are then aggregated to provide accurate information on the poverty level of each of the schools.

For this study, data on elementary schools were used as it reflects the most accurate information on the poverty level of a school. A factor for using elementary schools over secondary was the higher concentration of schools that qualify for the program. In addition, using eligibility for secondary schools is not as reliable because the students may attach a stigma to receiving a school lunch subsidy (National Science Foundation, 2006).

The data focused only on those public elementary schools with grade levels of PK-6 (*N*=1591) for the school year of 2005-06. The elementary schools in the MSID file were ranked from highest poverty level to the lowest poverty level. These data were then broken into four quartiles with a focus on the top 25% of schools that have a larger student population at poverty level and the bottom part 25% of schools that have a smaller student population a poverty level. For this study, low SES schools were defined as the top quartile of elementary schools with a high poverty, and high SES schools were defined as those schools in the bottom quartile with low levels of poverty.

Instrument

For more than twenty years, the state of Florida, Office of Educational Technology, has collected information from the 67 school districts about the access to technology in the schools. Historically, the Computer Survey has focused on "counting the boxes" – reporting how many computers were available in each school and the age/type of each computer. In response to the *NCLB* legislation, the Florida Department of Education significantly revised its annual technology survey in 2002 to provide more meaningful information about technology integration and capacity in Florida's schools. The result of those modifications culminated in the School Technology and Readiness (STaR) Chart and updated Technology Resource Survey.

Construct Definition

In the summer of 2002, educational technology leaders in Florida expressed a desire to modify the Computer Survey, shifting the focus from simply the numbers and types of computers per student to areas such as technology planning, integration, and accountability. Content experts from across the state were assembled to define key elements for the revised survey. Using a model from the state of Texas as a starting point, strands and categories were identified and discussed. The result was the School Technology and Readiness (STaR) chart, which was comprised of five strands, each made up of 3 to 5 categories (See Table 2).

Table 2.

STaR Strands and Categories within Each Strand

	Strand I	***Strand II***	***Strand III***	***Strand IV***	***Strand V***
	Technology Administration and Support	***Technology Capacity***	***Educator Competency and Professional Development***	***Learners and Learning***	***Accountability***
Category Name	Technology Planning	Student Computer Access	School Administrators	Student Use of Technology	Student Technology Standards
	Technical Support	Teacher Computer Access	Professional Development Budget	21st Century Classroom	Teacher Technology Standards
	Instructional Technology Support	Internet Access (not in analysis)	Models of Professional Development	Secondary Technology Courses	
	School Budget	Video Capacity	Content of Professional Development	Community Outreach	
	Funding	LAN/WAN			
		Curriculum-based Tools			

Survey Development

The STaR chart provided the initial structure for the subsequent Technology Resource survey, which was developed with input from the Office of Educational Technology (OET) and technology leaders from around the state. First, the Florida Center for Instructional Technology (FCIT) staff at the University of South Florida worked closely with OET representatives to create survey items and verify alignment with the Florida STaR chart. Next, several work group sessions were held with content experts in order to write and revise items. Item formats included multiple-choice, check-box, and open-ended response. These review sessions began in August 2002, and continued through December 2002.

In December 2002, experts in survey development at the University of South Florida reviewed the draft survey, which was then posted on an FCIT server for comment from technology leaders across the state. Throughout January 2003, FCIT staff visited principals in their schools to observe them and elicit comments as they worked through the draft survey. Each page of the draft survey also allowed for immediate email feedback from principals or other content experts who were field-testing the survey. Survey items were revised based on feedback from field-testing and emailed comments from participants.

Pilot Test Implementation

The survey was initially programmed using open source software such as Apache, PHP, and MySQL. An Xserve server was used, to ensure that the survey could withstand hundreds of simultaneous connections with schools entering data. The survey was designed so that a school could log on and answer some of the questions and then quit. When the school logged back on, all of the previous answers were available for viewing or revision. A menu page was provided to indicate the questions that had been answered and those that had not yet been answered.

Survey Structure. The initial survey contained a base set of 47 items. The answer for each of the initial questions determined which, if any, contingency (follow-up) questions were asked. The contingency questions allowed for a more precise placement within the STaR chart categories, and provided additional information for future item development. Questions were presented one at a time; schools could skip and go back to questions multiple times.

District Review. When a school finished with the survey, the district was informed that the survey was ready for review. The appropriate district representative was then able to review and accept or reject the survey. If it was accepted, the results were written into a permanent database and were not available for revision. If rejected by the district for inaccurate data, the school was able to revise the answers as directed by the district.

Data Review and Verification. Schools were given approximately six weeks to complete the survey. Districts then had an additional three weeks to accept the completed surveys. At this point, the data were downloaded and screened for missing, extreme, and anomalous responses. A spreadsheet was provided to each district technology supervisor with the response cells coded yellow for a response that was outside of the normal range, orange for an anomalous or unusable response, and red for missing. Surveys were re-opened so that corrected information could be recorded and the surveys re-accepted.

The implementation of the survey was an interactive process that entailed a variety of individuals, from the district level technology personnel to the school-based technology specialist. The district received the password for the survey system and had the responsibility of sharing it with the individual schools. It was then the role of individuals at the school level to gather and input all of the data necessary for completing the survey. During this process, the district and schools were in constant communication through email and phone calls to verify the accuracy of the data being reported. Accuracy was determined when the data reflected the purchase invoices for the hardware and software at the district level.

Current Implementation

The Technology Resource Survey has been implemented over the last three years with all public schools in the state of Florida, which includes elementary, middle school, combination, junior high school, high school and charter. In 2003-04 there were 2,514 respondents (97% response rate); in 2004-05 there were 2,553 respondents (96% response rate); and in 2005-06 there were 2,667 respondents (97% response rate).

Each year, the survey has been implemented in the fall with districts being provided with secure passwords for the district administrator and the school administrator. The respondents are provided a nine-week time span to complete the survey with guidance from the DOE on item verification. The district administrator coordinates with all public schools, including charter and special centers to complete the survey and verify data provided.

At the end of the data collection, the DOE provides districts with a spreadsheet on the school data to examine any anomalies in the reporting. For example, a school may have reported 5,000 modern computers in the general education lab, when it is actually 50 modern computers. The district administrator contacts the school to verify the data and correct the information.

Over the past three years, revisions to the Technology Resource Survey have been limited to ensure the integrity of the data for reporting purposes to the United States Department of Education. At the end of each year, items are analyzed and revised with input from experts in item development, technology, school leadership, and programming. The majority of items have remained the same with only a tweaking of terminology to ensure the item reflects the data that are required for a particular section.

A validation report was done in the summer of 2006 (Florida Center for Instructional Technology, 2006), on the integrity of the web-based reporting tool. The Structured Query Language (SQL) used to access the response data from the database was analyzed for accuracy. The researchers examined the records for county level analysis and school level analysis, and determined the reporting utility produced valid records. In addition, the SQL statements appear to provide the correct grouping information: elementary, middle/junior, high, and combination classifications. The researchers concluded that the reporting software for the STAR online reporting utility provides reliable information.

Data Source and Analysis

Data from 2005-06 School Technology Resource Survey were the primary source of data for the research questions. Selected items from the *Administrative and Technical* portions of the survey were analyzed for elementary schools. The data from the survey were merged with the statewide data for student enrollment from public elementary schools. Other factors that were considered in this analysis include issues such as urban and rural settings, size of school, and ethnicity of the student population. This section will address the reliability and validity of the items to be used from the survey and the type of statistical analysis and descriptive statistics.

