# HIGH SCHOOL EARLY ADOPTERS OF DIGITAL TECHNOLOGY

BY

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ABSTRACT

HIGH SCHOOL EARLY ADOPTERS OF DIGITAL TECHNOLOGY

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Although the number of studies was growing, there was little qualitative research investigating the issue of how classroom teachers were integrating technology for educational purposes. With all the money spent on technology in education, there had not been many studies attempting to determine how teachers were using it in classroom lessons. The findings of this study will contribute to the literature on technological integration to promote content learning.

A qualitative case study design was used to examine how teachers in advanced technology high schools were integrating digital technology into classrooms. A preliminary screening survey identified the three technology advanced high schools in a defined geographical region. Three early adopter teachers in each of these schools were interviewed, observed in classrooms, and asked to provide documents regarding their lessons and student products. By closely examining and describing the teachers' uses of specific technology applications, recurring themes shed light on the use of technology in advanced technology public high school settings.

The findings highlighted teacher technology use and some best practices by the early adopters in high schools and provided significant insight into the three interactive domains that must be balanced: teacher, project, and school. The factors that influenced

teachers to adopt technology were categorized into school and global forces. The teachers reported using multimedia to communicate and engage the students. They used more of a constructivist approach to extend their students' learning experience and used the power of the Internet to continue class discussions and enhance their lessons beyond the classroom. In the end, the teachers perceived the benefits of technology use greatly outweighed any frustrations they experienced.

This case study can serve as a model for how teachers and administrators may incorporate technology into their classrooms. Technology offered many benefits to teachers and students, yet few qualitative studies support this and demonstrate how technology's integration had been successfully and meaningfully accomplished. This study provides insight and knowledge regarding how teachers and administrators may successfully integrate technology and assist in replicating the success in other schools and classrooms.

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# CHAPTER I

## INTRODUCTION

As did the Guttenberg printing press, digital technology has created a fundamental worldwide paradigm shift in processing information that schools now must learn to embrace (Hokanson & Hooper, 2000). Since the 1980s, children have been surrounded by digital technology in their homes and schools. Commonplace examples include video and audio content and equipment, cellular phones, computers, and the Internet. Digital technology has flattened the world and has created a global workplace environment in which students today can look forward to participating, at times competitively, with other candidates worldwide (Friedman, 2006). To participate effectively, students need 21st century skills that include digital literacies. "These new literacies of the Internet and other ICT [Information and Communication Technologies] are required to ensure more fully realized personal, civic, and professional lives" (Leu, Leu & Coiro, 2004, p. 17). It is the CEO Forum on Education and Technology's (2001) position that technology offers the greatest promise for improving education as it has helped revitalize American business. Likewise, Becker (2000) concluded that technology is becoming a valuable and well-functioning instructional tool that is having an impact on students in and out of class.

To stress the importance of digital literacy skills, all states now include technology standards among other curriculum standards as part of the core knowledge and skills that must be met in public education (CEO Forum on Education and Technology, 2001; International Society for Technology in Education, 2008b). Spurred

on by a vision of new possibilities through technology, the United States invested more than $40 billion between 1990 and 2002 to place computers, educational software, and Internet connections in schools (Benton Foundation, 2003). Promoters of digital technology in schools claim that such technology will prepare students for the future workplace, make schools more efficient and productive, and transform teaching and learning into an engaging and active process connected to real life (Cuban, 2001). In view of a growing worldwide reliance on digital technology for countless purposes, this study was designed to investigate specific reasons why teachers were integrating technology, how they were integrating digital technology, whether digital technology integration may be accompanied by more constructivist pedagogies, and with what results or consequences.

## Research Problem

The workplace has changed dramatically since the 19th century, and many people believe that public schools should be re-focused on the development of skills needed for success in a digital workplace (Liu, 2003). The U.S. Department of Labor reported that of 54 jobs expected to experience the most significant growth between 2000 and 2005, only eight did not require technological fluency (CEO Forum on Education and Technology, 2000). Parents of American school-age students were hiring e-tutors from abroad to help with their schoolwork (Friedman, 2006). Armed with this growing awareness of digital opportunities and resources, schools have spent billions of dollars to provide students with access to some of the latest commercial technology.

To reduce achievement gaps, the *No Child Left Behind Act* anticipated that schools should expand the use of digital technology for learning and ensure students were to become technologically literate before enrolling in high schools (Benton, 2003; No

Child Left Behind Act of 2001, 2008). Although the U.S. Department of Education was working on a definition of "technologically literate" (Benton, 2003), some people have described it for the 21st century as being able to think critically, solve problems, use information, communicate effectively, innovate, collaborate, and produce high-quality work–all skills presumed necessary for success in the global economy (CEO Forum on Education and Technology, 2001; Partnership for 21st Century Skills, 2006). Under the right circumstances, technology has been shown to help develop 21st century skills (CEO Forum on Education and Technology, 2001).

In addition to preparing students for the workforce, public education should provide students with the basic social skills necessary for success in life. A New Literacies Perspective considers the effective use of the Internet a necessary skill for student success (Leu et al., 2004). Emergent digital literacies may allow students to identify important questions, navigate complex networks, critically evaluate and synthesize information, and communicate answers so as to be successful with the Internet and other information and communication technologies (Leu et al.).

To better understand how teachers are preparing students for the workforce and teaching them basic social skills, research needs to be conducted on what the teachers who are leading the way, or early adopters, are striving to accomplish trough technology today. To that end, questions must be answered regarding what digital technologies are most useful to them; under what pedagogical conditions might digital technology be obstructed or facilitated; and what consequences or results do technology early adopters expect to produce through classroom technology integration.

## Study Design

For this study, an early adopter was defined as a teacher demonstrating skills, knowledge, and understanding of current available technology and translating that knowledge by designing developmentally appropriate learning opportunities for students (Angers & Machtmes, 2005). To examine how early adopters in high schools were integrating digital technology into the classroom, the investigator addressed the following questions:

1) What factors influenced teachers to adopt technology in high-technology high schools?

2) How did teachers think about and demonstrate the use of technology in their classrooms?

3) What was the relationship between classroom technology use and the adoption of constructivist teaching practices?

4) What common benefits and frustrations did teachers experience when using technology for instructional purposes?

From the teachers' perspectives, the questions aimed to understand how teachers were integrating technology in the classroom. The first question searched for the school and beyond school factors that influenced teachers to incorporate technology. Questions were asked regarding school forces such as mandates and peer and student pressures, as well as global forces such as college and work force pressures, and how the teacher was supported through the school climate, culture, and professional development.

The second question focused attention on what may be the key component in determining the successful integration of technology into the classroom–the teacher. Zhao, Pugh, Sheldon, and Byers (2002) "confirmed the assumption that a teachers' technology proficiency plays a major role in classroom technology innovations" (p. 489). This question delved into the lesson design and use of technology by the teachers to

deliver the curriculum and by the students to meet their assignments. It also investigated how technology was used, in and around the classrooms, to promote content learning.

The third question looked at how the teacher's pedagogy may have changed as a result of using technology. Thus, teachers having access to technology may have adopted a more student-centered constructivist philosophy. The final question recorded the common frustrations and benefits the teachers realized when using technology. Each of the four questions attempts to find some of the answers that contribute to the successful integration of technology in the classroom, which can be visualized though Figure 1.

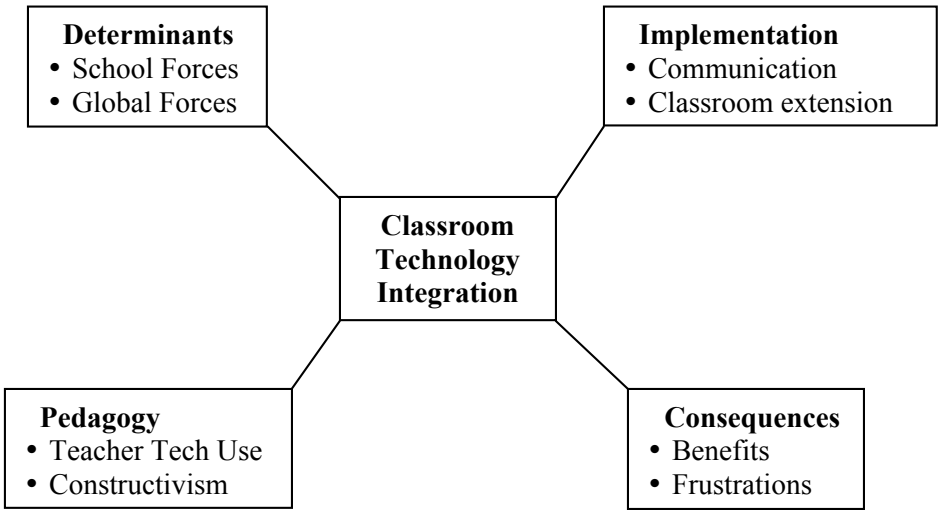


*Figure 1.* Classroom Technology Integration

## Pilot Study

In partial fulfillment of a qualitative research course, the investigator conducted a small, related pilot study. The purpose of the pilot qualitative case study was to investigate the technology use of two teachers and four students at a high school and learn more about ways to structure the main study, including how to identify sites and participants, collect qualitative data through field notes and observations, utilize multiple

sources of information for purposes of triangulation, and recognize themes and potential hypotheses qualitative data.

The teachers' use of technology was examined through documents, search engines, databases, grading and assessments, presentations and lectures, and communication techniques used for lessons that included e-mail, Web pages, Web logs (blogs), and chat rooms. For the students, the areas of investigation were their use of technology to work on assignments, communicate with teachers and other students to complete schoolwork, and gather information. After careful analysis of the data from multiple sources, seven key findings were determined to answer the three guiding questions.

With the emergence of the computer and the Internet, information became available at any time of the day to anyone with access to a computer. Not surprisingly, the primary type of technology the teachers and students used was the computer. The main reason teachers and students reportedly used the computer was for communication purposes. The teachers used technology to disseminate knowledge and communicate with their students while the students used it to ask teachers questions and convey their acquired knowledge. The Internet allowed teachers and students to research information for class lessons and class projects, respectively.

The teachers and students perceived two benefits and limitations regarding their use of technology for educational purposes. The benefits, whether accessing information or producing finished work, were that it was more convenient to obtain information to complete schoolwork because of technology and that technology and the access to so much information was a motivating force. The limitations that teachers and students perceived were their lack of skill base and security issues.

Although the pilot study was limited to a small group of teachers and students, the findings did indicate there was a great difference in the amount of time students used technology for personal reasons versus educational purposes. Students used technology on average three hours per day for personal use versus three hours per week for schoolwork. There was also a chasm regarding knowledge and comfort between the educators and the ones being educated regarding the use of technology or potential use of technology for educational purposes. The students were much more comfortable and knowledgeable.

The researcher used the methodology and results of the pilot study to more accurately focus the research questions and types of teachers to be investigated in a larger study. The pilot study also helped the researcher to identify the types of questions to ask during the interviews and how to process the large amount of data collected. The pilot study became a springboard to the larger qualitative study.

## Significance of the Study

Almost anything believed to enhance learning and assist in this goal is considered a necessary tool for a child's education. One such tool is digital technology and the appropriate corresponding skills. "Unfortunately, for all of the investment in educational technology, there is a surprising lack of hard data on its effects" (Wenglinsky, 1998, p. 5). Few studies examined how classroom teachers use technology in instruction and which methods may promote content learning. To be sure, researchers have investigated the integration of technology "as a generic topic" and have studied how some software affects student learning, but there is still much to investigate and confirm about the instructor's role in using technology to support students (Wallace, 2004). In the classroom, previous studies regarding computers often focused on specific educational

programs that have “significant methodological problems” and may not be easily replicated (Wenglinsky, 1998).

According to Culbertson, Daugherty, and Merrill (2004), research on connections between technology and other academic subjects is sparse but necessary going forward. When Culbertson et al. (2004) began their research, there were few prior studies indicating technology education improved student achievement in other disciplines. More studies have been done over the past several years. However, current studies of digital technology integration, especially at the high school level, continued to be lacking.

At the same time, students acquired many skills through their use of new technologies outside of the school (e.g., parallel processing, graphic awareness, and random access) “that are almost totally ignored by educators” (Prensky, 2001b). In a study completed in 2000, for example, although Internet and computer access were available in many schools in 1999, only half of all public school teachers used them for classroom instruction (National Center for Education Statistics, 2000). Moreover, one study examining teacher technology use found that teachers used technology to maintain traditional practices rather than transform their pedagogy (Cuban, 2001).

Hence, increasing software and hardware access in schools is not enough. To address the issue of technology use for high school education, the next studies must focus on teachers. As Zhao et al. (2002) argued, there was a conspicuous lack of attention to the complexities and intricacies of how classroom teachers actually incorporated technology into their teaching. Having technology available and policies in place did not mean that technology was being used at all, or used effectively. The studies that attempted to add to the literature have thus far focused more on a particular use of a software package, technology survey information, or a K-8 class incorporating a technology technique such

as a WebQuest, a lesson where students search Internet Web sites for specific information (Becker & Riel, 2000; Culbertson et al., 2004; MacGregor & Lou, 2004–2005). There have been even fewer studies that interviewed teachers in a qualitative manner to capture their experiences and perspectives regarding technology integration. For example, Becker (2000) surveyed teachers nationwide to determine which subject teachers were using what software databases. While these studies added to the literature regarding the use of technology in education, there still remained a need for studies focused on specific teacher integration of technology for educational purposes at the high school level. More specifically, Angers and Machtmes (2005) found that evaluation data based on prolonged observations was absent in the research literature.

Prensky (2001a) wrote that with the advent of computers and their inclusion in schools society had reached a "'singularity'–an event that changes things so fundamentally that there was absolutely no going back" (p. 1). Teachers in general are not technophobes; they will alter their pedagogy to the degree that technology helps them solve problems, adds benefits to the class and the students' experience, and does not increase their burden (Cuban, 1986). The minority of teachers that had fully embraced technology saw it as an integral part in achieving their goals (Cuban, 2001).

There was a large literature base addressing the issue of schools acquiring and having access to technology and some research on students using certain technology components in the classroom, such as computer modules and stand-alone personal computers. Despite the growing quantity of studies, there was little qualitative research investigating the issue of how teachers were integrating technology for educational purposes in the classroom. With all the money spent on technology and the implication that technology was beneficial to education, there have not been many studies trying to

determine what teachers were doing with all this new technology. The findings of this study will contribute to the literature on technological integration by teachers to promote content learning.

Technology is a tool that has vastly changed the way people live and learn. Unfortunately, schools are slow to accept this change. For teachers and students to take full advantage of technology's offerings, practical studies must illuminate the ways in which schools can develop the conditions necessary to better use digital technology. Until more can be learned about how to support education practitioners in reaching this goal, teachers will be frustrated, students will be bored, and another generation of students will graduate with many more lost opportunities to learn.

Although the investigator considered numerous topics such as technology improving student learning, student use of technology for educational purposes, and technology sustainability in schools, the primary focus of this qualitative case study emerged regarding how high school teacher technology leaders were integrating digital technology into the classroom.

Many administrators and teachers have purchased technology *ad hoc* only to later determine the best way to use it. The intended audience of this study is school administrators and teachers, and the main purpose was to aid in their pursuit in the effective integration of digital technology. The findings will provide insight into better ways of addressing teacher preparation, professional development, curriculum development, and education reform (Hernandez-Ramos, 2005) and establish research-based instructional methods that can be widely replicated (No Child Left Behind Act of 2001, 2008).

The findings of this case study indicate that the teachers used technology to further their classroom educational goals. Despite complications that arise in adopting technology early, teachers stated that technology allowed them to explore new opportunities to have the students understand and work with the content while incorporating 21st century skills, such as collaboration and digital-age literacy. Various software applications were used to achieve their goals. For example, some students used Movie Maker to produce class projects while others used Facebook to communicate with children in Africa. Furthermore, the software incorporated in the classrooms facilitated more constructivist practices. The findings of technology integration in three high schools will indicate that technology integration helps students learn 21st century skills and even 19th century skills, such as reading comprehension, by broadening their horizons. With this in mind, the results of this study hope to add to the literature to assist teachers and administrators in making decisions to enhance professional development and classroom instruction.

# CHAPTER II

# REVIEW OF THE LITERATURE

The researcher examined the literature through the four research questions to determine what scholars had previously learned: What factors led to technology integration? How was technology thought about and integrated into education? What was the relationship between technology and constructivism? What were the results of incorporating technology into education? The review of the literature will be reported following the structure of the four main research questions.

## Factors Influencing Technology Integration

Prensky (2001a) divided the world into two categories of people: digital natives and digital immigrants. Digital natives are children today who are "native speakers" of the digital language of computers, video games, and the Internet. Digital immigrants are those who were not born into the digital world but have, at some later point in their lives, adopted some or most aspects of the new technology (Prensky, 2001a).

> Today's average college grads have spent less than 5,000 hours of their lives reading, but over 10,000 hours playing video games (not to mention 20,000 hours watching TV). Computer games, e-mail, the Internet, cell phones and instant messaging are integral parts of their lives. (Prensky, 2001a, p. 1)

Similarly, Albright, Purohit, and Walsh (2002) claimed that "between online games, Internet surfing, and chat rooms, a significant number of students spend even more time online than in school each day" (p. 694).

Prensky (2001a) wrote that "our students have changed radically. Today's students are no longer the people our educational system was designed to teach" (p. 1). Louis Gerstner, Jr., IBM's Chief Executive Officer said, "our public schools are low-tech institutions in a high-tech society" (1995 in Cuban, 2001, p. 13). Even though Prensky and Cuban wrote that the students and society have changed, they insisted schools and teachers have not. Many teachers still taught in traditional fashion and students were held accountable by standardized tests administered with paper and pencil. Some educators today who incorporate technology into their lessons have merely transplanted existing instructional methods onto computers (Cuban, 2001; Hokanson & Hooper, 2000). A lecture is still a lecture; however, a computer or video projector may have been added to help deliver the message. In Prensky's (2001a) research regarding student's behavioral patterns with technology, one student complained that, "Every time I go to school I have to power down" (p. 1). This was reinforced by the fact that even though most teachers and students had and used a computer at home, few teachers fully integrated technology into the curriculum (Cuban, 2001). The problem, however, was not the lack of computers in schools, at least not among early adopters in affluent schools.

In 1999, the results of the National Center for Education Statistics (NCES) survey found that 99 percent of all public school teachers reported having computers available somewhere in their schools, 84 percent had computers available in their classrooms, and 95 percent had computers available elsewhere in the school (National Center for Education Statistics, 2000, p. 5). Maine, New Mexico, Texas, and Michigan, to name a few states, had invested heavily in providing its students with laptop computers (Electronic Education Report, 2004; Sack, 2005).

According to Maine administrators, the laptop initiative had realized its promises of better engaging students in learning and had leveled the academic playing field for Maine's many rural and underserved districts (Schachter, 2004). The principal of a small middle school in Maine claimed that since the start of the laptop program, the students' scores in reading, writing, and math improved enough to remove the school from the list of underperforming schools (Schachter, 2004). In a county in Virginia where a similar laptop distribution program took place, the District saw substantial savings on calculators, periodicals, maps, and reference books, all of which were available on the computer (Schachter, 2004). More important, district administrators claimed that installing an SAT preparation program on the laptops of the county's high school students produced a thirteen-point gain and the highest average scores in the District's history (Schachter, 2004). This was supported by the findings that students with laptops rated stronger than nonlaptop users in four categories of writing (Rockman et al., 2000). Such decisions to incorporate technology into education were further supported by "several studies suggesting that any student, including the at-risk student, who has technology integrated into the curriculum could potentially see a positive change in student classroom grades, GPA, and attendance" (Muir-Herzig, 2004, p. 114). These positive changes, if subsequently confirmed, would also translate to better preparation for a technology-enriched college and workforce.

Since our schools aim to prepare students for the workforce, where computers have become commonplace, it is not surprising that schools have become more technology oriented (Cuban, 2001). In this era, computers are used for Internet, e-mail, word processing, desktop publishing, spreadsheets, and scheduling, and had become the

primary medium for written communication (Russell & Abrams, 2004). California State Superintendent of Schools Delaine Eastin in 1996 said,

> Technology is an essential part of education as we approach the twenty-first century. Ninety percent of the jobs created from this moment on will require advanced technological training. To compete for these jobs, our children will have to be skilled in the use of information technology…If we allow our educational system to fall behind the tide of change in the larger world, we prepare kids for bit parts at best. (Cuban, 2001, p. 33)

Emphasizing this point, Bussiere and Gluszynski (2004) stated,

> The use of computers at school as well as at home will impact learning, and this trend will most likely continue into the future. By the time these youth enter the labour force, ICT literacy might no longer be a specialized skill (except for specific applications), but rather a necessary one for a successful career. (p. 27)

Bridging the connection of transferable skills from school to the workplace, Liu (2003) finds that hypermedia-based projects or schoolwork promote higher-level cognitive skills, teamwork, and goal attainment–all aspects needed for success in business. Liu also determined that multimedia technology projects positively influenced student motivation toward learning, encouraged creativity, developed cognitive skills, and helped students learn design, content, and computer skills. These skills acquired through the project in school were transferable and helped students become better problem solvers, which is a vital skill in the workplace (Liu, 2003). Calling for immediate action, the former superintendent of Henrico County, Virginia, Public Schools proclaimed, “Our children can’t wait. The future is now. We need to be preparing them for a future that few of us can even visualize” (National Education Technology Plan, 2004, p. 39).

## Technology in the Classroom

> Technology should not drive educational decisions or learning. Rather, decision-making should be based on the learning and teaching needs of the student. Technology cannot prescribe for a teacher which students should use the

> technology, how often it should be used, or how to integrate technology into existing instructional practices. Unless teachers start out with specific technology goals that support their vision of learning, technology will most likely be used to reinforce the status quo. (Cohen and Cuban as cited in North Central Regional Technology in Education Consortium, 2008)

Based on data from a national survey of teachers, Becker (2000) found that a "student's intensive computer experience" (p. 5) occurred outside of the core academic subjects. He cited five reasons to explain this finding. First, few secondary teachers planned computer activities because the period lengths of the master schedule were usually less than one hour. Second, secondary teachers felt constrained because of pressure to cover the course curriculum and the need to transmit large amounts of data to the students. Third, frequent use of computers occurred more in the classrooms that had a 1:4 ratio of computers to students. Fourth, the barrier of teachers who have limited computer skills and expertise prevented them from frequently using computers with students. Last, the teacher's "personal philosophical beliefs about the basic nature of student learning and what type of instruction is optimal" (Becker, 2000, p. 10) determined students' computer use in school, which can be explained as more of a "constructivist" approach to teaching.

Cuban, according to Becker (2000), maintained that teachers found it too difficult, because of accountability, time constraints, and curriculum coverage, to incorporate computers into their pedagogy. While Becker believed this might have been true prior to the turn of the century, under the right circumstances "computers are clearly becoming a valuable and well-functioning instructional tool" (p. 4). Computers were having an impact on student class performance and on their academic effort beyond the school walls (Becker, 2000). Studies need to focus beyond access, the number of schools that have Internet connections or computers available, to integration, how computers are

supporting and enhancing learning in the classroom (National Center for Education Statistics, 2002; Hernandez-Ramos, 2005).

Sandholtz, Ringstaff, and Dwyer (1997) stated, "students who did not do well in a typical setting frequently excelled when working with technology. Low achievers had a chance to experience success and began concentrating and applying themselves to their projects" (p. 95). A report out of England found evidence that ICT can lead to increased motivation, particularly with traditional underachievers (Reynolds, Treharne & Tripp, 2003). Thus, these studies give credence to some of the expenses schools are investing in technology.

However, money expended for technology is only part of the equation. Teachers do not always have the knowledge and skills necessary to meaningfully integrate technology into their lesson plans in innovative ways (Boling, 2005; Zhao et al., 2002). To make technology work in classrooms, teachers need proper training and assistance. The NCES (2002) insisted that technology "should be a seamless part of the school environment, requiring no more prior learning to apply than, say, electricity" (p. 64). To help achieve this seamlessness, teachers, through proper professional development, will learn ways that technology can support and enhance the curriculum and increase the students' learning experience (Boling, 2005).

Realizing that professional development was an important aspect of integrating technology into the classroom, the *No Child Left Behind Act* required 25 percent of the technology funds received from the federal government be devoted to training and professional development (National Center for Education Statistics, 2000). "The emerging evidence suggests that access to these technologies is not as important as the quality of its use" (Bussiere & Gluszynski, 2004, p. 27). Quality computer use can be

achieved only through properly educating the teachers through strong professional-development workshops. Professional development for teachers to implement technology in the classroom must focus on instruction-and curriculum-based uses rather than technical issues (Sandholtz & Reilly, 2004). Providing workshops that reduce the technical aspects of learning technology and offer teachers time to explore and learn in a nonthreatening environment will "enhance their instructional use of technology" (Sandholtz & Reilly, 2004, p. 494).

With proper training and encouragement, teachers will slowly incorporate technology into their lessons. As evidenced in the 1990s, school computer use evolved from computer programming and drill and practice to reflect a greater emphasis on problem solving and in-depth learning (National Center for Education Statistics, 2000). To fully integrate technology into the curriculum, teachers must experience the five stages of development: entry, adoption, adaptation, appropriation, and invention (Dwyer as cited in Muir-Herzig, 2003).

In the entry stage, teachers have doubts about their classroom technology integration while they use technology to support traditional text-based drill and practice in the adoption stage (Dwyer as cited in Muir-Herzig, 2003). These early stages of development are directly supported by Hokanson and Hooper's (2000) research that adding technology does not change the instruction qualitatively. The initial educational uses of computers focuses on replicating existing instructional methods (Hokanson & Hooper, 2000).

It is not until the later stages of development that teachers use computers in innovative ways, resulting in positive research findings regarding student achievement. In these stages, student work patterns and communication become collaborative and

teachers develop learning environments using technology as a flexible tool (Muir-Herzig, 2003). For example, although many of today's students know how to surf the Internet, they may lack the necessary strategies to negotiate effectively and determine which Web sites are relevant or important to their schoolwork (MacGregor & Lou, 2004–2005). WebQuests, an example of the appropriation and invention stages, represent a higher-order use of technology because it "requires students to analyze and synthesize information and exercise information seeking strategies that represent higher levels of cognition than simple knowledge acquisition" (MacGregor & Lou, 2004–2005). So the key to student success with technology in the classroom comes from a well-designed lesson.

> Students report that there is a substantial disconnect between how they use the Internet for school and how they use the Internet during the school day and under teacher direction… Students perceive this disconnect to be the result of school administrators setting the tone for use at school. (Pew Internet & American Life Project, 2008, p. iii)

A clear and visionary approach of student technology access, basic computer skills and knowledge requirements, and technology-literacy skills would enable students to better use technology in a way they are accustomed to outside the school day.

## Technology Use and Constructivist Teaching

Traditional instruction is didactic, focusing on known learning goals using predetermined, well-organized resources and directed learning activities (MacGregor & Lou, 2004). This is the typical "sage upon the stage" format. Teachers lecture, assign textbook readings, and give an assessment at the end of a chapter. In contrast to traditional teaching methods, WebQuests, predesigned Internet research projects, are learner-centered and focus on open-ended learning goals. To use technology properly, schools must shift their pedagogical approach from teacher-centered instruction to

learner-centered (Hokanson & Hooper, 2000; MacGregor & Lou, 2004). This approach shifts the focus of technology from a delivery system or tool to that of a medium for cognitive growth (Hokanson & Hooper, 2000). This new educational medium, technology, may change how people think and learn (Hokanson & Hooper, 2000), which may better suit the requirements for the 21st century. Technology is a "cognitive" medium that provides an environment for intellectual growth–it shifts our focus as a tool or delivery system to a generative use for construction (Hokanson & Hooper, 2000).

Technology has allowed teachers to take a more student-centered constructivist approach to students' learning versus a traditional teacher-centered format (Becker, 2000; Cuban, 2001; Hernandez-Ramos, 2005; Zhao et al., 2002) and independent student learning, as perpetuated by a constructivist style, was enhanced by the use of technology (Muir-Herzig, 2004). Therefore, under the right conditions technology could enhance the learning experience of students (Becker & Riel, 2000; Benton, 2003; President's Committee of Advisors on Science and Technology, 1997).

Cuban's (2001) study indicated a ray of light by finding that a minority of teachers had successfully incorporated technology in new and innovative ways. Becker (2000) took Cuban's study one step further and investigated how this minority group of teachers, called early adopters, were transforming their classrooms by incorporating technology. Their classes were more student-centered with fewer lectures and gave more independence to students. These constructivist lessons were a fundamental shift in pedagogy spurred on by the use of technology (Becker, 2000; Cuban, 2001; Conlon & Simpson, 2003). In other words, instead of disseminating the subject material in traditional format by standing in front of the room and telling students the information, most computer-engaged teachers appeared to endorse a pedagogical emphasis (a) "by

developing examples connected to students' own personal experience or by providing opportunities for students to present detailed explanation of their reasoning;" and (b) by "developing students' capacities to understand a subject deeply enough, and see the interrelationships of different ideas and issues" (Becker, 2000, p. 11).

The "traditional" teacher is the gatekeeper of learning and imparts knowledge matter unto the students in class. This "transmission pedagogy derives from carefully planned direct instruction on a narrowly defined skill or content topic" (Becker, 2000, p. 10). This method can easily be assessed and students' performance can be tracked. This type of knowledge dissemination, student analysis of data, and creation of a finished product is not how most students will encounter problems in life after school. Constructivist learning, however, takes a different approach.

The theory of constructivism "claims that understanding comes from a person's effortful activity to integrate newly communicated claims and ideas with his own prior beliefs and understandings…effective teaching involves creating environments in which students take mindful effort towards developing their understanding" (Becker, 2000, p. 11). This approach to teaching can be categorized as "the guide on the side." According to Hernandez-Ramos (2005), constructivist teachers were more likely to have students do meaningful work with computers. Becker (2000) also found that an emphasis on computer use at both teacher and school level helped teachers move toward a constructivist pedagogy. Rockman et al. (2000) revealed that teachers with laptops "showed a statistically significant change toward more constructivist teaching practices" (p. 6) than those without. These practices included more frequent uses of student-led inquiry and collaborative work and departed from more traditional classroom roles (Rockman et al., 2000).

## Benefits and Frustrations When Using Technology

The studies that have been conducted regarding student learning with technology were somewhat mixed, but in general showed that under the right circumstances it could improve learning. Wenglinsky (1998) concluded that significant gains in mathematics achievement were found when students used computers to learn higher-order concepts and when teachers were technologically proficient. Other studies have shown that technology has improved student achievement when it was "applied to well-defined educational objectives, and integrated into the curriculum by trained teachers" (CEO Forum on Education and Technology, 2001). Motivation consistently increased when students used the Internet and other technologies in the classroom, which is almost always associated with increases in learning (Leu et al., 2004).

"Technologies can provide powerful tools for student learning, but their value depends upon how effectively teachers use them to support instruction" (Fulton, Glenn & Valdez, 2004, p. 1). The infusion of technology in schools had not brought about a significant change in teaching and learning (Becker, 2000; Conlon & Simpson, 2003; Cuban, 2001; National Center for Education Statistics, 2000). The NCES (2000) survey found that only approximately half of the public school teachers who had computers or the Internet available in their schools used them for classroom instruction. Technology in the classrooms was often incorporated to maintain existing practices rather than revolutionizing school curricula (Cuban, 2001). Research studies have revealed similar results (Condie, Simpson, Payne & Gray, 2002; Cuban, 2001).