Research Question #1: *Is there a significant difference between student access to computers in high and low socioeconomic schools? Is there a significant difference between total number (desktops and laptops) of modern and non-modern computers? Is there a significant difference between the locations of the computers for student use?* Item #2 and #3 within the Access to Technology category of the Technology Resource Survey provided the data on students' access to computers in the schools. These two items have strong face validity in reporting the modern (purchased within the last three years) and non-modern (purchased more than three years ago) computers, the types of computers, and instructional location. Specifically, item #2 requires respondents to provide data on the exact number of modern laptop and desktop computers available for students in specific areas of instruction (See Figure 2).

2. Indicate the number of desktop and laptop computers (excludes handhelds such as iPAQ, Palms, and Alphasmarts, etc) **FOR STUDENT USE** in each of the following school locations that meet **both** of the following specifications:

- **Internet and multimedia capable**

  -- AND --
- **Purchased within the last 3 years (Purchased after July 1, 2002)**

(if number is zero, put "0")

Location	**Total # of Desktops for student use** *(Enter "0" if none.)*	**Total # of Laptops/Tablets for student use** *(Enter "0" if none.)*
Instructional Areas :		
Media center		
Classrooms (including portables, resource rooms, etc.)		
Labs:		
Computer labs primarily serving general education		
Computer labs primarily serving special education		
Computer labs primarily serving vocational education		
Other student gathering places (e.g. cafeteria)		
Mobile Computers :		
Mobile computer labs		
Computers assigned to students		

Figure 2. Student access to modern computers.

Item #3 asked respondents to provide data on the exact number of non-modern laptop and desktop computers available for students in specific areas of instruction (See Figure 3).

3. Indicate the number of desktop and laptop computers (excludes handhelds such as iPAQ, Palms, and Alphasmarts, etc) **FOR STUDENT USE** in each of the following school locations that meet ***either*** of the following specifications:

- **NOT Internet and multimedia capable**

  -- OR --
- **Purchased more than 3 years ago (Purchased before July 1, 2002)**

(Enter "0" if none)

Location	**Total # of Desktops for Student Use** *(Enter "0" if none.)*	**Total # of Laptops** ***(Enter "0" if none.)***
Instructional Areas :		
Media center		
Classrooms (including portables, resource rooms, etc.)		
Labs:		
Computer labs primarily serving general education		
Computer labs primarily serving special education		
Computer labs primarily serving vocational education		
Other student gathering places (e.g. cafeteria)		
Mobile Computers :		
Mobile computer labs		
Computers assigned to students		

Figure 3. Student access to non-modern computers

Data from items #2 and #3 were analyzed to answer the difference between the total number of modern and non-modern computers available for student access. The two categories of desktops and laptops were combined for each room location within the modern computer group and the non-modern computer group. The next step was to compute by dividing the school size by number of computers. The two variables of modern computers and non-modern computers were then analyzed will an independent t-test. The poverty level of students was a dichotomized as the median was used for the high socioeconomic schools and the low socioeconomic schools.

To answer the question of location for computers, the data from the total number of modern computers was split into two groups of classroom versus non-classroom or labs. The classroom variable was the total number of modern computers in the classroom, mobile labs, and computers assigned to students. The non-classroom variable was a combination of the media center, general education lab, special education lab, vocational education lab, and other student gathering places. A independent t-test was used to examine the difference in high and low socioeconomic schools. Additional analysis included descriptive statistics with graphical descriptions of the median and mode for the high and low SES schools.

Research Question #2: *Is there a significant difference between the types of software available on the computers for high and low SES schools?* In order to answer this question, item #16 from Access to Technology section was used to provide data on tool-based software (See Figure 4). Cronbach's alpha measure of internal consistency reliability of scores on this group of nine survey items was .76.

16. What percentage of student computers at your school have the following software types available on them?

	0%	1-24%	25-49%	50-74%	75-100%
Concept mapping (e.g. Inspiration)	○	○	○	○	○
Graphics (any paint or draw program)	○	○	○	○	○
Multimedia authoring (e.g. eZedia, iMovie, HyperStudio)	○	○	○	○	○
Presentation software (e.g. PowerPoint, Keynote)	○	○	○	○	○
Spreadsheet	○	○	○	○	○
Video editing	○	○	○	○	○
Web authoring (e.g. Dreamweaver)	○	○	○	○	○
Basic word processing (e.g. Wordpad, Notepad, TextEdit)	○	○	○	○	○
Robust word processing (e.g. Word, Works, AppleWorks)	○	○	○	○	○

Figure 4. Tool-based software on computers.

The item to answer this question comes from the category *Access to Technology* for curriculum-based software (See Figure 5). Cronbach's alpha measure of internal consistency reliability of scores on this group of seven survey items was .70.

17. What percentage of student computers at your school have the following software types available to them?

	0%	1-24%	25-49%	50-74%	75-100%
FCAT Explorer	○	○	○	○	○
Other test prep tools	○	○	○	○	○
Integrated Learning Systems (e.g., Successmaker, Read 180)	○	○	○	○	○
Content-specific skills practice/tutorials (e.g., Math Blaster)	○	○	○	○	○
Content-specific simulation (e.g., Frog Dissector)	○	○	○	○	○
Other content-specific resources	○	○	○	○	○
General Reference tools (e.g., encyclopedias, databases)	○	○	○	○	○

Figure 5. Curriculum-based software on computers.

The two variables for this question are tool-based software and curriculum-based software. The first item represents the availability of tool-based software on student computers and the second item represents the availability of curriculum-based software. The data from the tool-based software was collapsed down to one category of availability on the computers in which the midpoint was calculated for the tool- based software. The same procedure was then done for the curriculum-based software. A t-test was done to examine the difference in the types of software available for high and low socioeconomic students.

Research Question #3: *Is there a relationship between the socioeconomic status of an elementary school and the frequency of student use by software type?* In order to answer this question, data from item #43 in the category for *Digital Learning Environment* was used. This item asks respondents for data on the frequency of student use of various software types (See Figure 6).

43. How often do **students** at your school use the following types of software?

	Not at all	Once a month	Once a week	Several times a week	Every day
Drill and practice software	○	○	○	○	○
Integrated Learning Systems (ILS; comprehensive software with assessment, diagnostics, and computer-based curriculum)	○	○	○	○	○
Multimedia (e.g., paint/draw, desktop video, sound-editing)	○	○	○	○	○
Simulation software (e.g., Oregon Trail, SimCity)	○	○	○	○	○
Tool-based software (e.g. graphic organizers, word processors, spreadsheets, databases)	○	○	○	○	○
Research (Internet, encyclopedias)	○	○	○	○	○
Presentation (PowerPoint, Keynote)	○	○	○	○	○

Figure 6. Frequency of student use of software.

The indicators from this item represent the frequency of student use for the variables of tool-based software and curriculum-based software. Cronbach's alpha measure of internal consistency reliability of scores on this group of seven survey items was .77. Data from the indicators for multimedia, tool-based software, research, and presentation software were collapsed into the tool-based category. Data from the indicators for drill and practice software, integrated learning system, and simulation software were collapsed into the curriculum-based category.

The categories for frequency were broken down to limited and regular. The indicators, "not at all" and "once a month" were collapsed for the limited category. The indicators, "once a week", "several times a week", and "everyday" were collapsed for the regular category. A t-test was used to analyze the types of software, frequency of student and use, and socioeconomic status.

Research Question #4: *Is there a relationship between the socioeconomic status of an elementary school and the teacher use of technology in the classroom?* In order to answer this question, data from item #1 in the category Digital Learning Environment from the principal survey were used (See Figure 7).