Cuban (2001) found that the early adopters of technology, or technology leaders, comprised only a fraction of the school faculties. Most teachers used technology in their classrooms occasionally, at best (Cuban, 2001). Conlon and Simpson (2003) reported that

teachers mostly employed technology in the classroom for administrative tasks and to "sustain existing patterns of schooling rather than to innovate" (p. 144). Cuban wrote that fundamental changes in teaching and learning because of the incorporation of technology will only "emerge from deep reforms in schools' organisational, political, social, and technological contexts" (Conlon & Simpson, 2003, p. 138).

However, the underutilization of digital technology in schools is extremely complex to address. Although there are many reasons, lack of time and professional development chief among them, regarding why technologies have not been integrated into the classrooms, these explanations are not the result of empirical studies (Zhao et al., 2002). In addition, it is extremely difficult for practitioners to draw any practical insights from many of these explanations because the key factors are not set in a context or not defined effectively (Zhao et al.).

The research base was hindered in part by rapid improvements in technology, and those who would offer technology impact studies have fallen behind. Researchers also had a difficult time disaggregating the data to isolate technology effects on learning. As Hokanson and Hooper (2000) stated, one of the most elusive questions concerning educational computer use continued to be how computers might improve learning. With the pressure on schools to improve, commercial package vendors have made claims that their software will improve learning and, therefore, lead to higher standardized test scores (Culbertson et al., 2004). Thus, districts have purchased various software packages without strong empirical evidence corroborating the claims.

Despite the lack of empirical studies showing positive and negative influences of technology on education, many districts have purchased costly hardware and software for their students. Hence, the push for more sophisticated utilization of technology in schools

may continue to be controversial. Critics cite concerns of security, maintenance, effectiveness, and cost. Laptop initiatives, for example, by various states have required millions of dollars in basic equipment (Electronic Education Report, 2004) and the effect of technology on increasing test scores and learning so far are not impressive (Angrist & Lavy, 2001; Trotter, 2002, 2004).

Similar studies have shown that there were no achievement gains or positive effects on grades and attendance (Culbertson et al., 2004; Muir-Herzig, 2004) and only mixed results when trying to determine if students could learn more from online literature circles and discussion groups than from similar traditional classroom-based activities (Albright, Purohit & Walsh, 2002). Yet, even though Cuban has been a harsh critic of digital technology in schools, he has not called for a rollback.

Advocates for technology integration claimed that it was too early to determine the results of the Internet's impact on test scores and that measuring success should not be limited to achievement test scores (Trotter, 2002). Technology supporters believed standardized bubble-sheet tests may not be an effective way to test students in a digital-driven age. Many students were working in classes producing hypermedia projects but had to sit for hours with paper and pencil to determine their proficiency. Instead of incorporating technology to establish a more comprehensive picture of a student, the SAT and other standardized tests recently made their tests longer to include a writing section. However, this may be counterproductive in the technology-driven age. For example, in order to practice for the standardized tests, many schools, prior to the test, had to stop using word processing software on the computers for writing assignments and practice handwritten assignments to prepare students for the paper and pencil writing section of the exam (Liu, 2003).

There were also a number of research studies that revealed positive results with technology integration in schools. The Organization for Economic Co-operation and Development study indicated there was a significant association between higher reading scores and the possession and frequent use of a computer or an Internet link at home (Bussiere & Gluszynski, 2004). These findings were consistent with an earlier study that found having a computer at home was associated with higher test scores in mathematics and reading (Attewell & Battle, 1999).

Similar results were noted at the primary and high school grades in England. The British Educational Communications and Technology Agency (Becta) found that national test scores were higher for students at the primary and secondary schools with "Very Good" ICT (Becta, 1999, 2001). Becta (2001) went further to state "that the individual subject use at secondary level is enhanced by the use of ICT across the whole curriculum…and that the development of pupils' skills is transferable from subject to subject" (p. 8).

The value of a computer, to enhance teaching and learning, depended on what purposes it served and how well it was used (Kleiman, 2000). Kleiman found that many schools were not using technology in ways that significantly enhance teaching and learning. He listed five main reasons for this being so: poor teacher training, software not supporting the curriculum, insufficient technical support, lack of computer availability, and computer activities treated as optional supplements by publishers. "The rapid influx of technology into schools is, in many cases, running ahead of the educational vision and careful planning necessary to put technology to good use" (Kleiman, 2000, p. 1).

# CHAPTER III

# METHODOLOGY

The majority of the research studies found in the literature were quantitative and survey based (Becker, 2000; Zhao et al., 2002). Beyond the use of specific types of software, such as Word, most studies did not ask or observe teachers specifically on how and why they were using technology in the classroom. As the aim of this study was to examine digital technology use in high schools through the four research questions, a qualitative case study design was used.

"A case study design is employed to gain an in-depth understanding of the situation and meaning for those involved" (Merriam, 1998, p. 19). This method allowed the researcher to use multiple styles of data collection while studying the subjects in their natural settings (Gall, Gall & Borg, 2003). To make sense of the data, an inductive type of analysis was conducted. This allowed for the data to reveal main concepts and theories instead of working from preconceived concepts and theories to determine what data was collected (Gall et al., 2003) and for the interviewees' perspectives to be in the foreground. The data collected and analyzed regarding technology integration by teachers was an attempt to understand its current and future impact on content learning.

The unit of analysis was the teacher. The research procedure was first to identify three high-technology environments and three early adopting teachers in each, by using two screening surveys supplemented by principal nominations. The researcher then

collected data on what technology integration looked like at its best in the hands of selected early adopters, when technology seemed to work well (Cuban, 2001).

## Definitions

Although technology could have different meanings in different contexts, for this study digital technology was defined as the full range of computers and computer-related equipment and associated operations systems; networking and tool software; audio and visual equipment; display equipment used in classrooms, including television monitors, projectors, electronic whiteboards, calculators, and measuring/data collection tools for scientific purposes; educationally pertinent software applications; and peripherals that were attached to computers, such as scanners, digital cameras, and projectors (National Center for Education Statistics, 2002). The integration of digital technology was defined as the incorporation of technology resources and technology-based practices into the daily routines, work, and lessons of teachers (National Center for Education Statistics, 2002).

Some terminology used throughout this dissertation may be unfamiliar and needs to be defined upfront. A blog is a Web log for students to write their thoughts or communicate with others through a software system via the Internet. A Wiki is a free Internet application that allows users to create simple Web pages that groups, friends, and families can edit and post on the Internet. To understand the methodology of this study, the setting, sample, data collection, and data analysis procedures are further described.

## Settings

Because high school students need to be prepared with 21st century workplace-readiness and college-preparedness skills more so than other grades, the focus of this study was on high schools. This study further focused on technology-rich classroom

lessons. Therefore, as Zhao et al. (2002) found it important for schools to have a technology-supportive school environment for successful technology integration, only technology-advanced high schools were selected. A preliminary screening survey identified three technology-advanced high schools out of a potential forty-eight from one northeast county in the shadows of New York City. The technology-advanced high schools were in the top ten of the highest scoring schools based solely on thirty-four weighted questions from the Northeast Department of Education Public Schools Technology Survey (see Appendix A). If a school did not wish to participate in the study, the next highest scoring school on the list was asked.

*Roosevelt High School*

Roosevelt High School is one of two high schools in a regional district located in a northeast suburb. The approximately 1,250-student high school was regionally based with three feeder towns. The three suburban residential communities had a total population of approximately 41,000. The parents of the student body were employed in professional, managerial, and executive positions in the northeast and New York City. The District was grouped in the second highest District Factor Group (DFG). This "I" grouping was based upon the level of education attained by the adults in the community, occupational status, and median family income, to name a few of the criteria.

Last year's student body, the Class of 2008, listed that 96 percent of its graduates continued their education after graduation with the average SAT score of a 538 verbal and a 562 math. A total of 416 Advanced Placement exams were taken in twenty subjects. The graduation rate was 98.2 percent compared with the state average of 92.8 percent. The student mobility rate was 2.1 percent compared with the state average of 9.9 percent. The ratio of the number of students per computer used for student instruction

was 2:1. English was the first spoken language in 99.4 percent of the homes. $17,748 was the total cost expended per pupil for educational purposes, compared with the state average of $15,489. There were 115 faculty members on staff, and 64 percent had a master's degree or higher. Each of the faculty members had an Apple wireless laptop computer.

In 2001, Roosevelt High School issued a Macintosh laptop computer to every teacher. In 2002, each teacher was required to keep student attendance and grades on the electronic gradebook system. Beginning in 2003, parents and students had access to this database via the Internet. The school also had wireless Internet access throughout the entire building.

Roosevelt was equipped with seven computer labs each with approximately twenty-five computers. Usually only three of these labs were available for teachers to bring their classes in for classwork, as four of the labs were primarily dedicated to computer application classes. The media center had an additional twenty-two computers for students to access during study halls and lunchtime. Furthermore, each of the ten departments had access to their own cart of twenty-five laptops that could be rolled into a classroom for student use.

Although most of the teachers at one time had a Web site, the District chose to go in the opposite direction. Being fearful of liability issues and a lack of consistency between all the Web sites, teachers were banned from having a Web site because of the inability to agree on acceptable format and content. Consequently, the District purchased Study Wiz as an alternative for teachers to post assignments and connect with students and parents.

*Washington High School*

Washington High School is one of two high schools in a regional district located in a northeast suburb. Its motto was "a technology-learning community." The approximately 1,200-student high school was regionally based with two feeder towns. The two suburban residential communities had a total population of approximately 20,000. The parents of the student body were employed in professional, managerial, and executive positions in the northeast and New York City. The District was grouped in the second highest DFG as an "I."

Last year's student body stated that 97 percent of its graduates continued their education after graduation with the average SAT score of a 533 verbal and a 560 math. A total of 134 students took 241 different Advanced Placement exams in eighteen subjects. The graduation rate was 100 percent. The student mobility rate was 1.5 percent and the ratio of the number of students per computer used for student instruction was 1:1. English was the first spoken language in 94 percent of the homes with Korean in 2 percent and Spanish in 1 percent. $19,498 was the total cost expended per pupil for educational purposes. 74 percent of the staff members had a master's degree or higher. Each of the faculty members and students had an Apple wireless laptop computer.

The District claimed to be the first in the state to provide wireless laptops to all students and teachers to be used in classrooms and at home. The school profile stated that the laptop initiative positively impacted teaching, learning, and communication between the school and home. It also created a technological bridge of learning between teachers and students that prepared the students for college and the workplace. It was one of approximately 200 high schools across the United States and the world participating in

Virtual High School, a program that offered online courses, which supplement more traditional learning.

In 2004, Washington High School issued a Sony laptop computer to every teacher and student. After numerous difficulties, Washington switched the computers to Apple in 2007. Each teacher was required to keep student attendance and grades on the electronic gradebook system. Beginning in 2004, parents and students had access to their own password-protected class grades via the Internet. The school also had wireless Internet access throughout the whole building. Washington was no longer equipped with computer labs because everyone in the building had their own computer.

*Lincoln High School*

Lincoln High School is located in a northeast suburb with close to 1,200 students coming from one town with approximately 15,000 people. The parents of the student body were employed in professional, managerial, and executive positions in the northeast and New York City. The District was grouped in the second highest DFG as an "I."

Last year's student body stated that 95 percent of its graduates continued their education after graduation with the average SAT score of a 583 verbal and a 623 math. A total of 227 students took 466 Advanced Placement exams in twenty-one subjects. The graduation rate was 99.6 percent. The student mobility rate was 4.8 percent and the ratio of the number of students per computer used for student instruction was 2:8. English was the first spoken language in 69 percent of the homes with Korean in 18 percent, Hebrew 5.6 percent, Catalan 1.9 percent, Japanese 1.8 percent, Mandarin 1.8 percent, and Cantonese 1.3 percent. $14,315 was the total cost expended per pupil for educational purposes. There were 137 faculty members on staff, with 88 percent having a master's

degree or higher. Each of the faculty members had access to a computer in their classroom and a central workplace with additional computers.

The District claimed it was the only public school in the state to receive the U.S. Department of Education Blue Ribbon NCLB Award a few years earlier. The published school profile stated that the school was always striving to be progressive with new and sound educational programs that also integrated technology into the daily instruction. Lincoln also participated in the Virtual High School online course program.

Each teacher was required to keep student attendance and grades on the electronic gradebook system. The school also had wireless Internet access throughout the whole building. Lincoln was equipped with five computer labs, each with approximately twenty-five computers. The media center had an additional twenty-five computers for students to access during study halls and lunchtime. Additionally, the school had four carts of twenty-five laptops that could be rolled into a classroom for student use.

## Sample

Since the purpose of this case study was to investigate how teachers were integrating technology for educational purposes, a participant who did not use technology, or used it in very limited ways, would not produce any insight into this study. The teachers selected from the school were already using a high level of technology. Theses teachers were selected based on having a high score on a survey (see Appendix B) based on the National Educational Technology Standards (NETS) (International Society for Technology in Education, 2003).

To achieve the sample of nine teachers, three teachers from each selected school, the NETS survey was administered to all the teachers in the school. The top ten teachers who scored the highest on the NETS survey and had a vision or commitment to integrate

technology into the curriculum on a daily basis were chosen for participation in this study. The survey was electronically created and made available to all faculty members through an e-mail link. Approximately 58 percent of the faculty members completed the survey.

To further reduce these ten teachers to the top three best candidates for participation, a snowball sampling method was employed. This technique involved asking well-situated people to recommend individuals who would be good candidates for participation (Gall et al., 2003). A highly credible sample of people emerged when different well-situated people, such as the principals and supervisors, repeatedly suggested the same names (Gall et al., 2003).

To achieve the sample of three teachers, the researcher asked the principal and supervisors of the academic departments who they believed best used technology for educational purposes. From this process, a credible list of potential candidates surfaced. Using these names, an informal interview of asking the potential candidates to expound upon the survey questions they previously answered (see Appendix B) was conducted to determine if the teachers were truly using technology for educational purposes and whether they were willing to participate in the study.

Because it was difficult to find technology innovativeness on a large scale (Cuban, 2001), early adopters were selected from multiple subject areas instead of just one to look for common trends or practices that transcended departments. A strong teacher technology leader, no matter which department, should have been demonstrating skills, knowledge, and understanding of technology and designing developmentally appropriate lessons (Angers & Machtmes, 2005; International Society for Technology in Education, 2008b). The research enlisted the cooperation of early adopters in selecting

lessons to be observed that showcased teacher and student technology integration. Teachers were not told specifically what was to be observed, but they were given the guidelines that the lessons should include technology for the purpose of enhancing instructional strategies and/or student learning. This could have taken many forms, such as using the Internet for research projects, blogs, interactive whiteboards, and WebQuests, as it was suggested that the researcher did not wish to see a lesson, for example, that was just a lecture with PowerPoint as a backdrop.

*Participants*

The teachers identified to participate in this study were chosen because of their high levels of technology use for their class lessons. After the faculty completed the NETS survey, the ten highest-scoring teachers were further reduced to the top three from each school after speaking with the principal and supervisors. Each teacher was committed to using technology almost on a daily basis and had a vision of integrating technology into the curriculum. The teachers were chosen from multiple subjects and although there was only one male in the study, gender did not play a factor in determining the participants. The information in this section was incorporated to further provide a thick and rich description of the participants as a whole. Information particular to the individual schools and teachers will subsequently follow.

When the notes of the field observations and interviews were looked back upon and compared to the original survey questionnaire answers, it was determined that the participants were modest and humble with their survey answers. Their vision and goals, as stated in the interviews, and the observed lessons, showed more competency than they readily admitted. For example, the responses to the survey question, “I feel competent describing instructional principles and research related to the use of computers in

teaching," resulted in teacher responses from "strongly agree" to "disagree." The teachers interviewed, very clearly explained their teaching philosophy regarding technology and how they incorporated it into their lessons. The teachers who answered "neutral" or "disagree" may not have been able to quote the authors of the latest research, but they applied the best practices findings into their daily lessons.

A similar type response was to the question, "I feel competent designing Web pages." Again, the responses filled the spectrum of answers from "strongly agree" to "strongly disagree." Yet, although set up and used to different extents, each teacher had a Web page or its equivalent. The teachers who answered in the lower half for this survey question may not have designed the most spectacular Web site, but they had a Web site and used it with their students.

For the most part, the majority of the participants answered "strongly agree" and "agree" for the survey questions. They overwhelmingly felt they could "use technology to locate, evaluate, and collect information from a variety of sources." Similarly, they collectively responded quite high when asked whether they could "use technology tools and information resources to increase productivity, promote creativity, and facilitate academic learning." These responses were verified through the observation and interview process. They also "strongly agreed" or "agreed" that they "can use technology tools to process data and report results" and "can use technology tools and resources for managing and communicating information."

Each teacher strongly agreed and felt "competent using word processing applications" and "using the Internet for research." Although they may not have known how to use all the aspects of the different software programs, they were not afraid to experiment or require the students to use the software to complete an assignment. All of

them also found Web sites and e-mail as great ways to communicate and stay in touch with the students.

Compared to four years ago, the teachers used technology in their classrooms considerably more. One of the main reasons for their lack of fear to aggressively incorporate technology into their lessons was that they all either "agree" or "strongly agree" that they "feel competent delivering student learning activities that integrate computers," and most important, "feel competent using computers to enhance [their] teaching and learning."

*Roosevelt High School*

At Roosevelt High School, two of the three teachers selected for the study were from the social studies department. Both teachers heavily used various components of technology to conduct and prepare their lessons. Shea had taught for twelve years, with the last four at Roosevelt. She taught United States History and an Anthropology elective. Her classroom was set up in a *U* shape configuration with the teacher in the front of the room and the rows of student desks forming the letter "u." When she had her students use technology, she brought them across the hall to the technology lab, which consisted of twenty-five computers along the perimeter of the room with a teacher computer and video projector connected to a SmartBoard.

She used the BBC (British Broadcasting Corporation) and NPR (National Public Radio) Web sites to enhance the curriculum and provide more video and audio to help the students "visualize" history easier. She enjoyed experimenting with technology and what it had to offer because she did not want to become bored and in turn bore the students. She used technology about three hours per day and was constantly seeking to improve her craft so she could become a better teacher. She felt she was the guinea pig for the District

technology staff developer with all the experiments they tried to incorporate technology into her classroom. One lesson in particular gave her students a new perspective on life; they communicated via Facebook with children in Mozambique. The students were able to talk to one another and ask daily life questions and were very engaged in this experience.

Hagan had taught United States and World History for the past five years at Roosevelt. She loved to use podcasts with her classes and then post them on her Study Wiz site. (A podcast is digitally recorded video or audio information file that is released over the Internet for others to download.) Students could then download these slide shows and listen to and watch them to review and study for tests. She also enjoyed having the students create their own iMovies on the different subject matter. She admitted to using technology approximately four hours per day and every day in class. Her range of use was from PowerPoint, to give students information, to accessing clips from YouTube for the students to hear a clip of a historical speech. She believed using all this technology got

> the students really involved with history instead of just being lectured at. It gets them somewhat emotionally involved and I think that way they remember a little bit better or at least they internalize a little bit easier so that they can understand and really feel what that moment was supposed to feel in history. I think that is really helpful.

Hagan was particularly fond of iTunes. She downloaded music all the time to enhance the classroom experience with music from the U.S. Civil War or songs by the Beatles when teaching her Modern European class. She professed, "Any application that is either taught to me or I am familiar with I try to use in the classroom." She had her classroom set up in a *U* shape and would go next door to the technology lab when she had the students working on a project that incorporated technology. To summarize her feelings about why

she used and required so much technology in her classes, Hagan simply said, “It’s important. I think it is very important.”

Sean, who had taught for the past five years, entered teaching after a career as an engineer in the business world. His teaching load comprised several periods of Physical Science and Digital Electronics. Frustrated by the slow progress of the District physically incorporating technology into the classrooms, Sean worked after hours to install a ceiling-mounted video projector and screen to be able to project his technology-based lessons. His students sat at science tables arranged in rows with two seats per table. In the back of the room were six lab tables, each equipped with a Macintosh computer to collect data for science experiments.

Drawing upon his corporate experiences, Sean’s favorite lesson was having his Digital Electronics class students design a month-long project, create an online calendar with benchmarks, make flowcharts, use Inspiration to make notes, and create drawings on AutoCAD, a drafting software program. All this was required for his students to design the automatic controls for a handicap access door. He commented, “It works out to be a really neat project and makes a nice portfolio piece for them when they are done.” When using technology, Sean liked to have it function as a critical-thinking tool rather than as a transmitter of knowledge. For example, as observed in one of his lessons, he had the students come to the front of the room to type in the video-projected PowerPoint slides to make the notes for the class as the discussion developed. He reasoned, “The students build the class notes through collaboratively building a PowerPoint [presentation]. So it is more using the technology as a tool for their learning rather than just presenting contents.”

*Washington High School*

Maggie was a Chemistry honors and Earth's Natural Disasters elective teacher. She had taught for twelve years, with the last seven at Washington. Her room was configured in a *U* shape with laboratory tables along the back perimeter walls. Her favorite lesson was when the students created a small hot-air balloon and made it work. She tried to incorporate different types of technology, such as iMovie or iComic, instead of always going to PowerPoint, which she believed every student felt comfortable with, because there were many different software programs and many opportunities to teach them to the students. She felt a responsibility to expose her students to these programs to better prepare them for the workplace.

Prior to teaching, Maggie worked in the business world as a telecommunications manager and then as a representative for a medical pathology company and used this experience to relate many of her lessons to the "real world." Reflecting upon the reports she used to prepare for her job at the medical pathology company, she said, "The reports produced for a biopsy company...are very similar to the things the kids now produce from my class. So it is something that they could use in the future." She created all her lessons via the Internet and devoted "at least five minutes of class per day to some kind of technology-based activity."

Christine had taught for several years, all of them at Washington. She taught various levels of English and a Theater Arts elective. Her classroom was configured in a *U* shape to allow for greater collaboration and discussion. Her favorite lesson was having her students create a podcast on themes from *Hamlet*. For this project, she allowed the students to work with partners, and each group was assigned a different theme from the play. The class was then instructed to write a script, which was essentially a thesis paper,

and record their voices reading the script. The students also incorporated images to go with the content and this podcast served as their assessment for the final project for the play. The students used Garage Band to record their voices for the project and Keynote, a presentation software, for the text.

Christine used technology in many different ways with a heavy reliance on the Internet. She maintained a Web site where she updated all her class schedules, handouts, and due dates. Every assignment was listed there. Being conscious of the environment, she tried not to use a lot of paper. For her classes, she used several Web sites, such as Literary Companion, a literature Web site, and Get A Clue, a vocabulary Web site. Additionally, she incorporated different Apple software such as Keynote, Garage Band, iMovie, iTunes, and podcasts. She approximated that she was on the computer at least ten hours per week for school.

In 2009, Christine was selected as an Apple Distinguished Educator. The Apple Distinguished Educator Program began in 1994, when Apple identified key educators from around the globe who were emerging as leaders in the field of educational technology. The distinguished group included more than 1,500 educators worldwide who used technology to impact how students were educated in elementary school through those in higher education.

Patricia was an emerging teacher in her third year of teaching. Her day was divided between Algebra II classes and a Math Analysis class. She enjoyed using the graphing calculator so her students could actually see the graphed results instead of on a flat piece of paper. For one project, she collaborated with a physics teacher and had her students create an Excel spreadsheet tracking the real-time data. This way “they saw how math aspects and real-world applications came into play.” Her classroom was set up in

traditional rows with a whiteboard in the front of the classroom and a computer and video projector on the cart in the center. Depending on the topic, she aimed to have her students on the computer at least three times per week.

She believed technology "is a tool but it doesn't teach." She used technology to keep the students updated, especially if one was absent, via her Web site. She was the only teacher observed to use the InterWrite tablets. Whatever she wrote on these hand-held tablets as she walked around the room was projected onto the screen in the front of the room for the class to see. All the information was saved so it could be uploaded to her Web site. She used the computer about two hours per day and more on the weekends.

*Lincoln High School*

Robyn was the supervisor of the World Language department for the past four years at Lincoln. Overall, she had been in education for fourteen years. In addition to being a supervisor, she taught a Spanish III honors class. She enjoyed accessing various Web sites on the Internet to enhance her classroom. She had her room set up in a *U* shape with a computer and cart in the middle of the room for projecting information. In the past, she had accessed a Colby College Web site for their Spanish grammar resources; BBC Mundo; El Pais, a Spanish newspaper from Spain; and CNN (Cable News Network) in Spanish. She also enjoyed bringing in music, videos, and current events broadcasted in Spanish to help her students understand the practical applications of what they were learning. Because of changes in the Advanced Placement (AP) Spanish exam, she began using Audacity, a digital audio editing and recorder software package, to better prepare her students for the test. On average, she was on the computer close to one hour per night for school-related work.

After leaving the business world five years ago, Beth Ann began teaching English at Lincoln. Prior to teaching, she worked in New York City at an advertising firm. It is there that she "learned about communication and media and using technology in the workspace." She enjoyed having the students create digital stories through Movie Maker and using many different programs to vary her instruction. She said, "I hate doing the same thing every single day and so it's really important for me to infuse variety into the instruction, in the curriculum, keep [the students] on their toes, keep them interested, and keep pushing them to do other things rather than the same rote program or mode of operating every day." She especially enjoyed having the students publish their work in a different way. She liked, "…the idea of an English class of writers and readers collaborating and using Web tools and programs." Her room was organized in the traditional format with the desks in rows and the teacher in the front of the room.

As for computer usage, Beth Ann stated three times that she "cannot do without it." She guessed she averaged between fifteen and twenty hours per week, including weekends, doing "reading and research for my classes." As for her students, she estimated that they were using technology for her class assignments approximately three to five hours per week. She believed that technology helped lift the barrier of collaboration between teacher and student.

Judy began teaching through Alternate Route, a process in which individuals can enter into the teaching profession even though they did not major in education in college. She was a fifteen-year veteran teacher of English and had spent ten of those years at Lincoln. Her room was in the traditional format with the desks in rows and the teacher in the front of the room. Her favorite lesson using technology was when she introduced her sophomores to Shakespeare by having them complete a quasi-WebQuest on the subject

with a final PowerPoint presentation to the class. She admitted to being on the Internet "constantly researching things for school" and spent at least five hours per week on the computer for school-related work. She had been known to use all types of technology to reach the students and make her classes more interesting by incorporating podcasts, Web sites, video and sound clips downloaded from the Internet such as student-created *Shakespeare Sonnet 19* located on YouTube, and many databases to which the school subscribed.

## Data Collection

Once the participants were selected, the ways they integrated technology were investigated. The teacher's use of technology was examined through documents, search engines, databases, grading and assessments, presentations and lectures, and communication techniques used for lessons, such as e-mail, Web pages, blogs, chat rooms, and any other technology used for teaching purposes.

Multiple data collection methods were used to build a portrait and describe how teachers integrated technology for content learning. These methods included (a) informal interviews with selected teachers; (b) observations of teachers in their classrooms; and (c) document collection of the teacher's lesson plans, vision statements, curriculum guides, Web pages, class assignments and such from the teachers. Each of the data collection methods is described next.

### *Interviews*

"Interviewing is necessary when we cannot observe behavior, feelings, or how people interpret the world around them" (Merriam, 1998, p. 72). The purpose of an interview is "to enter into another person's perspective" (Patton, 1990, p. 196). Therefore, the qualitative data were collected through face-to-face interviews with

teachers as the primary informants to describe how they integrated digital technology to create technology-rich lessons in the classroom. During the interviews, the three participants from each school demonstrated and described, during a nonteaching period, how they integrated specific technology applications into their most successful lessons, explained why the instructional technology worked well educationally, and provided copies of lesson materials, if appropriate. Participants were also observed in the classroom delivering technology-rich lessons, although not necessarily the same one demonstrated during the interview.

The approximately forty-minute interviews were semistructured, following a set of open-ended questions about the teacher's experiences with specific technology applications. The interview questions (see Appendix C) were mapped directly back to the research questions using a coding system (see Table 1). This method allowed for set predetermined questions to be asked, however, there was flexibility as to how and in what order they were presented. Hence, the interview process flowed, was more exploratory, freed the researcher up to ask additional probing questions, and gave the participants an opportunity to elaborate when interesting statements arose. The interview sessions were digitally audio-recorded on a laptop computer. Field notes during the interviews were jotted down in a notebook reflecting any mental notes, connections to the literature, or key statements. The digitally recorded interviews were transcribed for coding at a later date for emerging themes, categories, and assertions. The interviews took place prior to the observations although informal follow-up interviews took place in a postobservation conference.

*Observations*

Another primary source of data in qualitative research were observations. Observations "represent a firsthand encounter with the phenomenon of interest rather than a secondhand account of the world obtained in an interview" (Merriam, 1998, p. 94). To gain a feel for the technology practices of teachers, each teacher was observed twice. The observations took place during the spring semester of the school year.

Each teacher observation lasted one period, approximately forty minutes, and was predetermined for a mutually agreeable time between the researcher and teacher. The observation occurred during one of the lessons the teacher submitted lesson plans and supporting information. The researcher was a nonparticipant observer and recorded the observations in Word directly on a laptop computer. The emphasis of the observations focused on teacher use and interaction with technology for the purpose of instructing students. So instructions, projects, notes, research, and classroom computer use were recorded and statements by teachers involving aspects of technology were quoted. The use of technology for preparation, delivery, class use, expectations, and final products were also recorded. Overall, the researcher tried to capture the general feeling of the lesson, its delivery, and the interaction of the students.

The Classroom Observation Tool (International Society for Technology in Education, 2008a) (see Appendix D) was used to record the preobservation, observation, and postobservation information. This instrument was structured to allow for activities in each class observation to be recorded at three-minute intervals with a combination of checklists, rating scales, and written notes to describe the activities and interactions of the teachers and students (Angers & Machtmes, 2005).

*Documents*

Teachers were asked to submit samples of their work. The strength of this type of data analysis was that it was unobtrusive and non-reactive, and allowed for the researcher to review and analyze the documents with little or no disruption to the setting (Marshall & Rossman, 1999). Each teacher was asked to submit two technology-driven lessons or unit plans and all the supporting information around the lesson, such as PowerPoint presentations, classwork, assignments, rubrics, and assessments. The lesson plans and activities the students were engaged in were of current projects or previously completed lessons. Two samples of anonymous completed student work, related to the assignment, were also submitted for evaluation. One of the lesson plans was submitted prior to the researcher observation. This artifact evidence provided physical documents and products to be analyzed to determine the type and quality of work that was produced using technology.

The primary method for communication between the teachers and researcher was e-mail. Most documents were submitted as Word attachments to the researcher, accessed from Web pages of the teachers, or collected from the survey the teachers previously filled out. Any additional questions that surfaced throughout the study were submitted and answered through e-mail.

The validity of the case study findings was strengthened through the use of these three data-collection methods. The interviews gave the teachers a voice regarding their perspective and pedagogy concerning technology in education. The observations provided an adequate example of how teachers were integrating technology for educational purposes. The information gathered from the documents widened the context of the study and aided in the examination process to find common themes. This

triangulation helped eliminate biases that may have resulted from relying exclusively on any one data source (Gall et al., 2003).