1. What percentage of your teachers use technology in the following ways?

	0%	1-24%	25-49%	50-74%	75-100%
Method for delivery of instruction (e.g. lectures with presentation software)	○	○	○	○	○
Supplement to instruction (e.g. programs or games used for skill practice)	○	○	○	○	○
Tool for providing instruction (e.g. integrated learning system)	○	○	○	○	○
Tool integrated into core curriculum areas (e.g. word processors, spreadsheets, probes, etc.)	○	○	○	○	○
Tool embedded in daily instruction for all curriculum areas (e.g. word processors, spreadsheets, probes, etc.)	○	○	○	○	○

Figure 7. Level of teacher use of technology.

The indicators from this item represent the teacher's use for both tool-based software and curriculum-based software with students. In addition, the indicators reflect the levels of the technology integration for the teacher from entry to innovation. Cronbach's alpha measure of internal consistency reliability of scores on this group of five survey items was .79. The midpoint for each composite variable was analyzed as a continuous variable. Descriptive statistics were used to examine the levels of technology integration in high poverty schools and low poverty schools.

CHAPTER FOUR

RESULTS

This chapter presents the analysis of the data from the 2005-06 Technology Resource Survey. This chapter is divided into five sections to represent the verification of the data and the research questions. The first section explains the process for the verification of the data. The next section examines students' access to technology in high and low socioeconomic schools. The third section examines the types of software available on the computers. The next section examines the relationship between the socioeconomic status of the school and frequency of student use by software type. The final section examines the teacher use of technology in the classroom.

Verification of Data

The first step in the process for the data analysis was to acquire the data from the Florida Innovates website. This website provides district contacts with access to results from the Technology Resource Survey through a secure log in. These data can be provided through a web interface and/or can be downloaded in raw format of a comma-separated values file. Once the data were acquired from the 2005-06 survey, it was then delineated to include only elementary schools, as defined to include all schools with grades PREK-5, PREK-6, K -5, or K-6. A new file was created to include only the schools that met the parameters of the research.

This file was then organized by school code to keep all of the data in an organized format. Fields were then deleted that did not pertain to the data, such as the school name, county, number of teachers, and additional items from the survey. This file was then merged with student population information from the "Survey 2", the October report from schools for the Master School ID (MSID) maintained by the Division of Accountability, Research, and Measurement in the Florida Department of Education. The MSID file contains information on every public school in the state, such as active school status, school ID number, school type(s), percentage of students on free and reduced lunch, grade levels taught, and other data that were used to amplify school-based analyses. A new file was created that included the variables for grade levels taught, free and reduced lunch, instructional rooms, computer labs, access to modern and non-modern computers, software installed on computers, teacher use of technology, and student frequency use of technology.

The total number of schools that met all of the parameters for the study was *N*=1591, out of 1897. Schools were divided into quartiles based on the percentage of student receiving free and reduced lunch. The top quartile (high socioeconomic schools) was labeled number 1, followed by the second quartile being labeled number 2, the third quartile was labeled number 3, and the bottom quartile, low socioeconomic schools, was labeled number 4. The *n* for quartile 1 was 400 schools, with the range of free and reduced lunch from 1.49 – 37.5%. The *n* for quartile 4 was 396 schools, with the range of free and reduced lunch from 77.8 – 100% (See Table 3).

Table 3.

Number of Schools and Student by Free and Reduced Lunch Status

	N	*Minimum Free/Reduced*	*Maximum Free/Reduced*	*Total Students*
Quartile 1	*400*	*1.49*	*37.5*	*324,089*
Quartile 2	*397*	*37.6*	*59.7*	*294,774*
Quartile 3	*398*	*59.8*	*77.7*	*271,436*
Quartile 4	*396*	*77.8*	*100*	*251,784*
Total	*1591*			*1,142,083*

The sample size of *N*=796 had 400 high SES schools and 396 low SES schools. An additional parameter was to only include grades Kindergarten through 6, hence those schools with students in Prekindergarten classrooms were excluded from the student membership totals. The Florida Department of Education classifies school districts as small, medium, or large based on the number of students that are served. A small district serves a student population from 1–10,000; a medium district serves 10,000–100,000 students; and a large district serves over 100,000 students. The high SES sample schools had a frequency of 7 percent from small districts, 40 percent from medium districts, and 53 percent from large districts (See Table 4). The low SES sample schools had 5 percent from small districts, 24 percent from medium districts, and 71 percent from large districts.

Table 4.

District Size for Sample Size

	Small	Medium	Large
High SES	7%	40%	53%
Low SES	5%	24%	71%

After the data were organized into the data sets, abnormalities were noticed with the data, such as schools that reported the same number for more than one variable. For example, one school reported a value of 232 for classroom laptop computers and the same value (232) for the number of mobile laptop computers. This irregularity was more apparent when analyses were run with SPSS on the ratio of students to computers in which the results reported that each student had access to two computers.

Since most of the irregularities found in the data related to the number of computers, further analysis was conducted to compare the value for modern desktop classroom computers to the value for non-modern desktop computers; the value for modern classroom laptop computers to the value for mobile computer labs; and the value for modern classroom laptop computers to the value for laptop computers assigned to students. This analysis was conducted using SPSS, and the different variables were compared for equivalent values. All of the cases were sorted by total modern computers, so that the values could be examined for extreme cases and/or duplicate values for different variables. In addition, new variables were created for the total number of modern classroom computers, total number of modern lab computers, total modern computers, total non-modern classroom computers, total non-modern lab computers, and total non-modern computers.

The final step of verification was to compare the values for each of the new variables with data collected from the 2006-07 Technology Resource Survey. The method of gathering the data was designed differently for the 2006-07 survey than it was for the 2005-06 survey. The revised 2005-06 06 survey placed the fields for the total number of modern and of non-modern computers in two separate sections increasing the potential for error in data entry. The new design would allow the users to view all of the access to student computers in one location on the survey. In addition, there was a field for the total number of computers for student use. This final step of the process helped to ensure the accuracy of the data for the 2005-06 surveys.

Access to Computers

An essential condition for effective integration of technology in the curriculum is students' access to computers. The first research question asked, *Is there a significant difference between students' access to computers in high and low socioeconomic schools?* Two components to the question of student access were considered. The first component of the access question explored the type of computers that students access in high and low SES schools. A comparison was made between access to modern and non-modern computers. The second component of the technology access question considered the location of the computers available to high and low SES schools.

Data to answer this question were organized according to student access to modern computers and non-modern computers in both classrooms and lab type settings.

Variables to examine classroom access included: student access to desktop computers, laptop computers, mobile computer labs, and computers assigned to students. Variables for lab type settings included: desktop and laptop computers in media centers, general education labs, special education labs, and other student gathering places. The number of computers used for vocational education was excluded from the data set of elementary schools, as this type of program is not universally offered in all schools.

Total Modern and Non-Modern Computers

The first component of the access to technology question asked, *Is there a significant difference between total number (desktops and laptops) of modern and non-modern computers?* Variables used to examine modern computer access for students included modern classroom computers and modern lab computers, which were then combined for the variable total modern computers. The same procedure was done for non-modern computers, in which the variables, non-modern classroom computers and non-modern lab computers, were created and then combined to form the variable total non-modern computers.

The descriptive statistics for total modern computers in high SES Schools (n=400) resulted in a median of 121 (SD=105.91) and a mean of 145.12, with a range of three to 532 modern computers available at schools (See Table 5). There was a positive skewness of 1.12 with a kurtosis of 0.74. The low SES Schools (n=396) resulted in a median of 114 (SD=90.16) and a mean of 114, as there was a range from zero to 448 for computers. There was a positive skewness of 0.97 with a kurtosis of 0.41. An independent t-test showed there was no significant difference (p=.005) with an extremely small effect size (*d*=0.08) for the total number of modern computers at the schools. The results in the data reveal there are extremes in the number of computers available at all schools. There was variability in the number of modern computers in both the high and low SES schools, for example one low SES school reported having zero modern computers.

Table 5.

Descriptive Statistics for Total Modern Computers by School SES

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	3	532	145.12	121	105.91	1.12	0.74
Low SES	396	0	448	136.82	114	90.16	0.97	0.41

*. *p*=.005. ***d*=0.08.

The total non-modern computers in high SES Schools (*n*=400) had a median of 93 (*SD*=84.56) and a mean of 102.32 compared to low SES Schools (n=396), in which the median was 73.50 (*SD*=80.36) and a mean of 89.39 (see Table 6). The range of computers in the high SES schools went from zero to 510 with a positive skewness of 1.02 and a kurtosis of 2.06. The range of computers in the low SES schools went from zero to 527 with a positive skewness of 1.31 and a kurtosis of 2.63. In addition, there was no significant difference (*p*=.188) for total non-modern computers (relative to SES level) at $p<.05$ level with a small effect size (*d*=0.18). There continued to be variability in the number of computers reported at the individual school level for both high and low SES schools.

Table 6.

Descriptive Statistics for Total Non-Modern Computers by School SES

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	0	510	102.32	93.00	84.56	1.02	2.06
Low SES	396	0	527	89.39	73.50	80.36	1.31	2.63

* *p*=.188. ***d*=0.18.

A variable was created for total modern laptop computers by combining classroom laptop computers, mobile lab laptops, and computers assigned to students. This variable was limited to those schools that reported having modern laptops at high SES schools. In high SES schools, there was a median of one (*SD*=76.28) with a mean of 39.96 (See Table 7). While in low SES schools, there was a median of zero (*SD*=47.05) with a mean of 19.85. An independent-samples t-test analysis indicated significant difference for total modern laptop computers (*p*=.000) in high and low SES schools. The magnitude of the difference was medium (*d*=0.32). This descriptive data reveals there are more modern laptop computers at high SES schools than at low SES schools.

Table 7.

Descriptive Statistics for Total Modern Laptop Computers by School SES

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	0	480	39.96	1	76.28	2.56	7.47
Low SES	396	0	348	19.85	0	47.05	3.49	14.41

**p*=.000. ***d*=0.32.

Additional data were analyzed to examine the number of computers available in classrooms and labs. A ratio was developed using total modern classroom computers divided by the number instructional rooms. High SES schools had a median of 1.53 (*SD*=1.88), a mean of 2.04, and a range of zero to 9.93 computers per classroom (See Table 8). Low SES schools had a median of 1.73 (*SD*=1.93), a mean of 2.16 and a range of zero to 16.76 computers per classroom. An independent t-test found no significant difference in the number of computers available in the classroom (*p*=.361) and no effect size (*d*=0.00). Generally, there is a distribution of two modern computers available in the classroom in both high and low SES classrooms.

Table 8.

Modern Computers per Classrooms by School SES

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	0	9.93	2.04	1.53	1.88	1.10	0.83
Low SES	396	0	16.76	2.16	1.73	1.93	1.85	8.11

*p=.361. **d=0.00.

The ratio for computers to labs was computed using the variable for total modern lab computers divided by the total number of labs. High SES schools had a median of 31 (*SD*=24.21), while low SES schools had a median of 31.50 (*SD*=23.19) modern computers per lab (See Table 9). An independent t-test found no significant difference in the number of computers for modern computer labs (*p*=.153) and no effect size (*d*=0.00). There was an equal distribution of modern computers in labs between high and low SES schools.

Table 9.

Modern Computers per Labs by School SES

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	0	237	30.60	31.00	24.21	2.78	18.36
Low SES	396	0	157	33.18	31.50	23.19	1.14	2.97

*p=.153. **d=0.00.

Location of the Computers

The second component of the technology access question was, *Is there a significant difference between the locations of the computers for student use?* To examine student access to modern computers, the variables for student access to modern classroom computers and lab computers were used. Variables representing modern classroom computers access included: student access to desktop computers, laptop computers, mobile computer labs, and computers assigned to students. Variables representing modern lab type settings included: desktop and laptop computers in media centers, general education labs, special education labs, and other student gathering places.

Data were analyzed to examine the ratio of students to total modern computers and total non-modern computers in high and low SES schools. The variable of total number of students was divided by the total modern computers. The median for students to total modern computers in high SES schools was 7.40 (*SD*=35.68) with a mean of 16.35 (See Table 10). The ratio for students to modern computers ranged from 1 to 461, with an extreme skewness of 7.36 and a kurtosis of 72.93. The median for students to total modern computers in low SES schools was 5.37 (*SD*=56.75) with a mean of 12.71.

The ratio for students to modern computers extended from 1 to 1053, with a positive skewness of 16.38, and a kurtosis of 294.83. An independent t-test showed there was no significant difference (*p*=.285) for the ratio of students to modern computers between high and low SES schools. The effect size for ratio of students to modern computers was extremely small (*d*=0.07).

Table 10.

Student Access to Modern Computers

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	1.00	461	16.35	7.40	35.68	7.36	72.93
Low SES	396	1.00	1053	12.71	5.37	56.75	16.38	294.83

Note. Ratio of students to total modern computers.
**p*=.285. ***d*=0.07

The same method was employed for determining the ratio of students to total non-modern computers in which the students were the numerator and the computers were the denominator. Students' access to non-modern computers in high SES schools exhibited a median of 7.34 (*SD*=91.29) and a mean of 22.41 (See Table 11). The range for students to non-modern computers was large extending from 1.81 to 1172, with an extreme skewness of 9.35 and a kurtosis of 98.45. The median for students' access to total non-modern computers in low SES schools was 6.27 (*SD*=38.97) with a mean of 15.92. The ratio of students to non-modern computers ranged from 1.42 to 566, with a positive skewness of 9.65, and a kurtosis of 12.75. An independent t-test showed there was no significant difference (*p*=.228) for the ratio of students to non-modern computers between high and low SES schools. The effect size for students to non-modern computers was extremely small (*d*=0.09).

Table 11.

Students' Access to Non-Modern Computers

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	1.69	1172	21.99	7.23	91.23	9.38	98.89
Low SES	396	1.06	566	15.24	6.74	36.98	10.67	147.61

Note. Ratio of students to total non-modern computers.
**p*=.228. ***d*=0.09

Students access modern classroom computers in high SES schools (*n*=400) had a median of 9.19 (*SD*=76.19) and a median of 7.92 (*SD*=68.21) in low SES schools (*n*=396) (see Table 12). The range for students' access to modern classroom computers in high SES schools went from 1.56 to 630, with a positive skewness of 5.79 and a peaked distribution with a kurtosis of 37.01. The range in low SES schools went from 2.79 to 751, with a positive skewness of 6.76 and peaked distribution with a kurtosis of 55.33. An independent samples t-test analysis indicated no statistically significant difference for student access to modern classroom computers between high and low SES schools (*p*=.376) with a no effect size (*d*=0.00). The high SES schools have a ratio of one student per 8.67 computers, while in low SES schools the ratio is one student per 7.43.

Table 12.

Students' Access to Modern Classroom Computers

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	1.47	630.00	23.27	8.67	65.05	6.89	54.01
Low SES	396	1.37	751.00	22.97	7.43	66.66	7.05	59.57

Note. Ratio of students to modern computers in classroom settings.
*p=.376. **d=0.00

The median for students' access to modern lab computers in high SES schools was 25 (*SD*=143.54) with a mean of 68.36 (See Table 10). The range for students to modern computers went from 4.01 to 1112, with a positive skewness of 4.63 and a peaked distribution with a kurtosis of 23.93. The median for students' access to modern lab computers in low SES schools was 16.92 (*SD*=99.03) with a mean of 42.07. The range for students to modern computers was large as it went from 2.79 to 1053, with a positive skewness of 6.75, and peaked distribution with a kurtosis of 55.38. An independent t-test showed there was a statistically significant difference in student access to modern lab computers (p =.004). The effect size based on Cohen's d revealed the difference in the means was small (d=0.21).