Merriam (1998) stated that the process of data collection and analysis was recursive, dynamic, and emergent. Hence, by closely examining the teachers' and students' use of resources and products, recurring concepts and themes emerged, shedding light on technology's role in today's education.

## Data Analysis

"Data analysis is the process of making sense out of the data" (Merriam, 1998, p. 178). The data in case studies usually were collected from interviews, observations, and documents. "[M]aking sense out of the data involves consolidating, reducing, and interpreting what people have said and what the researcher has seen and read" (Merriam, 1998, p. 178). As the voluminous amount of data were reduced into manageable chunks, categories or themes that captured some recurring pattern were constructed (Merriam, 1998). From these categories, meanings or insights were developed which led to the findings of the study. The data were collected from nine high school teachers using the data-collection methods of interviews, observations, and documents. The analysis of the collected data was divided into five stages, each guided by the four research questions.

According to Marshall and Rossman (1999), data analysis is the process of bringing order, structure, and interpretation to the mass of data collected. Miles and Huberman (1994) and Merriam (1998) stressed the importance of simultaneously analyzing the data as it was collected. Therefore, in the first stage of analysis, after each of the nine interviews, the researcher's thoughts and questions were typed up in a Word file. This reflection on what each participant said helped identify aspects of the research questions for further analysis.

Each interview was recorded directly onto the computer and saved as an electronic audio file. When the interviews were complete, the files were e-mailed to a company in California, which outsourced the data-transcription process to paid transcribers in India. The typed transcriptions were then e-mailed back to the researcher for analysis. To check for the accuracy of the transcription, the typed file was read while the audio file was listened to.

In the end, the data consisted of nine transcribed interviews; numerous e-mailed documents, such as teacher Web site links, student completed work, Internet links for assignments, teacher assignments, and lesson plans; and eighteen observations typed into Word. These data were imported into a qualitative-analysis software package, HyperRESEARCH.

Once imported, the researcher was able to code the data during the second stage of analysis. The researcher separated the data into four categories (see Table 1) based on the teacher interview questions (see Appendix C), observations, and collected data. Guided by the suggestions of Miles and Huberman (1994), one piece of datum was coded "FI" to explain the factors the teachers said influenced them to use technology. During the interview, Hagan admitted that the primary factor that influenced her to incorporate blogs into her lessons was when she attended a professional-development workshop on the topic. This datum was coded as "FI" because it was gathered during the interview process and was an influential factor as to why a teacher used technology in the classroom.

Other data were coded "CO" to explain that it was observed when teachers demonstrated a constructivist approach toward their teaching and "CI" if the teachers' answers during the interview were more constructivist in nature. This was determined

through seven interview questions, one of which asked for the teacher to explain how his or her students learned through his or her lessons; e.g., reception of facts and repetitive practice of discrete skills or through effortful integration of new ideas with those previously believed. An example of an observed constructivist approach was when Sean built on the students' previous knowledge of waves at the beach and lectured how it connected to the lesson at hand regarding wave frequency.

An example of a document illustrating a teacher's perceived benefit of the use of technology, coded "OBD," was the printed finished copy of a group's work for the presidency project in Hagan's social studies class. The printed version was of a Web page the students developed that incorporated pictures of Andrew Jackson, written primary source statements regarding his presidency, and commentary by the students themselves. This multimedia project was perceived by Hagan as a technology benefit due to the fact that the Web page allowed the students to research information on their topic via the Internet, collaborate with peers, and publish the finished product for a global audience to view.

So after each line of the transcripts or other pertinent electronic data was read, the researcher assigned each selected data section to a new or preexisting code. This preliminary analysis assigned each line of datum to one of the specified number of codes. This data code list was managed in the HyperRESEARCH software system.

*Table 1.* Data Coding

| Guiding Questions | Interviews | Observations | Documents |
|---|---|---|---|
| 1) Factors that influenced teachers | FI | FO | FD |
| 2) How teachers think and demonstrate tech use | TI | TO | TD |
| 3) Constructivist teaching practices | CI | CO | CD |
| 4) Perceived benefits with tech use & perceived frustrations with tech use | OBI<br>OFI | OBO<br>OFO | OBD<br>OFD |

In the third stage of analysis, the previously coded data were further refined to determine their relevance to the research questions. To make sense of and sort all the information, the data was repeatedly analyzed and reduced into manageable chunks (Marshall & Rossman, 1999). To accomplish this task, the researcher sorted all the data by code and printed it out. Then each coded datum was read, color coded by research question, and assigned to one of the emerging subheadings, which related back to a research question. For example, the factors that influenced the teachers to incorporate technology into their lessons were further subdivided into school and global forces. As for the factor of teacher-perceived frustrations with technology use, the subheadings of lack of time, lack of access, and technology problems emerged through the findings. Data collected from the observations and interviews contributed to these subheadings. For example, one technology problem observed in Judy's class was that many of the students could not connect to the Internet for the in-class assignment, resulting in frustration for both teacher and students. For clarification purposes, the researcher suspected there would be benefits and frustrations with the use of technology, however, what those exact benefits and frustrations were emerged as the data were sifted through.

In the fourth stage of analysis, the coded data were interpreted for meaning. To start, the consistency by the different participants through different data collection methods was checked, as Patton (1990) suggested, by comparing the observational data with the interview data; by comparing what the participants wrote in their lesson plans and documents to what they said in the interview; and by comparing the teacher-anticipated outcomes to that of the actual perceived ones. This triangulation of data sources added validation to the research by overlapping data and reinforcing findings. Any inconsistencies found in this crosschecking of data, by reading and rereading the

information, did not mean the data were invalid, "more likely, it meant that different kinds of data have captured different things" that needed to be understood and explained (Patton, 1990, p. 467). One example of the triangulation process was the *Hamlet* podcast Christine incorporated in her class. The data were triangulated when (1) the researcher observed her students working collaboratively on their theme for their *Hamlet* podcast; (2) the lesson was documented with a measurable objective, activities, and procedures in her lesson plan, and finally, (3) when Christine discussed the purpose of the podcast and expected outcomes during her interview.

Through a process of inductive reasoning, the coded data were analyzed for importance and meaning to the study (Coffey & Atkinson, 1996). During this process, similar data were grouped together under thematic headings for each research question. Therefore, each coded datum was analyzed and assigned to one of the four research questions, such as factors influencing teachers or how teachers demonstrated technology use. When all the similar type of data were placed under the research questions and reread as such, themes began to emerge. Ideas such as communication, classroom extension, and research for class were able to offer explanations of teachers demonstrating technology use. Factors that influenced teachers to use technology were categorized as school pressures that stemmed from the administrators, students, or teachers themselves; and global pressures that came from the community or perceived world competition. In support of the classroom-extension theme, an electronic document collected from Shea noted that she required her students to access her Study Wiz page to acquire information pertaining to her class assignments. Whereas the self-imposed pressure Hagan felt to incorporate blogs into her teaching after participating in a professional-development workshop was placed under the subheading school forces.

Another example was the emerging theme of student technology use. For example, Judy stated that most of her students "use PowerPoint for presentations…and a lot of them are very proficient at making movies because it is so easy with iMovie," and Sean shared that his "students are using [technology] in quite a few different ways. They are using it to access information." Each theme was again checked against each research question for validity to the study. At the end of this stage of analysis, the researcher was able to print out pages of good quotes and supporting information for each research question. The color-coded data that were selected to answer each research question were retyped in a Word file. This inductive approach to the data allowed for new patterns, fourteen themes, and five sub-themes to emerge.

In the final stage of analysis, each emergent theme was related back to answering the guiding questions. For example, themes such as convenience and lack of time emerged in relation to the benefits and frustrations of technology use, respectively. As a benefit, Sean found, "Appropriate use of technology is fantastic for enhancing lessons and building activities that you cannot do otherwise." Whereas at Washington School, where every student had a laptop, Patricia stated that working against the clock was a continuous issue. "Time is definitely a big factor…to get out [the students'] laptops and get started takes time in the classroom."

As a result, several themes were derived from the data for each research question. Each theme was explained how and in what context it emerged from the data. In this written analysis, examples and quotations were extracted from the interviews, documents, and observations to add to the richness of the analysis. Additionally, a detailed description of the case, participants, and setting was written. This thick description

helped provide statements that re-created the study and as much of its context as possible (Gall et al., 2003).

# CHAPTER IV

# FINDINGS

After careful analysis of the data from multiple sources, several key findings were consistent with those of previous studies (Becker, 2000; Cuban, 2001; Conlon & Simpson, 2003; Zhao et al., 2002). The current findings also suggest what may be the best current practices in use by the leading technology teachers or early adopters in three high schools today. No effort will be made to generalize the results more widely given the limitations of this qualitative research design.

## Overview

The pressures experienced by the early adopters came from students, peers, and administrators, as well as external environments. Administrators applied a certain amount of pressure, for example, by purchasing and supplying the teachers with software and hardware, and because of those investments, administrators expected to see the teachers incorporate the technology into their lessons. To ensure this was happening effectively, administrators also invested time and money through professional development in digital technology for teachers. Though some people believe that administrators should know how to integrate, relate, and align technology to the curriculum (Staples, Pugach, & Himes, 2005), administrators can exert a significant amount of pressure on teachers by marshalling resources alone.

The global forces reported by teachers included a constant rhetorical pressure from various environmental sources urging them to upgrade their teaching and to make it

more relevant to the future. The teachers generated many of their ideas and gained much of their knowledge by attending workshops or conferences and through exposure to ways teachers outside of their local school community had shared with them.

## Characteristic Applications

Not surprisingly, participating teachers reported using digital technology for communicating, extending the classroom, and researching for class. To convey facts, concepts, and values, the teachers extensively prepared multimedia experiences that were expected to strongly engage their students. Outside the classroom, the teachers primarily relied on e-mail to communicate with their parents and students. To further extend the students' learning experience beyond the actual class, all of the teachers utilized the power of the Internet by creating their own Web site, or its equivalent. Some even used the newest innovations, such as Wikis, to extend class discussions. Predictably, nearly all participating teachers used technology to enrich the content of their classes and to enhance their lessons. As shown by Mills and Tincher (2003), the teachers used technology "to create learning environments that augmented student learning" (p. 397).

## Technology and Pedagogy

As expected, teachers also demonstrated a distinctly constructivist approach to student learning and a conscientious effort to encourage higher-level thinking in many assignments (Becker, 2000; Cuban, 2001).

## Consequences for Teachers and Students

Though teachers were frustrated with a lack of time, problems with gaining greater access to technology within their schools, various glitches that required outside support, and security issues such as plagiarism, they expressed satisfaction and a sense of accomplishment with two things; the ease with which students could be led to enriching

information when the digital technology worked and the ways in which their students reacted to it positively.

## School and Global Forces

There were two types of forces, school and global, that greatly influenced the teachers to adopt technology for classroom use. The school forces that pushed the teachers to use technology came from the administration, through District initiatives, investments, and expectations, as well as from the teachers themselves, colleagues, and the students' interests and skills. The global forces that influenced the teachers came from the support of the community as well as the perceived pressures to prepare students for college and the workforce. These combined forces were the main factors that influenced the teachers to alter their pedagogy so the students could effectively compete beyond high school.

### *School Forces*

Each of the schools had made a considerable investment in technology for teacher and student use. Although there may not have been many directives, there was the expectation from students, teachers, and administrators that it was to be used throughout the student's learning experience.

*Administrative Pressures.* "For technology to have an enduring effect, [administrators] themselves have to take an active role in defining and communicating a *sensible* role for technology integration" (Staples et al., 2005, p. 302). For the most part, the teachers said they did not feel as though there were direct mandates from the principal or superintendent. However, through the school districts' actions, many new initiatives were started, which resulted in the teachers having to adopt new teaching practices with the inclusion of technology. As Judy put it, "In my opinion it has been a very gentle

invitation." In fact, she continued that the technology initiatives had been very positive. "I don't feel that there's been strong pressure. I think it's a bonus…the fact that I have a Web site, parents love that, my department chair loves that, but nobody said you must do this."

Roosevelt, for example, was one of the first schools in the state to give teachers laptops. Roosevelt also invested in purchasing ten wireless carts with twenty-five laptops and a printer on each. This was in addition to the eight computer labs for classroom use. Likewise, Lincoln was equipped with six locations for class computer access and an additional four computer carts to be brought into the classroom. Because Washington had a 1:1 laptop to student initiative, the school did not have computer labs or carts. All three high schools had wireless Internet access throughout the whole building.

In the beginning, there were no real requirements of the teachers. However, several years later, all the teachers at each school were required to post their gradebook online for password-protected parent access, maintain a Web page or Study Wiz page by posting homework and other work for student access, and communicate via e-mail. As for resistance, Christine did not see this as an issue. She remembered, "I was here for the first year of the program. You know, teachers who had been here for thirty years did not seem to resist it."

In regards to the teacher laptop initiative at Washington, Christine was a little more direct. "There is a major push from the District. As soon as we got these [laptops] it was pretty much, 'You are using them–find ways.' When we are observed we are expected to use technology in some way."

"[T]he discussion of technology integration must first be a discussion of the curriculum–and the leadership role has to be curriculum-based. The initial discussion of

technology makes sense only insofar as it is directly related to the curriculum…" (Staples et al., 2005, p. 302). The supervisors of the schools seemed to be the direct influence over the push to incorporate technology into the lessons. Patricia's supervisor expected at least one computer project per marking period. Although this did not seem like much, it is the expectation that technology should be incorporated that was set. Christine commented that their Web sites at Washington were required to be updated weekly. Maggie summed up the expectations of using technology at Washington, "It's here and they do expect us to use it."

Shea and Hagan's supervisor at Roosevelt took a different approach last year. To encourage his teachers to incorporate technology into their lessons, he told them that he would give them a $10 Starbucks gift card for every two technology-driven lessons that he was invited in to observe. This positive reinforcement worked, and a few teachers took advantage of this incentive and benefited from his generosity.

To assist the teachers and students in their research, each school invested in databases for various purposes. Teachers and students from all the schools frequently used research databases such as JSTOR, an online storage system that archived academic journals, and EBSCO, an online storage system that archived full-text and abstract articles from newspapers, magazines, and reference books. For her English classes, Judy used the Internet and then demonstrated "how to use our services and the databases that our school subscribes to. We use those a lot. JSTOR is our favorite…They all have been invaluable. [They] are a great resource." All three schools also subscribed to Turnitin, an online antiplagiarism software package that required students to submit their papers to the company for an antiplagiarism scan prior to handing in their papers to the teachers.

Despite having this procedure, students still handed in either plagiarized or incorrectly cited work. The teachers felt this was because of laziness on the students' part.

The perceived pressure to continually prepare their students to compete with students around the world was strong. To that extent, Robyn believed that the pressure to prepare students for the future should come from the administration. Although she hated admitting it, she said schools needed a "mandate saying that teachers must use technology in order to connect with kids." Further, she believed that teachers needed to be given time to work on ways to infuse technology into their lessons. Understanding there were budgetary and other contractual limitations to her proposal, she still insisted schools should demand more professional development from teachers instead of the typical one day a year for teachers to create a Web site or such.

Although teachers may have experimented when technology was given to them, it was easier when they were exposed to new ideas and trained on how to incorporate it into their lessons. Therefore, each school spent a lot of money on professional development. Roosevelt hired a full-time employee to assist the teachers to use technology-infused lessons. Roosevelt teachers were also required to attend twenty-one hours of professional development per year after school, and many teachers used that time for technology instruction. Lincoln gave release time during the school day for teachers to be trained by a technology staff member through a program called "Project Infusion." Judy said, "The technology person teaches us about a topic of our choice…I have learned how to create a Web site…how to make movies, [and] just recently I learned how to create podcasts."