Table 13.

Students' Access to Modern Lab Computers

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	4.59	1112.00	58.95	24.43	125.64	5.47	34.93
Low SES	396	2.79	940	3.92	15.39	76.39	7.11	66.76

Note. Ratio of students to modern computers in lab settings.*p=.004. **d=0.21.

Summary Access to Computers

The first research question examined students' access to technology by focusing specifically on their access to computers in high and low SES schools. Data analysis between high and low SES schools found no significant difference between total modern computers, total non-modern computers modern classroom computers, and modern computers labs. There was a higher distribution of modern laptop computers in high SES schools than low SES schools. However, low SES schools have a significantly higher ratio student to total modern computers, total non-modern computers, modern computers in classroom settings, and modern computers in lab settings.

Software Types on Student Computers

Another essential condition for the integration of technology in the curriculum is development of a student-centered learning environment. The second research question was, *Is there a significant difference between the types of software available on computers between schools serving high and low SES schools?* This question focused on the availability of types of software (tool-based and curriculum-based) on student computers. Tool-based software refers to application-based programs that provide opportunity for teachers and students to perform a task. Curriculum-based software refers to those programs that deliver content for student consumption.

Tool-Based Software on Student Computers

The data analyzed for this question came from items on the survey that required the respondent to report the approximate percentage range of software types on each given computer. The response scales used were: "0%"; "1-24%"; "25-49%"; "50-74%";

and “75-100%”. The midpoint percentage of each option selected was used to create a continuous variable. Variables for tool-based software included: concept mapping, graphics, multimedia authoring, presentation, spreadsheet, video editing, web authoring, basic word processing, and robust word processing. A Cronbach’s alpha of .74 for the group of nine survey items was used to measure the internal consistency reliability for tool-based software, which is an acceptable value for this portion of the survey.

The mean for the availability of tool-based software on students’ computers for high SES schools (*n*=400) was 57.18 (*SD*=13.94) and for low SES schools (*n*=396) was 50.59 (*SD*=16.90) (See Table 14). An independent samples t-test was conducted to compare the availability of tool-based software at high and low SES schools. There was a significant difference related to the availability of the tool-based software (*p*=.000). The magnitude of the differences in the means tended toward a medium effect size (*d*=0.43). There was a higher distribution of tool-based software on student computers for high SES schools than the low SES schools.

Table 14.

Tool-Based Software Availability on Student Computers

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	0	87.50	57.18	58.22	13.94	-0.54	0.98
Low SES	396	0	87.50	50.59	51.38	16.90	-0.37	0.10

**p*=.000. ***d*=0.43.

A factor analysis was performed on the nine survey items for tool-based software to create two different variables, basic and robust (See Table 15). The basic tool-based software variable consisted of three items: presentation, spreadsheet, and robust word processing software. The basic tool-based software reflects the average suite of tools which are available on the computer when purchased. A Cronbach's alpha for the three items was .81, which was adequate for these three items. The robust-tool-based software variable consisted of multimedia authoring and video editing, with a Cronbach's alpha of .69 which was adequate.

Table 15.

Factor Analysis for Tool-Based Software

	Factor 1	Factor 2
Spreadsheet	.927	-.023
Presentation	.784	-.060
Robust word processor	.594	.084
Basic word processor	.345	.067
Graphics	.318	.268
Multimedia	-.053	.815
Video Editing	.007	.661
Concept Map	.065	.457
Web authoring	.126	.290

Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization.

An independent samples t-test was conducted to compare the availability of basic tool-based software on high and low SES schools computers. There was significant difference in availability for high SES schools (*M*=77.29, *SD*=17.21) and low SES schools (*M*=70.71, *SD*=24.90) with p=.000 (See Table 16). The magnitude of the differences in the means tended toward a medium effect size (d=0.30). The data show that computers in high SES schools have a higher distribution of basic tool-based software than in low SES schools.

Table 16.

Basic Tool-Based Software Availability on Student Computers

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	0	87.50	77.29	87.50	17.22	-2.12	4.88
Low SES	396	0	87.50	70.72	87.50	24.90	-1.40	.728

Note. Basic tool-based software consisted of presentation, spreadsheet, and robust word processor.
*p=.000. **d=0.30.

An independent samples t-test was conducted to compare the availability of robust tool-based software at high and low SES schools computers. There was significant difference in availability for high SES schools (M=33.27, SD=28.68) and low SES schools (M=25.02, SD=27.00) with the p=.000 (See Table 17). The magnitude of the differences in the means tended toward a medium effect size (d=0.30). There is a significant distribution in the availability of robust tool-based software on computers in high SES schools than on computers in low SES schools.

Table 17.

Robust Tool-Based Software Availability on Student Computers

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	0	87.50	33.27	24.75	28.68	0.62	-0.83
Low SES	396	0	87.50	25.02	12.50	27.00	1.02	-0.05

Note. Robust tool-based software consisted of multimedia authoring and video editing
*p=.000 **d=0.30

Curriculum-Based Software on Student Computers

Variables for curriculum-based software included: FCAT Explorer, other test prep tools, Integrated Learning Systems, content-specific skills practice/tutorials, content-specific simulation, other content-specific resources, and general reference tools. The composite variable for each software type was created by finding the mean of all options selected. Cronbach's alpha for the seven survey items was used to measure the composite variables for curriculum-based software was .68, which is acceptable for internal consistency with the items.

An independent samples t-test was conducted to compare the availability of curriculum-based software at high and low SES schools. There was no significant difference in availability for high SES schools (*M*=55.36, *SD*=17.80) and low SES schools (*M*=54.74, *SD*=18.45) with the *p*=.628 (See Table 18). The effect size was extremely small (*d*=0.03). There tends to be an equal distribution of curriculum-based software on computers in high and low SES schools.

Table 18.

Curriculum-Based Software Availability on Student Computers

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	00	87.50	55.36	55.35	17.80	-0.22	-0.33
Low SES	396	00	87.50	54.74	53.57	18.45	-0.12	-0.47

*p=.628. **d=0.03.

Summary of Software Types on Student Computers

The second research question focused on the availability of tool-based and curriculum-based software on student computers. There was a statistically significant difference in the basic tool-based software, with a mean of 77.29 for high SES schools and 70.72 for low SES schools. In addition, there was a statistically significant difference with the robust tool-based software, with a mean of 33.27 in high SES schools and 25.02 in low SES schools. A single variable was created for curriculum-based software available on students' computers. There was no statistically significant difference in the curriculum software, with the mean of 55.36 in high SES schools and 53.57 in low SES schools.

Student Use of Software Types

The third research question was, *Is there a relationship between the socioeconomic status of an elementary school and the frequency of student use by software type?* This question expanded on the availability of the software types on the computers, to examine the frequency of use by the student. The data analyzed for this question came from the item on the survey that required the respondent to report the frequency of student use of software types. A composite score was developed for each of the variables by adding the categories for frequency of student use.

Limited and Regular Use of Software Types

Two categories "limited" and "regular" were used to examine the frequency of student use of software. The limited category included the total frequencies for "not at all”, “once a month”, and “once a week” while the regular category included the total frequencies for “several times a week” and “everyday”. A frequency table was developed to examine these two categories for each of the variables for student use of software types (See Table 19). The frequency table reveals that students in low SES schools use Integrated Learning Systems and drill software on a regular basis with limited use of other software types. The high SES schools had regular use of drill and research based software with limited use of the other software types.