During one of the professional-development classes required at Roosevelt, Hagan had a great experience this past year. Her teacher explained that it was required for her, among other things, to create a blog for the course by a given due date. Upon reflection,

Hagan thought this hands-on approach to teaching was "much more effective than sitting in a room and having someone say, 'I will show you PowerPoint and Excel.' To get credit for the professional-development hours, we were actually being forced to create for the classroom, which I think was very beneficial." The pressure to create a blog forced her to take the professional development seriously and, in turn, Hagan learned a skill that she now uses in her classes.

Washington was no different. In addition to professional-development opportunities throughout the school year, every summer Washington sponsored "Tech Camp." This three-day professional workshop allowed volunteer teachers to be trained in various technology programs. These workshops were taught by outside presenters and faculty members. During the school year, Maggie stated that there was "a lot of professional development. [But] a lot is just talking to other teachers and learning from them…by being open to their suggestions."

During the initial years of the rollout of technology in each school, the initiative and utilization of technology in the class did not go smoothly. Teachers struggled to find ways to incorporate technology into their lessons. In fact, at Washington the pendulum swung too far in the wrong direction. Teachers found they were using technology just to use it. Maggie gave an example: She and her colleagues had students use Microsoft Word to type essays in class instead of using paper and pencil. They believed this was not the best use of the technology and students' time. However, after a while and much experimentation, she thought she had found a balance. She reflected, "There are times we will go a whole week without opening the computers. Finding when it's appropriate to use technology to actually enhance what I am trying to do [in class] is important." The laptop initiative was rolled out during Maggie's first year as a teacher at Washington, and

she “felt more pressure because it was my first year and we had just gotten those [laptops].” Several years later, she has learned how to infuse technology into her lessons effectively and believed her teaching “has evolved” and will continue to evolve “in the next few years with [the releases] of newer software.”

*Teacher and Student Pressures.* Besides the pressure from the administration, the teachers felt a pressure from colleagues, students, and themselves. “The responsibility to meet expectations for integration should be given to the faculty, empowering them with the control to collaborate and develop curriculum strategies that incorporate available technology” (Goddard, 2002, p. 23). To this point, Beth Ann believed that “most of the teachers you know take [technology integration] upon themselves in [Lincoln].”

Internally, all the teachers put a self-imposed pressure upon themselves to constantly try to provide the best for their students. Patricia claimed, “I do almost everything that I give them…I look at the textbook, online for resources, anything to find the best problems that the students will benefit from.” Because most teachers took on the responsibility of incorporating technology into their lessons, Beth Ann “kind of felt pressured to keep up.” She continued, “It’s one thing to learn [the technology] and it’s another to master it.” Commenting on this huge investment in technology at Roosevelt and the personal internal pressure to incorporate it into daily lessons, Sean stated, “I feel pretty strongly about how we have this incredible district-wide investment in technology and I feel we have to use it somehow. We really should use it but only if it is going to make a better learning environment.”

Along that same line of thinking, Maggie tried to make her classroom experiences something special. For her Earth’s Natural Disasters class, she felt that the students would never be able to see an actual volcano explode. Therefore, she found live video

coverage of a recent volcano eruption that was played over the Internet and projected onto the SmartBoard in her room so her students could see and experience a natural event they would never be able to do otherwise.

Hagan did not believe there was much pressure to use technology, but she did "feel if there is a teacher who is uncomfortable with technology, I think that then there would be pressure." She felt that the social studies department was very friendly and she and her colleagues were "very happy to sit down and show [others] how to use any program."

Maggie did not feel forced by the District to use technology in her classrooms. The pressure was more intrinsic and a reflection of her students' positive attitude, which motivated her. She reflected, "It wasn't that you were forced. It was, of course, wanting to use more of [technology] and trying to incorporate it into your classroom." When asked where all her motivation came from, she responded that using technology is

> actually more interesting than just writing on the blackboard with a piece of chalk. There are a lot more visuals and student participation as opposed to being all teacher focused. The students bounce questions and answers off each other a lot. So the dynamics of the classrooms have changed a lot.

One way students have changed is that they are more savvy and not intimidated by working with technology. Most of the students had been exposed to many of the software packages such as Word, Excel, and PowerPoint, and were able to quickly adjust when a new software was introduced, such as Audacity, iComic, or Movie Maker. Maggie believed that part of the students' comfort factor was that the platforms were similar in their setup. She stated, "many applications, once you know how to do one of them, are pretty standard. [The students] help each other a lot of times and they know more than you do with some of these applications." Angers and Machtmes (2005) also

found that students would peer tutor each other and that the technology skills were learned within the context of the lesson's objectives. Consequently, the notion that students knew more than the teachers in regards to technology was an underlying pressure the teachers were continually aware of.

The teachers knew not every student in their classes owned a computer, but they also knew that every one of them had access to a computer at school. Therefore, not sacrificing the technology aspect of the assignments because of some students not owning their own computer, Shea gave all her students enough time to use the school's resources to complete an assignment. She said, "I do know the stereotype is that everyone here has a computer…and it is not necessarily true. I give them enough time in advance so they can get it done here and also the library." Judy knew it to be an exaggeration that most of the students at Lincoln had their own laptops but sometimes "that's what it seems like to me." The perception that the students were always on the computer and in many cases owning their own added pressure on the teachers to incorporate technology in their lessons to appeal to the new digital student.

*Global Forces*

One of the main reasons for incorporating technology into class lessons was to prepare students for their future. Whether a student was going on to the workforce or college, teachers felt that acquiring a technological base was essential for their future success. Boling (2005) found, "In response to a globalized information society and a need to prepare students for the new literacies that are becoming central for accessing, acquiring, and critically analyzing information and knowledge, local, state, and federal initiatives have been created to assist teacher candidates to effectively integrate technology to support student learning" (p. 1). For an already established teacher like

Christine, she believed it was vital for students to use technology in schools. Even though her school had a laptop for each student she stated,

> I don't think that every student needs their own laptop but I think schools, which are not providing computers to their kids, are doing them a huge disservice and [those students] are going to be behind in college and definitely in the workplace. I think that they are vital right now and should be a priority for a lot of these schools.

After reflecting upon her own teacher-preparation courses in college, Christine continued, "the colleges have been doing a disservice in preparing the teachers to take kids to the next level."

To this end, Hagan has been thanked by former students returning from college for preparing them with technological skills. In college, Hagan believed that students "are going to be using podcasts, and nobody is going to be there to hold their hands and teach them how to do it." These skills she exposed her students to in class would also carry beyond college. She stated,

> Who knows what types of jobs are going to be created in the next couple of years for technology and if we are not allowing for students to explore technology as an option for them as a career…I do not think that is preparing them much.

Robyn felt the pressure to incorporate more technology into her lessons after attending several education conferences. The focus of these conferences was how to connect to the students through technology and prepare them for the 21st century. The ultimate goals of 21st century and technology advocates are to prepare students to succeed and prosper in life, in school, on the job, and keep America competitive internationally (Partnership for 21st Century Skills, 2006). Further, Robyn felt additional external pressure when the Spanish AP exam changed three years ago. Because of the changes, she incorporated Audacity to be able to digitally record the students speaking the target language. She then listened to the recordings and graded their performance at a later time.

She felt this experience was invaluable in preparation for the AP exam. Prior to this change, she admitted, she was not using technology in the class "in the context of how to make the focus of the class more real world."

Hagan, during her second year as a teacher, was selected by her supervisor to attend a local *Teaching American History* professional-development workshop. At this workshop she was exposed to other teachers outside of her school who were using technology for the classroom in ways that she had never thought of before. This was a pivotal moment in her career, when these more experienced teachers shared their knowledge with her. She remembered that this experience "really sent me into the driver's seat when it came to brining technology into my own classroom."

Over the past four years technology has changed significantly. Previously, Wikis, podcasts, and blogs were not as common. Maggie stated, "Technology is continually changing, and you have to stay on top of what is going on." Robyn worried that it might take a revelation on the teachers' part to shift their thinking. She predicted,

> Until something really scary happens where teachers look around and realize that they are not really connecting with their students or some school from Asia comes over here and blows our doors off, the reality is not going to hit people and they are just going to keep doing the same thing… If it is really going to make an impact it just has to be mandated.

Because of this belief, Washington was constantly trying to keep pace with the ever-changing world. For example, Washington set up a video-conferencing system so that teachers could connect with a school in Singapore to have the students communicate around the world to work on school assignments.

Luckily, the teachers in this study did not wait for something scary to happen. Maggie, a chemistry teacher, incorporated iMovie and Excel into her classes to help better prepare her students to succeed in life because "that is what a good teacher does."

She–like Sean, who also came from the business world prior to teaching–believed that students "are not going to succeed in life just knowing chemistry…you've got to be more well-rounded and I think the goal of education is to teach [the students] how to succeed in life and how to be a good person."

The teachers felt the students needed to master research skills or basic software packages necessary throughout life. Projects stressed the need for students to understand how to navigate the Internet, use various database sources, and determine which Web sites were credible. When PowerPoint or Keynote was required of students, teachers also taught basic presentation skills, which will be used during interviews or in public speaking scenarios. The advantage of learning these skills with technology, as reinforced by Hagan's project below, was that these skills would definitely benefit them in the future.

To make the projects more relevant to the student's lives, the majority of the projects observed or collected incorporated some type of publicized end product. This was accomplished by requiring students to present their project in front of classmates or publish it on the Internet. One of Hagan's favorite lessons was to have students create a podcast on a historical topic. The podcast incorporated historical pictures with the students recording their voices talking about the subject matter. She was "amazed how [the students] get involved in the podcasts rather than putting on a video from Discovery Channel." Hagan took the project one step further by requiring the students to upload their podcast onto her Study Wiz Web site so that others in the class could view and listen to them.

Overall, the teachers believed that the students needed to have a strong foundation in computer and analytic skills to succeed in school and life. Although students may have

understood that certain skills were needed for college and business, they did not have the perspective like that of the teachers regarding the critical need of technology and analytical skills needed for life beyond high school. The Partnership for 21st Century Skills (2006) stated, "The United States can no longer claim that the American workforce is uniquely qualified. Workers around the world compete head-to-head with Americans." To emphasize this point, Hagan felt,

> It is extremely important for them to know at least what I know, because then I know they're going to be prepared once they get into college and college can prepare them even more…so I think that the advantage to learning all this technology would definitely benefit them in the future.

Christine reflected,

> I think [students] are going to need to be familiar with [technology] because it's going to be something that they cannot really avoid in any field. So I do think that it is doing them a major service by allowing them to become familiar with [technology]. Do I think that it is necessary to learn Shakespeare? No, I don't, but I think that [technology] makes it more relevant to them and I think that it is teaching them other skills that they will need. So I do think [technology] is necessary today.

### Technology for Class

With the emergence of computers and the Internet, information had become available at any time to anyone with access to a computer. Not surprisingly, the primary type of technology teachers reportedly used was the computer, mainly for communication purposes. The teachers also used technology to disseminate knowledge and communicate with their students while the students used it to ask teachers questions and convey their acquired knowledge. Lastly, the Internet had allowed teachers to research information for class lessons and the students to publish class projects.

*Communication*

The teachers used technology in various ways and purposes to communicate. Various multimedia were incorporated into class lessons to convey ideas and concepts regarding the topic being learned. In addition, e-mail was used as a primary correspondence method to parents and students. Teachers used an electronic grading system for parents and students to view their grades via the Internet.

*Multimedia.* "[W]hen teachers emphasize communication and information-oriented objectives for their students' software use (e.g., publishing for an audience, communicating electronically, writing, and finding information), they expand students' academic effort…result[ing] in greater student engagement in their academic assignments" (Becker, 2000, p. 27). In one form or another, all the teachers almost on a daily basis used technology to communicate information to the students. Hagan stated, "Every day I use some sort of technology." For her history classes she used PowerPoint, iMovie, podcasts, and even YouTube videos to engage the students. She reflected,

> I use PowerPoints with primary documents and pictures, and sometimes I even have links to YouTube clips on famous speeches. What that does is get the students involved with history instead of being lectured at. It gets them emotionally involved and I think they remember it a little bit better, or at least internalize it a little bit easier, so that they can understand and really feel what that moment was supposed to feel like in history.

Similarly, Beth Ann sometimes began a class by "setting the mood" with a photo essay from the Internet. "I have had some really powerful moments where I have set the tone or I have showed some clips…connected to a novel. It's just a fun way to start things off." She admitted that she was not able to "put on the dog and pony show every day" so incorporating technology-centered lessons on a fairly regular basis helped the teaching process. For example, as an introduction to a recent unit she played a digital photo essay

downloaded from the Internet. The students viewed a modern version of the Vietnam novel *The Things They Carried* but with the current troops in Iraq. Her reasoning for this lesson was that it was "just a great way to get things rolling." The notes from her observed class stated,

> Judy introduced the concept of Wikis to her students for their book literature circle. The objective was for students to create their own Wiki on *The Things They Carried*…She explained how easy it was to set up the free Wiki Web site and that the students' work would be published on the Internet.

To assist in making the classroom experience more authentic, Robyn had students watch YouTube videos and various Internet news stations. For her Spanish class, one of her favorite lessons was to have the students watch a Spanish music video "to see the cultural depiction in the video and hear authentic music from Argentina…So they can actually see and hear how the Spanish language and things that we've learned are incorporated in everyday use in popular culture." Along the same line of thinking, Robyn accessed different Web sites like BBC Mundo and CNN in Spanish "to get discussion topics for the kids." These sites and videos, she added, ensured "we were not doing some boring reading that had no connection with anything that was going on in the world."

In order, "To try to bring in as much enthusiasm and as much interest into the class as I can using technology," Hagan learned iMovie. This software allowed the user to save documents, pictures, audio recordings to a file which, when played, was projected onto a screen and viewed as a movie. Hagan "used it for [the War of] 1812 as a wrap-up session–music, primary docs, teacher narration–[the] kids loved it, which drives me to learn more and make [class] more interesting and fun." Liu (2003) found that students engaged in multimedia project-based learning were more motivated, supported

information gathering and presentation skills, and promoted high level cognitive skills. As observed in one lesson,

> Hagan created an iMovie that incorporated pictures and video segments sent from a friend serving in Iraq. Along with the pictures, Hagan added music and written and verbal narration for background information regarding the current Iraq war. Every student was silent and did not move during the presentation. When the iMovie was over the silence continued until Hagan asked the students their thoughts. One student responded that he could not believe how real it all seemed.

When Hagan was asked why she put so much effort into the iMovies she replied that the students "loved [them] so much. So, that [makes me, that] drives me to learn something else. You know, what else can I do to make it more interesting and fun for them?" In Shea's Anthropology class, the first of two days the students were working on a project were observed by the researcher, which read as follows,

> The students worked individually at a computer and had to choose an archeological dig site of their choice, such as Turkey, the U.S. Civil War, and Bolivia. They were encouraged to look at videos, photos, and readings related to their choice. The final project was to create a brochure/newsletter containing certain information regarding their dig site. They were told that they could e-mail the onsite archeologist and ask questions. The finished product could be done using Word under project gallery and would be posted on the teacher's Study Wiz page.

Having teachers that were willing to go beyond what was expected of them and take risks with assignments was essential for success with technology in the class (Vannatta & Fordham, 2004).

Judy would agree. She felt that iMovie was easy to use and the level of student proficiency was so strong that she assigned projects requiring this use of technology. She continued that the school was so advanced in its level of technology integration that the students have learned how to use the various types of software, which has resulted in "the students mak[ing] movies and videos all the time for class projects."

In the math and sciences, technology was used slightly different. For example, in Patricia's math classes she enjoyed using graphing calculators and the spreadsheet software Excel. She stated that the calculators and Excel allowed students "to look at a graph and see a little bit more than what they would have put on a piece of paper. They see where real data could be put together and see where real-world applications come into play."

Patricia was also the only teacher observed using an InterWrite tablet. This tool allowed the teacher to circulate the room and control the computer by running applications from a hand-held tablet. This enabled her to check on a student's progress and keep others on task. Anything written or used on the tablet was wirelessly projected onto the screen in front of the room. This tool, however, was not solely relied upon. As observed in one lesson, Patricia flowed seamlessly back and forth between the InterWrite tablet and writing on the whiteboard in the front of the room. In this lesson, she demonstrated the use of technology, then no technology, and finally some lecture. Her notes from the lesson were also saved and posted on her Web site for the students to access.

One type of hardware and software used was specifically for the science classes. Sean and Maggie's students regularly used electronic probes, tools such as thermometers and calibration devices that measured and collected data for experiments. The probes collected the experimental data and directly uploaded the information into graphing-analysis software. This collection and visualization of the data, according to Sean, "allows the students to work with the data at a higher level."

Additionally, Sean used Applets to introduce a lesson. An Applet was a small free program retrieved from the Internet that animated something physical happening that was

somewhat difficult to demonstrate in class. For example, one Applet demonstrated the concept of refraction. The Applet showed, or communicated, in an animated format, how white light was bent when it came through a lens. He enjoyed using this software because it allowed the students to "see something happening that might be difficult to demonstrate or for students to understand."

The last software primarily used by the teachers to communicate with their students and likewise the students with their teachers was with Word. As indicated by all of the teachers' lesson plans and submitted documents, most assignments were typed in Word, printed out, and copied for distribution to the class. In return, most of the student's assignments and assessments were communicated back to the teacher using the same software. For the most part, all assignments that required a written component had to be typed when submitted. This was usually accomplished by using Word.

*E-mail.* The other type of communication used by teachers was e-mail. This medium allowed teachers to correspond with students and parents and vice versa. Judy, for example, was a self-proclaimed "big e-mailer" with her students. She e-mailed assignments to the students much of the time and stated that e-mail was an easy way to connect with the kids. "They can e-mail me at all hours of the day and there is no pressure for me to get back to them…it increases communication." Effective communication is one of the 21st century skills that will be required for students to thrive in their future (CEO Forum on Education and Technology, 2001).

The communication highway worked both ways. Technological fluency is a combination of information, communication, and technology skills (Mills & Tincher, 2003)–all of which are exhibited through the use of e-mail. Because Judy taught many seniors, e-mail was a great tool to stay in contact with her students who missed class for

college visitations and absences. She believed it actually reduced the stress level of the students. “If [the students] have been out sick they shoot me an e-mail. I think it is a pressure reliever because at least they have their assignments and can communicate with me any questions.” She also e-mailed her students questions after class that were due later on in the week. She admitted that e-mail had become a “very big backup” and that she would “send [students] assignments…that I haven’t necessarily handed out in class.” Along those same lines, Shea sent out e-alerts to parents and students about upcoming due dates and tests.

Christine, who also “e-mails a lot,” found that e-mail was a great communication device for her with parents and students. She admitted her students “e-mail [her] from home all the time with questions.” As for the job becoming twenty-four hours a day seven days a week, Judy clarified that she usually did not check the school e-mail account at home but it was nice to read the e-mails in the morning and know what was going on with her students. Maggie said that most of her e-mails come around six o’clock at night, when the students began working on their assignments. According to her, the e-mails typically read, “Oh my God, I totally forgot to ask.’ They start freaking out but they know how to use e-mail so we go back and forth to help with their questions.”

Robyn, who did not e-mail her students as much, did use it to let her students know that she found a link on the Internet and would ask her students to investigate. To her surprise, she found that certain students responded positively to this communication and would return her e-mail with additional information related to the topic. Beth Ann actually had conversations with students at night when they e-mailed her regarding what they did in class. “I was so excited about this and I can reply to them and have open discussions with them when the moment strikes.”

Similarly, Shea used e-mail as a communication tool with her students. She told them they may "e-mail [her] anytime, within reason at night, and [she] will give them an answer to a question they do not understand." She estimated that 90 percent of her assignments were e-mailed to her by her students. Hagan went one step further and told her students that she would be online at a certain time of night for any questions the students wanted to instant message her. She said, "I actually have my own instant message name for the students…I find it to be really helpful, because sometimes in class those students aren't going to want to speak up because they might be embarrassed." By her account, half the class had taken advantage of this medium. When asked why she put in these extra hours not required by the teacher's contract she simply replied, "It's for the kids."

Additionally, e-mail helped Robyn stay organized. She organized her e-mails from students to remind herself when someone was absent or submitted an assignment. Then she would send that individual student or the whole class an assignment or when she was feeling creative "an enhancement to a lesson to create a link between what is in the textbook and what's in life."

Some of the teachers used Wikis and blogs in their classrooms more as a classroom extension of the lesson rather than a primary way of communicating with their students. These findings will be discussed in a following section.

*Grading Software.* To communicate the teacher's gradebook to parents and students, each school subscribed to an online grading software program. All the teachers were required to mark students present or absent through the system and maintained their gradebook online. In addition, the grades could be viewed by parents and students in real time. This meant that as soon as a teacher posted a grade for an assignment it could be

instantly viewed. Students and parents could view only their own grades and not another student's grades.

Although there was pressure on the teachers from students and parents to upgrade the gradebook daily, for the most part the online grading system removed much of the mystery of the teacher gradebook, guessing of a student grade, and, therefore, potential confrontations. None of the teachers used the paper gradebooks anymore. Shea's comments reflected the sentiments of all the teachers, "You get used to it. Now I can't imagine doing the paper gradebook anymore." The teachers did not seem to give this medium of communication much thought. The use of the electronic gradebook was second nature and expected. This use of technology to communicate is one of the main standards of NETS (International Society for Technology in Education, 2008b).

*Classroom Extension*

Teachers took advantage of the accessibility offered by the Internet and thereby extended their learning experience of the students beyond the classroom walls. All of the teachers, except the ones from Roosevelt High School, had Web sites and encouraged the parents and students to access it. The Roosevelt teachers used a management database called Study Wiz, which allowed them to effectively communicate with their students much the same way as a Web site. The use of technology altered how teachers ran their classroom and shifted the responsibility of learning from the teacher to the student (Angers & Machtmes, 2005). "The teacher's role is to plan for and manage the computer-learning environment, and to facilitate and guide the learning that goes on within it (Angers & Machtmes, 2005, p. 773).

Shea, for example, rarely distributed handouts to the class. She stated she recently had not made " a single copy of a handout or a document and hand it out to the students.

Everything was run from the Web site." When asked why she liked this method she continued,

> Because I can really almost talk to the kids on a Web page and explain in detail what I want…to go to [a particular] Web site, which I can't do if I just have a document that they pull up… I really enjoy updating this site where the kids can go, they see the day, they see the instructions, they see the whole week and they can click right on to a link and it can take them immediately to where I want them to go.

Judy used her Web site to communicate "homework, assignments, and upcoming tests and quizzes. She even encouraged "the parents to go there, to see what is happening, and see various resources." Some of these resources were homework assignments or handouts given in class that were saved as electronic files that anyone could download from their home computer. She also included suggested Web sites on her home page "to make it easier so [the students] don't have to start out cold when searching on Google for various assignments." Sean used his Study Wiz page equally effectively. The site was password-protected so only students and parents from the class could access it. He placed study guides, PowerPoint presentations, information for the students' lab work, and links to related topics on the Internet on his Study Wiz page. He even posted his lesson plans on his Study Wiz page "for students and their parents to see. There should not be any surprises."

Beth Ann required her students to constantly check her Web site and was "pretty diligent about keeping a Web site because it keeps everybody on the same page." However, she felt "it is a huge responsibility…I expect a lot of my students, so if I make a change I will update it on the Web site so they are prepared." She reflected, "I did not have a Web site in my first year of teaching and now I have a page for every unit and book. It is very detailed." Beth Ann and Patricia found that their students had

downloaded the necessary information from their Web sites when they forgot their book or homework or were absent. As for her students, Maggie said, “They are 100 percent responsible when it comes to checking the Web site for homework and assignments.” Maggie even commented how the parents of her students accessed her Web site.

Patricia uploaded her class notes directly from the InterWrite tablet onto her Web page and Beth Ann posted links to books that were accessible in the public domain of the Internet so students could easily find readings for their assignments and to various Modern Language Association (MLA) formatting sites so students could check their work. Beth Ann explained, “Things like that can really smooth over a lot of problems that kids have regarding being organized.”

Shea and Hagan used the District-issued Study Wiz program in much the same fashion as a Web page. On this site, the teachers posted PowerPoint lecture slides, visual aides, and primary documents for students to read. To help with the visual learners in her class, Hagan posted pictures in PowerPoint with the guided notes. The posted PowerPoint presentations were saved as three slides per page with the slide information on the left half of the page and blank lines on the right half of the page for students to take corresponding notes during class.

Some teachers extended the classroom discussions beyond the class setting by creating message boards for the purpose of threaded discussions. Motivated by wanting to add to the students’ experience in the classroom, Beth Ann began using Moodle in her AP English class. Moodle was a free Internet application that allowed users to create a forum for discussions to be held online. She explained, “It is difficult to hear [in class] from all my students, especially the shyer ones.” So she incorporated Moodle into her

lessons as a place for students “to put their ideas down and people can respond to them.” She stated that her students found this experience to be “kind of cool.”

In a related approach, Christine had the students each create an account with Blogger.com. When students were given the option of maintaining a journal or blog she said most of her students chose the blog. The online blog was another way for her to continue the class discussion with her students when they posted their thoughts and she responded to them. This was all accomplished outside of the actual allocated class time and extended the learning period into the evening hours and into the homes.

Besides only having the teacher comment on student work, Shea had her students critique each other’s archeological podcast that was posted on Study Wiz. Having each student publicize their own work for a different audience allowed for more authenticity to the project. Also, by viewing others’ work, each student was exposed to more than one project and thus enriched their experience and scope of learning beyond their own project. As found by Cuban (2001), many of the projects did not need to have technology integrated for the students to learn the subject matter, however, the teachers would not achieve the outcomes they desired, such as visual presentations and publishing for an audience.

Patricia enjoyed mixing up the experience for the students. Although she gave test and quizzes the traditional way with paper and pencil, she did incorporate an online quiz aspect as well. During one observed lesson, when the students entered the class they were instructed to take out their laptops and log on to a specific site and answer six multiple-choice questions. The answers were corrected by the software and e-mailed to the teacher with a grade. Each student had different problems and after the problem was answered the next problem appeared on the screen so nobody could cheat off one another. Each

student also received instant feedback by the software letting him or her know if the answer was correct.

Another software the teachers used for class was a Wiki. In one of Hagan's observed class lessons, the students created their own Wiki. Included in their Wiki were pertinent downloaded pictures from the Internet, music, and facts regarding their topic. The observation notes of this class read,

> Hagan taught the basics of how to create a Wiki. Some students did not receive her previously sent e-mail explaining the directions so they experienced problems setting up initially. Hagan cautioned the students to limit the amount of pictures in the project and keep their file size smaller to avoid potential issues...The students spent the class time researching their topic, summarizing their findings, and putting them in their own words. From this assignment the students will build a future WebQuest for the class.

Additionally, she commented how the students "always use the Internet" and now with this Wiki project they would leave "their mark on the Internet, which they find to be fun and different."

The idea of making the lessons students learn more relevant was one that the teachers continually grappled with. Beth Ann liked the idea of pushing her English students by "giving them an opportunity to write for different audiences and for different purposes." To accomplish this, she had the students write for an assignment and then publish their work on a Web site so they were not just authors but "kind of experts on what they are doing." She believed this type of project made the students feel important and that they had a purpose to what they were doing by being able to "share their thinking and creativity with not just me the reader but one another and then maybe even other people along the way."

*Research for class*

Angers and Machtmes (2005) found that teachers who were experienced at integrating computers into their teaching changed their current practice and transformed it to incorporate technology. Teachers in this study accessed the Internet usually as their first reference point when researching information for lessons or projects. Judy said that she "is constantly researching things for school, looking up books, looking up lesson plans, and checking the availability of books for [her] students." She accessed the Internet to look for ideas for lessons. She continued, "The first thing I do is go to the Internet and search for lesson plans. I am not a plagiarist, but I am a good copier, so I will go and see what other people have done."

Robyn accessed the Colby College Web site for its Spanish grammatical resources and downloaded information from various free Web sites that have reading texts, video, and pictures for the students to use. For example, she used the Internet to access a free Spanish newspaper "to get some discussion topics for the kids." Along the same line of thinking, Maggie accessed video from NBC News on the Internet to watch an event unfolding. For example, in her science elective she was able to pull up video "when the underwater volcano erupted near Fiji. We were able to view it live and discuss it in class. This was real-time data, which was very cool, that you don't get under other circumstances."

Also on the Internet were ideas that helped inspire the teachers. Judy was amazed that "these ideas [for the classroom] that are out there and ready-made like NCTE [National Council of Teachers of English] or PBS [Public Broadcasting Service]. It is pretty amazing–stuff I would never even in a million years think of doing with my kids." Using these Web sites from the Internet connected the teachers to numerous resources,

ideas, and other educators. Getting in touch with all this readily accessible information was a continual professional-development workshop where anything of interest could be further investigated. The information, in turn, as Judy said, could be "shared with my colleagues."

The teachers encouraged their students to access the Internet usually as their first reference point when researching information for lessons or projects. Shea poignantly stated, "the Internet is today's encyclopedia." When researching educational information, teachers said students typically typed their search request into one of the Internet search engines, such as Google, and viewed the various Web sites listed. To make class handouts more appealing, Hagan "put fun and interesting facts in there and then I can pull pictures off of the Internet, and I will make it fun and just visually pleasing." To find more serious information for class lectures, Hagan accessed a list of Web sites from an American History seminar she attended "that has excellent resources on the Internet."

Aware that valuable information was found on the Internet, the teachers required Internet sources on more formal assignments. According to Shea, a research paper she assigned required students to reference "maybe six Internet sources and seven book sources." Along that same line, Hagan assigned a project in the beginning of the year where her students "had to look up an actual Pilgrim's last will and testament…I gave them a Web site and then they found their last will and then they had to type up their life story from looking at their will."

Aside from Web sites, each school subscribed to various electronic databases. These databases, such as Ebsco and Proquest, allowed students to type in topic search parameters and access, at home or school, specific articles published and categorized in

that database. Judy took advantage of these databases and used “them a lot.” She was especially fond of JSTOR for her English classes.

Because of the Internet, information could be obtained through the various databases and Web sites without leaving the house and going to the local library. Regarding the way students conducted research nowadays, Judy commented, “Having the Internet being so fast and getting what you want so quickly is so much easier than going to the library and sitting down and reading through book after book after book just to find a little bit of information.” Christine echoed the sentiment regarding the convenience of being able to access information from home. She felt that it was “helpful and easier to use the Internet and school databases for information rather than having always to go to the library and search.”

Robyn further used technology in her class to help students listen to their responses in her Spanish class. For example, Lincoln’s language lab was equipped with SANAKO, a language learning software system, which enabled students to digitally record their responses, play their voices back, speak to each other, and record their comments after watching a video that was played on their computer screen. She felt this software greatly enhanced her students’ learning experience and helped them progress further along with their language mastery.

### Teaching with Technology

Technology for the teachers had changed the way they approached their lessons and assignments for their students. Technology was used to engage students in authentic tasks, and in many lessons the teachers turned the learning over to the students who then took ownership and responsibility for their work and learning (Angers & Machtmes, 2005). Technology enhanced their lessons to convey a deeper meaning of what was being

taught and the students were able to use technology to produce products that required higher-level thinking skills. “Although …a constructivist teacher is more apt to use technology in the classroom, typically a constructivist teacher uses technology as a tool to advance constructive learning” (Vannatta & Fordham, 2004, p. 261).