Table 19.

Student Limited and Regular Use of Software

		High SES	Low SES
Multimedia	Limited	76%	85%
	Regular	24%	15%
Presentation	Limited	79%	90%
	Regular	21%	10%
Tool-based	Limited	50%	64%
	Regular	50%	36%
Research	Limited	41%	46%
	Regular	59%	54%
Simulation	Limited	87%	97%
	Regular	13%	03%
Integrated Learning System	Limited	42%	24%
	Regular	58%	76%
Drill	Limited	36%	25%
	Regular	64%	75%

Note. Limited category consisted of the total frequencies for “not at all”, “once a month”, and “once a week”. The Regular category consisted of the total frequencies for “several times a week” and “everyday.”

The data in each of the software types exhibits there is extreme use of software types within high and low SES schools. The use of simulation type software in high SES schools was limited to 87% with only 13% regular use. While presentation types of software in low SES schools was limited to 90% with regular use of 10%. The tool based and research types of software showed an even distribution of student use within the high and low SES schools.

Frequency of Student Use of Software

The indicators, “not at all”, “once a month”, “once a week”, “several times a week”, and “everyday” were assigned a corresponding value of 0, 25, 50, 75, and 100. A variable was created for frequency of student software that included: tool-based, presentation, multimedia, research, simulation, drill and skill, and Integrated Learning System. An independent samples t-test was conducted to compare the frequency of student software use between high and low SES schools. There was a significant difference in frequency of student use for high SES schools (*M*=51.01, *SD*=17.50) and low SES schools (*M*=47.42, *SD*=16.07) with the *p*=.003 (See Table 22). The magnitude of the differences in the means was small (*d*=0.24).

Table 20.

Frequency of Student Software Use

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	0	100	51.01	50.00	17.50	0.18	-0.10
Low SES	396	0	100	47.42	46.42	16.07	0.32	-0.09

**p*=.003. ***d*=0.24.

Factor analysis was performed on the frequency of use for software types to create a variable for frequency of student tool-based software use (See Table 21).

Variables for frequency of student tool-based software included: tool-based, presentation, multimedia, and research with a Cronbach's alpha of .78.

Table 21.

Factor Analysis for Frequency of Student Use

	Factor 1	Factor 2
Tool-based	.765	.023
Presentation	.712	-.101
Multimedia	.638	.027
Research	.620	.132
Simulation	.398	.033
Drill and skill	-.027	.720
Integrated Learning System	.022	.497

Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization.

An independent samples t-test was conducted to compare the frequency of student tool-based software use between high and low SES schools. There was a significant difference in frequency of student use for high SES schools (M=50.18, SD=20.55) and low SES schools (M=41.84, SD=20.30) with p=.000 (See Table 22). The magnitude of the differences in the means was medium (d=0.40).

Table 22.

Frequency of Student Tool-Based Software

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	0	100	50.18	50.00	20.55	0.20	-0.32
Low SES	396	0	100	41.84	43.75	20.30	0.39	-0.31

Note. Student tool-based software consisted of tool-based, presentation, multimedia, and research. *p=.000. **d=0.40.

Summary of Student Use of Software

The third research question examined the essential condition of the frequency of student use of software types. The frequency table of "limited" and "regular" use highlighted there were extreme differences with all software types within high and low SES schools. In addition, there was regular use of Integrated Learning Systems and drill software with high SES schools. There was a statistically significant difference in the variable for frequency of student software use (p=.003), however, the magnitude of the effect size was small (d=0.24), with high SES schools (M=51.01, SD=17.50) and low SES schools (M=47.42, SD=16.07). There was also a statistically significant difference in the variable for frequency of student tool-based software use (p=.000), with the magnitude of the effect size medium (d=0.40) in high SES schools (M=50.18, SD=20.55) and low SES schools (M=41.84, SD=20.30).

Teacher Use of Technology

The final essential condition for the integration of technology in the curricular framework is dependent on the teacher use of technology in the classroom. The fourth research question, *Is there a relationship between the socioeconomic status of an* *elementary school and the teacher use of technology in the classroom?* examined the teachers' level of use of technology in the classroom with students.

Basic Teacher Use of Technology

The data analyzed for this question came from the item on the survey that required the respondent to report the percentage of teachers' use of technology in the classroom. A midpoint score was given for each of the responses, "0%", "1-24%", "25-49%", "50-74%", and "75-100%", for percentage of time in which the teacher uses technology in the classroom. A basic teacher use of technology variable was developed that encompassed the sum of the means for the variables that included: delivery method, supplement to instruction, instructional tool, core curriculum, and daily curriculum tool. The basic teacher use of technology variable represents the teacher's overall method for the use of technology in the classroom with students.

An independent samples t-test was conducted to compare basic teacher use of technology between high and low SES schools. There was a significant difference in the combined teacher use for high SES schools (M=51.56, SD=19.96) and low SES schools (M=48.55, SD=20.51) with p =.036 (See Table 23). The magnitude of the differences in the means was extremely small (d=0.14). The mean for high SES schools was 51% of the time, while in low SES schools it was 48% of the time.

Table 23.

Frequency of Basic Teacher Use of Technology

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	0	87.50	51.56	52.10	19.96	-0.05	-0.72
Low SES	396	0	87.50	48.55	47.20	20.50	0.05	-0.90

*p=.036 **d=0.14

Curriculum-Focused Use of Technology

A factor analysis on the teacher use of technology examined those variables with similar characteristics (see Table 24). The "daily instructional tool" variable and "core curriculum tool" variable were closely aligned to form a new variable curriculum-focused use of technology as a tool with Cronbach's alpha of .86.

Table 24.

Factor Analysis for Teacher Use of Technology

	Factor 1	Factor 2
Daily instructional tool	.981	-.085
Core curriculum tool	.759	.099
Delivery of instruction	.387	.229
Instructional tool	.027	.728
Supplement to instruction	.025	.528

Extraction Method: Principal Axis Factoring.
Rotation Method Promax with Kaiser Normalization.

An independent samples t-test was conducted to compare curriculum-focused use of technology as tool between high and low SES schools. There was a significant difference in frequency of student use for high SES schools (*M*=47.46, *SD*=26.29) and low SES schools (*M*=43.06, *SD*=27.31) with *p*=.021 (See Table 25). The magnitude of the differences in the means was small (*d*=0.16).

Table 25.

Frequency of Teacher Curriculum-Focused Use of Technology as a Tool

School SES	N	Min	Max	M	Mdn	SD	Skewness	Kurtosis
High SES	400	0	87.50	47.46	46.62	26.29	0.12	-0.72
Low SES	396	0	87.50	43.06	37.00	27.31	0.31	-1.20

Note. The curriculum-focused use of technology as tool consisted of "daily instructional tool" and "core curriculum tool.
*p=.021 **d=0.16

Summary of Teacher Use of Technology

Data for this question came from an item that examined the percentage of teachers' use of technology in the classroom. Two variables were developed from the items: the basic teacher use of technology in the classroom and the curriculum-focused use of technology as a tool. There was a statistically significant difference with the basic teacher use of technology in the classroom variable (*p*=.036), however, the magnitude of the difference was extremely small (*d*=0.14). There was also a significant difference in the curriculum focused use of technology as a tool (*p*=.021), however, the magnitude of the difference was small (*d*=0.16), with high SES schools (*M*=47.46, *SD*=26.29) and low SES schools (*M*=43.06, *SD*=27.31).

CHAPTER FIVE

DISCUSSION AND RECOMMENDATIONS

In response to the *NCLB* legislation, the Florida Department of Education (FLDOE) defined technology integration in the classroom as the students' seamless use of technology as a productivity tool to accomplish a given task in a disciplined study that promotes higher-order thinking skills. The FLDOE put into practice an annual technology resource survey to provide more meaningful information about technology integration in Florida's schools. The purpose of this study was to examine the use of technology with low and high socioeconomic students in the state of Florida.

Findings from this study expand our knowledge about the use of technology in high and low SES schools. Data from this study informs policy makers and state/district level administrators on how to plan for the high level integration of technology in all public schools. In addition, the data provide guidance on professional development for teachers on the use of technology with low SES students.

Summary of Questions and Results

Data for this study were from the 2005-06 Technology Resource survey with elementary schools (*N*=1591) that responded in the fall of 2005. The schools were then ranked by the percentage of students who received free and reduced lunch and divided into four quartiles. High SES schools (*n*=400) had a range students who qualified for the free and reduced lunch program with an average of 810 students per school. The low SES schools (n=396) had a range of students who qualified for free and reduced lunch, with an average of 636 students per school.

The first research question was divided into two separate components for examining students' access to computers in high and low SES elementary schools. The first component was: *Is there a significant difference between the total number of modern and non-modern computers?* The results showed there was no significant difference found between total modern computers, total non-modern computers, and modern computer labs. There was a significant difference for total modern laptop computers (p=.000), however, the magnitude of the difference was medium (d=0.32). The descriptive data made known there are more modern laptop computers in high SES schools than at low SES schools.

The second component of the question was: *Is there a significant difference between the locations of the computers for student use?* Items from the survey were categorized into two groups of classroom versus non-classroom or labs. The classroom variable was the total number of modern computers, including desktop and laptop computers, in the classrooms, mobile labs, and computers assigned to students. The non-classroom variable was a combination of modern computers in the media center, general education labs, special education labs, and other student gathering places. Data analyzed for this question found no significant difference in students' access to modern computers in the classroom with the p =.376. The ratio for students to modern classroom computers in high SES schools was 8.67 to 1, and it was 7.43 to 1 in low SES schools.

A statistically significant difference was found in students' access to modern labs (p=. 004), however, the effect size was small (d=0.21), which meant the difference was trivial. The ratio of students to computers in modern labs for high SES schools using the median was 25.00 to 1, and it was 16.92 to 1 in low SES schools. There was a statistically significant difference for access to the modern laptop computers (p=.000, d=0.35) between high and low SES schools.

The second research question stated: *Is there a significant difference between the types of software available on the computers?* The two items examined for this question had the respondents provide the percentage of tool-based software and curriculum-based software on student computers. The tool-based software variable included: concept mapping, graphics, multimedia authoring, presentation, spreadsheet, video editing, web authoring, basic word processing, and robust word processing. There was a significant difference (p=.000) with a medium effect size (d=0.43). The curriculum-based software variable included: FCAT Explorer, other test prep tools, Integrated Learning Systems, content-specific skills practice/tutorials, content specific simulation, other content-specific resources, and general reference tools. There was no significant difference (p=.628) in the availability of curriculum-based software on student computers in high and low SES schools.

The third research question stated: *Is there a relationship between the socioeconomic status of an elementary school and the frequency of student use by software type?* Data for this question came from an item that examines the frequency of student use of computer software programs. The variable for frequency of student software use included: tool-based, presentation, multimedia, research, simulation, drill and skill, and Integrated Learning System. There was a significant difference in the variable for frequency of student software use (p=.003), however, the magnitude of the effect size was small (d=0.24). A factor analysis developed a second variable for student tool-based software that included: tool-based, presentation, multimedia, and research. There was also a statistically significant difference in the variable for frequency of student tool-based software use (p=.000), with the magnitude of the effect size medium (d=0.40) in high and low SES schools.

The final question stated*: Is there a relationship between the socioeconomic status of an elementary school and the teacher use technology in the classroom?* Data for this question came from an item that examined the percentage of teachers' use of technology in the classroom. The basic teacher use of technology in the classroom variable included: delivery method, supplement to instruction, instructional tool, core curriculum, and daily curriculum tool. There was a statistically significant difference with the basic teacher use of technology in the classroom variable (p=.036), however, the magnitude of the difference was extremely small (d=0.14). A factor analysis developed a the curriculum-focused use of technology as a tool variable that included daily instructional tool and core curriculum tool. There was also a significant difference in the curriculum focused use of technology as a tool (p=.021), however, the magnitude of the difference was small (d=0.16).

Discussion

The following discussion addresses the results with regard to the essential conditions for technology integration in the classroom in Florida's elementary schools. Researchers have identified the conditions to be: (a) students' access to technology, (b) the development of a student-centered learning environment, and (c) integration of technology in the curricular framework (Glennan & Melmed, 1996: Kelley & Ringstaff, 2002; Sandholtz, Ringstaff, & Dwyer, 1997). All three conditions are crucial aspects to the effective integration of technology in the classroom. The final section will address the essential condition's impact in the low SES schools.

Student Access to Technology

The process for the collection and analysis of the data for this study was much more rigorous than current national studies on student access to computers. For example, in the Technology Counts 2007 report, the process for gathering data was to interview selected 4th and 8th math teachers across the state of Florida on their access to computers (Bausel and Klemick, 2007). In contrast, the data from Florida's Technology Resource Survey involves a coordinated effort between the survey programmer, the state technology director, district personnel, and the school technology specialists to ensure the accuracy of the data. The data from the Technology Counts 2007 stated that Florida had 3.2:1 ratio of students to computers in the classroom (Bausel and Klemick, 2007). This study showed that median access for computers in the classroom for high SES schools was 8.67:1 and in low SES schools was 7.43:1. Although this difference was not statistically significant (relative to SES level), it does illustrate a higher ratio than is being reported nationally.

In reports on effective integration of technology in the classroom, teachers have stated one of the main barriers for the integration of technology in the classroom is the access to computers (Ringstaff & Kelley, 2002). Data were analyzed in this study to determine the average number of computers per classroom. The average number of computers per classroom in sample in Florida was less than two. This limited access to computers in the classroom affirms teachers' concerns that access is only one barrier to effective integration of technology in the classroom.

Nearly a decade ago, education reformers began implementing laptop computer programs across the nation as a method for increasing access to computers in the classroom (Rockman et al, 1998). Strategies for providing access to laptop computers have ranged from providing one computer for every child to providing a set of mobile carts that can travel from room to room. When teachers have access to laptop computers in the classroom, they can be utilized as an educational tool for the movement toward constructivist ideals and pedagogy that engages students in the learning process (Fouts, 2000; Lowther, Ross, & Morrision, 2001; and Rockman, 2000). Results from this study revealed there was a statistically significant difference for the availability of laptop computers with low SES schools (p=.000, d=0.35). Data from this study shows that low SES have limited opportunities to use technology as a tool for constructing knowledge in the classroom, particularly when considering laptop computers.

Student-Centered Learning Environment

The second condition for effective technology integration is the development of a student-centered learning environment in which technology is used as a cognitive tool for learning (Culp, Hawkins, & Honey, 1999; Means, 1994; and Reeves, 1998). The computer as a tool allows teachers and students the opportunity to construct knowledge that enhances curriculum and instruction (Ringstaff & Kelley, 2002). In order to facilitate this type of environment, adequate software needs to be available on the computer that enables the use of the computer as a tool. This type of software includes tool-based software, such as word processing, spreadsheet, presentation, concept mapping, and video editing programs.

Studies have shown that technology will have the greatest impact in the classroom if it is used for higher order learning activities with students. However, when technology is used for drill and practice, there tends to be a negative impact on student achievement (Wenglinsky, 1998). Students of low SES schools need to develop cognitive skills and independent thinking, which are often lacking due to their social situation (Renchler, 2000). Frequently, the students live in environments over which they have little control and lack the vision for their future (Brophy, 1998; Bandura, 2001).

The results from this study affirmed there is a statistically significant difference in the availability of software types on the computers between high and low SES schools. The high SES schools had an average of basic tool based software on 77% of the computers, while the low SES schools had a frequency of 71% (See Table 16). These data do not support the 1998 Teaching, Learning, and Computing (TLC) national survey, that found no significant difference in the availability of skill/game software between high and low SES schools (Becker, Ravitz, & Wong, 1999).

However, the largest practical difference was in the availability of additionally purchased software, such as robust tool-based software. This type of software requires the school to make a conscious effort to purchase specific programs that are not built into the computer or part of a basic software package. The robust tool-based software was on approximately 33% of the computers in high SES schools and 25% of low SES schools (See Table 17). When computers are equipped with robust tool-based software, such as those in the Multimedia Project Classrooms, a student-centered learning environment can be created (Penuel & Means, 1999). In this type of learning environment, there can be an increase in the frequency of student use for robust tool-based software, such as concept mapping, video editing, and multimedia authoring.

Technology in the Curricular Framework

The frequency for the utilization of tool-based software programs confirmed there was limited use, between none to once a week, with low SES schools (See Table 19). For example, in high SES schools the frequency of use for tool-based software was 50% limited and 50% regular, while in low SES schools it was 64% limited and 36 % regular. However, the frequency for drill and practice software in high SES schools was 36% limited and 64% regular and in low SES schools 25% limited and 75% regular. The discrepancy with the frequency of student tool-based software user reveals that students in low SES schools may not be provided the same opportunity to develop higher order thinking skills (Knapp & Shields, 1990; Waxman, Padron, &Knight, 1991). The students are learning "from" the software programs rather than "with" the software programs, hence the computers are being used as tutor rather than a cognitive tool for learning.

The results obtained from this study support the need for professional development on the integration of technology in the curricular framework. A significant difference was found with basic teacher use of technology in the classroom (p =.036, d=0.14) for high SES schools (M=51.56, SD=19.96) and low SES schools (M=48.55, SD=20.51). The data mirrors the information that has been stated by researchers when there is limited access to the technology, the teachers will not be able to make the shift toward the use of technology as a tool for instruction (Sandholtz, Ringstaff, & Dwyer, 1997). In order for change to occur, teachers need to learn how to take advantage of integrating technology in the classroom, hence there needs to be an increase in professional development on the use of technology in the classroom.

The role of technology must move beyond the teacher's use of technology to improve students' basic skills. Teachers' beliefs about the use of technology need to transform learning "from" technology to learning "with" technology (Ringstaff & Kelley, 2002). The essential condition of technology in the curricular framework depends on teachers' understanding and development of tasks that engage students in the learning process (Baker, Herman, & Gerhart, 1996). Data from this study reveals that just having computers in the schools does not ensure effective use of the technology. There needs to be a sustained professional development effort for teachers in high and low SES schools on the use of technology as a tool for learning in curriculum.

Recommendations

Based on the results of this research and literature review, this section offers recommendations for policy makers, modifications to the survey and future research.

Recommendations to Policymakers

Policymakers at both the federal and state level need to develop a common definition for technology integration in the curriculum that can be disseminated to all stakeholders. A common definition for technology integration will address three main issues of student access to technology in the classroom, integration of technology a tool for learning, and professional development of educators. Policy needs to be established that ensures all students have access to technology in the classroom. There needs to a set of target dates for a student to computer ratio in classrooms at every grade level. In addition, policymakers need to identify innovative methods of students to bring existing computers to the classroom.

A second recommendation for policy is to develop common goals for the use of technology as a tool for learning in the classroom. Data from this study show there is still a gap in student access to computers, however there is a larger gap in the frequency of software types on the computer. There have been tremendous strides in providing students access to curriculum-based software, however, there is amble room for growth in the area of tool-based software. Students need to have access to those software tools, such as multimedia, web-based, presentation, and video editing, that will allow them to be productive citizens in the 21st century.

A third recommendation for policy is the development of a sustainable professional development plan for educators on the use of technology in the classroom. As the data reveals, while there is access to computers at the school it does necessarily ensure the computers are being used in the classroom for core curriculum instruction. Further analysis of the data could show the current methods of professional development being done with those schools that high level of teacher technology use as a tool.

A final recommendation for policymakers is a common method for reporting the use of funds needs to be developed at the state and federal level. It is imperative that data gathered on this issue be as accurate as possible to ensure accountability for the expending of federal dollars for technology. The data elements need to reflect the use of technology in the classroom that promote higher order thinking skills. The data used from the Technology Resource Survey provide a framework for the elements that could be used at a federal level.

Recommendations for Modifications to the Survey

After using data from the Technology Resource Survey, it became apparent there are gaps in the survey. A key limitation in the survey was the lack of a mechanism in the access to technology portion that ensured the accuracy of the data being collected. A mechanism needs to be developed within the user input that ensures that the reporting of computers in each area is accurate. Verification for each field in the location of modern and non-modern computers needs to be added to the survey.

Further analysis needs to be done on the items in the survey to ensure the data being provided represent the actual use of technology in the classroom. This could be done by rewording the items to be consistent and specific through a common terms glossary. For example, the item that examines the types of software on the computers needs to be clearly defined so that there is no repetition among items, such as the delineation between "Integrated Learning System" and "Drill and Practice" software. A common set of terms needs to be clearly defined for the survey.

Recommendations for Future Research

Data from this research revealed there is still a lack of information on the actual use of technology in the classroom with low SES students. Further research needs to be done on the actual work being done by students with technology. Is a learning environment being created with high expectations for all students in the use of technology? Researchers need to be in the actual classroom to understand all the aspects of the classroom and the method in which technology is being integrated into the curriculum with the low SES students.

Additional research needs to be done on those schools that are integrating technology in the curriculum as a tool with high and low SES students. It is important to understand all of the aspects of the school that has created a learning environment for technology to be integrated as tool in the curriculum. For example, the method in which technology is integrated into the school's improvement plan and the philosophical beliefs of the principal and teachers about the use of technology with low SES students. An observation tool which examines the levels of technology integration in the classroom.

Further research also needs to be conducted on the teachers in high and low SES schools. This can be done by examining teaching experience, philosophy on classroom instruction and level of degree. In addition, examining the actual professional development the teacher has received on the use of technology in the classroom would be beneficial. For example, was the focus of the training an actual software program or the creation of a student product, such as a digital book? In addition, there should be interviews with educator on how the use of technology, concerns for high-stakes testing, and curriculum goals for technoloby.

Summary

This purpose of this study was to examine the use of technology in low and high SES elementary schools in Florida. Through an iterative process with districts and schools, the Florida Department of Education conducts an annual survey in which they gather data on the capacity of technology in the schools. Data from the 2005-06 Technology Resource Survey were used to examine the essential conditions for technology integration: access to technology, student-centered learning environment, and technology in the curricular framework. The variables examined in this study were students' access to computers, the types of software available on the computer, the frequency of student use of software programs, and the teacher use of technology.

Findings from this study expand our knowledge about the essential conditions for the integration of technology in high and low SES schools. The Technology Resource Survey data provided information on access to technology, student-centered learning environment, and the use of technology in the curricular framework. However, additional research must be done on the actual use of technology in the classroom with high and low SES students. As education continue to have increased high stakes testing, we need to ensure that technology is being used as a tool to develop high order thinking skills for students. This study should serve as the launching point for an in-depth examination of the use of technology in low SES classrooms.

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