*Teacher Pedagogy*

Upon entering the classrooms for observations, all the rooms were “traditional” in their look with approximately twenty-five student desks, a blackboard and teacher desk in the front of the room, and four walls with various posters and student work hanging on them. The two science rooms had tables with two students at each table instead of desks with lab stations in the back of the room. Each room had a teacher computer and a video-projection device to project the images from the computer onto a screen in front of the room. On two occasions, the Social Studies teachers at Roosevelt moved their classes across the hallway to a computer lab, which housed approximately twenty-five computers along the perimeter of the room to conduct their lesson. The teachers stood in front of the room, began their lessons by taking attendance on the electronic gradebook system, and announced the objective of the day. As observed in Shea’s classroom, the Roosevelt’s school announcements were broadcasted from the school’s student-run TV studio over the internal closed-circuit system on a TV mounted on the wall. It was after this initial settling in point that the lessons took on a more constructivist approach.

All the teachers felt they needed to cover the curriculum and teach their students the subject matter. In fact, Judy felt she was “holding the reins pretty tight” when it came to giving students choice on projects. However, how they covered the curriculum and what they required as a finished student project reflected a more constructivist approach than that of a traditional or transmission pedagogy.

The teachers all incorporated whole group as well as small group discussions and activities into their lessons and tried to vary the lessons away from the traditional lecture format. To begin a unit or lesson, they tried to incorporate current events and student interests to capture their attention. For example, in Spanish class around the holiday time, Robyn compared and contrasted the Christian holiday traditions celebrated in America to the way they were celebrated in Latin America. Understanding of the concepts being taught came from a combination of an explanation from the teacher as well as from the student's own learning. Beth Ann "would love for there to be more student-driven initiatives. I would love a more ideal situation." However, lessons and learning were still interactive between teacher and student and the teacher was needed to guide the instruction. Additionally, mistakes made by students became opportunities for learning and growth. Beth Ann thought, "Mistakes…are an opportunity for reinforcement. It is an opportunity for competiveness…" Maggie believed this "allowed for more spontaneous learning."

According to Hagan, a typical day's lesson included projecting images and notes via a PowerPoint presentation around which she built her lecture. She commented that she liked to use PowerPoint images "for introduction of topics to provoke interest–a prompt." Hagan's teaching style was similar to this format. She added that she would "put the main points on PowerPoint and flesh it out with lecture." Shea approached her lessons in a comparable format. As observed in one of Shea's lessons,

> Upon entering Shea's classroom, there was a cart in the middle of the room whereon was situated a laptop computer connected to a video projector. The video projector was projecting a PowerPoint slide with an image of former President Nixon, Chairman Mao, a map of China, and four bulleted facts regarding U.S. and Chinese relations.

According to Hagan's and Shea's lesson plans and interview statements, the different presentations also included scanned historical documents, audio soundtracks, maps, and pictures of the topic being covered. For example, she found video clips from the 1950s to illustrate the "duck and cover" procedures students participated in and the Berlin Airlift to help rescue the citizens of West Berlin.

Although the teachers began a unit or lesson with setting up the context and expectations, afterward they had the students do more independent or small group work to answer questions or create a project. Parallel to Cuban's (2001) findings, Beth Ann said, "I try to make the instruction as student-directed as possible rather than me telling them, 'You need to answer these questions'…I try to have them figure out where the meaning is." She continued, "I try to have a discussion-forum type of environment or smaller groups…so they are not used to a person standing in front of the room and telling them." However, to begin her unit she provided the students with detailed instructions before they were ready to go off on their own. This technique was reminiscent of her days of working at an advertising firm in New York City when she was given detailed briefs. Similarly, Beth Ann provided detailed explanations regarding assignments because it reflected more of the "real world" and then allowed the students to work without teacher direction.

Hagan tried to approach a topic in multiple ways "so that if they did not get it once on the first time then they probably hopefully are going to pick up on it with the other resources." This may have been through a PowerPoint, diary entry, research, or some other creative assignment. Christine, too, stated she "definitely take[s] more of a discovery-learning project-based" approach. "It is rare that I am lecturing…I give instructions and I definitely get them to ask a lot of questions…It is more, here is where

you can find this information, now go find it." Each teacher felt comfortable with students asking questions in class. In fact, they actively encouraged them. Christine made her lessons more student-centered where "they could explore all kinds of different sources and find various forms of information and make their own conclusions." Rather than receiving information from the teacher, Maggie agreed that her lessons involved "a lot of self-discovery" on the part of the students. Beth Ann incorporated many different student activities. She believed "student understanding [came] from working collaboratively with the teacher and other students…I always try to make class collaborative whether it is small or whole group instruction…I really try to do that as often as I can."

Teaching this way was not always easy. In the past, too often students were lectured to by teachers and then tested on the information. Patricia reflected, "I don't think [the students] have ever been forced to constantly self-discover…they do not like to self-discover. They want to be told the answer. So it is kind of a fight."

To tackle this issue the teachers tried to make the subject matter interesting or related to their students' lives. Sean said, "The first activity you try is to make something related to [the students] and bring in an experience with the concept being taught." For example, he drew comparisons to the human wave that was performed by the audience at sporting events to ocean and sound waves. Shea thought that the use of technology in class was similar to a time capsule. When she used video and audio clips from the Internet she was able to have her students "relive a time period and truly experience what it must have been like to live back then."

Student independence occurred frequently. Regarding his Electronics elective, Sean stated, "we are more coaching [the students] and giving them a little bit of new

information as they need it." For a WebQuest project, Judy placed the students into groups to get different background information on a topic. Then the students came together and shared their segment of the topic on the Web site and taught the class using PowerPoint presentations. She "enjoyed this lesson because it allowed the students to research, work collaboratively, construct a project, and present their findings." WebQuests challenged students to critically evaluate Web sites, synthesize information from a variety of resources, and manage complex information–all higher-order skills (MacGregor & Lou, 2004–2005).

Sean, who was greatly influenced by an undergraduate course he took, tried to incorporate the main concepts into his daily teaching. He attempted to use technology to have students use critical-thinking skills to solve complex problems. He stated, "The best use of technology was to teach our kids to enhance their critical thinking and problem-solving skills." He admitted he liked to use technology as a critical-thinking tool. He explained that he tried to give his students "another way to represent their knowledge and take a constructivist approach to building knowledge as they use technology as a tool." For example, he used Inspiration, a visual learning and thinking software tool to build graphic organizers and concept maps to force the students to think about the concepts he was teaching. He commented on the software, "It is not a productivity tool. It is really a thinking tool." This type of learner-centered instruction attempted to engage the student in activities that supported knowledge construction through technology use. In this lesson the students used technology to investigate and think (Hokanson & Hooper, 2000).

To incorporate this constructivist approach, it was observed that Sean tried to build upon the students' previous knowledge when he introduced the concept of waves. This lesson began with a class discussion when Sean tried to have the students make

linkages to their own lives and draw out answers so they could make connections. He believed he met with some success in this area. To assist, the Inspiration software allowed his students to think more critically about the material and process the information better. This software allowed students to update diagrams and flowcharts when making notes. He stated that the mapping feature of the software "really did help the students create stronger links to topics…I think it is going to be more of the way teaching is going to evolve toward." As a result, Sean was creating a class environment in which his students were working toward developing their understanding by having opportunities to learn how to apply their knowledge and when to do so (Becker, 2000).

Maggie believed that she was able to get through more curricula and in more depth when she used technology "because you can really show them applications and they can manipulate things." For example, she had her students write equations for lines that moved on the Applet software. Then they could adjust the equations to see how it affected the movement, which "would not have been possible had it been done on paper with pencil."

The driving force behind Sean incorporating technology into his lessons was that he wanted to better prepare his students for the workplace. He believed students needed to be better critical thinkers and more creative, and have the ability to use complex thinking skills. He felt these skills were very important because "there will be two types of jobs in the future–flipping burgers and solving problems. We need to teach our kids how to solve problems so they will be valuable future employees."

*Student Technology Use*

Judy enjoyed giving her students choices when it came to the finished product of an assignment. She stated, "Options. I always give [the students] options. Even the good

old-fashioned poster…but most of the time they're very, very comfortable with PowerPoint." Beth Ann also did not require PowerPoint but made it an option. For example, one of her field trip assignments required an artistic response instead of a written component. Some of her students decided to use their photographs from the field trip and placed them into PowerPoint or other similar type software. Therefore, when students had a choice regarding their finished project, most preferred to use technology to complete an assignment.

If the students chose or were required to use the different databases available in school, very little time was spent teaching them the software. Christine summed up the feelings of many of the teachers by stating, "I think a lot of the programs are set up similarly so once they get a feel for one of them they can pretty much pick the others up. They can play with it and figure it out."

Other times the use of a specific software package was required. The Microsoft programs of PowerPoint, Excel, and Word were the most common. At Washington, since it was a Macintosh district, Keynote was used instead of PowerPoint. Beyond these programs the teachers also required others for specific purposes. For example, in an observed lesson, Beth Ann introduced students to a Wiki. The final project for the unit was for the students to publish their work on the Internet using a Wiki. She encouraged the students to "take pride in the project because anyone who searches the Internet on your topic may read your information." At roughly the same time but miles apart, Hagan required a similar type project from her history students at Roosevelt.

After an assignment was given and the parameters set, the teachers perceived the students enjoyed working on their own or with partners to complete a project. One science project related to gasses that Maggie assigned was a hot-air balloon project. The

requirements were that the student-created object must fly and be filmed flying, and the student must figure out how to accomplish this feat. Although the project did not necessarily require any technology, it demonstrated the type of constructivist thinking Maggie used when deciding how to teach science lessons.

Robyn used the Internet and different software available to make her "class more real." Some of her students accessed the Spanish version of metroFLOG, a personalized social utility to share information similar to Facebook, at home. They reported to her that they were amazed how they were exposed to the popular use of the language and learned many new words that expanded their repertoire.

After speaking with the teachers and observing their lessons, a trial-and-error approach to their teaching was constantly conveyed. For example, prior to demonstrating and requiring her students to create a Wiki, Beth Ann "only played around a little and learned how to use a Wiki the period before coming to class." Hagan, on the other hand, felt comfortable with a Wiki project. In her class, each student worked in a group to complete a history project and each individual was instructed to create a personal Web page on their topic. By combining technology with engagement, Hagan created an atmosphere of student collaboration (Goddard, 2002). Then the topics within the group were linked together so all the information could be found on a certain topic. For example, one group had the topic of Andrew Jackson while each individual had a different aspect of this topic such as his presidency, Indian relations, and military career. This type of assignment was a prime example of students being "meaningfully engaged in learning activities through participation with others on worthwhile tasks" (Goddard, 2002, p. 24).

Hagan believed the technology enabled her students to go to new levels. She remembered how her students interviewed people of the Great Depression and created movies that were edited on their home software. This project was an example of students making "useful contributions to their fellow students, family, and community, providing them with a sense of 'service' while increasing personal motivation and satisfaction" (Goddard, 2002, p. 24). Students would go "ten steps past where I'd even thought and it's just amazing… I love it when [the students] make a product like a podcast or brochure. It just blows your mind how well it's been done."

Hagan believed that technology really helped the students learn. She felt by working on projects, technology helped students take responsibility for their learning themselves, as opposed to just sitting passively in a classroom lecture. She stated,

> Today they are now using the knowledge with technology…it makes them accountable for what it is that they are researching, for what they are writing, for what they are creating and that's important for today. They can't just sit back and catch the wave. They have to go to work and that's good.

## Perceived Benefits of Technology Use

Cuban, Kirkpatrick, and Peck (2001) found teachers had changed their teaching because of their use of information technologies, e.g., "they planned more efficiently, communicated with colleagues more often via e-mail, and secured information from the Internet" (p. 824). The teachers in this study perceived two primary benefits regarding their use of technology for educational purposes. The first benefit, whether accessing information for class or producing finished work, was that it was more convenient to obtain information to complete work for school because of technology. The second perceived benefit was that technology and the access to so much information was a

motivating force. One additional beneficial finding, environmental concerns, surfaced throughout the interview process that also deserved some attention.

*Convenience*

Because of the Internet, information could be obtained through the various databases and Web sites almost instantly. Sean found, "Even if [the students] ask a question and I don't know the answer to it, I will go online and I'll find the answer during class." Judy believed that in the fifteen years since she began teaching, being able "to access the ideas, the inspirations, the lesson plans alone make [her] life so much easier…I would rather have an exciting lesson off the Internet that is amazing that I would never think of–it is very convenient." Because of technology's ease of use, all of the teachers typed their lesson plans electronically, usually in Word, so they were saved year to year.

Sean shared a similar philosophy of how technology kept him organized, which in turn made his life easier. He stated,

> It's really helped me to stay organized in terms of getting through the curriculum. I have a guide from last year. I can see how long it took me to get from point A to point B and from point B to point C. So, it keeps me moving. Technology keeps me moving.

He further predicted how he envisioned technology making his life easier,

> You know I'm trying to get rid of the busy work. That's how I saw technology helping me. I saw the Web site as a way to give me more free time…just not doing so much busy work…I mean, that's the only way I see it as the future. The only way I see technology working in education and in the classroom is if the teacher sees it as a time saver, making their life easier, making them more efficient.

There was a lot of free information on the Internet to help the teachers enhance their instruction. Students downloaded pictures for projects and Robyn did the same for tests and quizzes. She sometimes scanned pictures into the computer and then placed

them on a test for a picture prompt. For this prompt, the students looked over the picture and either responded to related questions or wrote an essay based on what they saw.

Shea could not believe how much she had become reliant on technology to teach her lessons. She reflected, "Within four years, I have come from teaching with almost no technology to teaching with technology all the time." By creating and saving her PowerPoint slide shows, edited video clips, and lessons plans, Shea had become "dependent on it." For her Civil Rights unit plan she had her students view edited Internet video clips of the Civil Rights Movement, read and compare northern to southern newspaper articles located on the ProQuest database, and read various accounts on Web sites. To her, technology not only brought history to life, it also "teaches a skill of perspective" not found from just reading a textbook.

When asked whether it was difficult in the past to reach all her previous students, Christine answered, "Yes, however, with computers I find it a lot easier to engage every student." Hagan agreed. She stated,

> Technology is great and I love technology. It really is limitless for us to be able to go on the Internet very quickly and find a clip of something or a sound bite. It really gets the students involved within the classroom whether it is personally, emotionally, or that they are actually using the history with technology. I think technology is hugely important for the classroom.

Field trips have traditionally played a role in students' education, but with the costs of trips increasing and the fear for students' safety ever-present in people's minds, Shea had found the ability to go on "virtual" field trips as a great enhancement to the students' classroom experience. For her Anthropology class, Shea accessed online digs from all over the world or had her students watch video clips from submersible cameras that captured digs under the sea.

The teachers also found that technology had equally helped students. Judy stated, "having the databases to use that the school subscribes to makes research for the kids so much easier." She also believed that technology made school more "interesting, fun, and convenient…It connects me to my students in a way that is easy for both of us" through the use of e-mail and the Web site. Sean found it to be "pretty neat" to be able to use Study Wiz for some of his online quizzes and tests.

E-mail and instant messaging had also opened up a new avenue of communication between teachers, students, and parents. The ease of asking teachers questions by chatting online or via e-mail gave students access never available before. Hagan found this to be a convenience as well when communicating with parents. When asked what types of technology she used for educational purposes she replied, "Obviously e-mail so I can send lesson plans to some concerned parents so that they have the assignments."

Hagan also found e-mail a convenient way to submit an assignment. Students in her classes could "e-mail [assignments] to me or they can hand it in." If the students decided to e-mail the assignment, Hagan would "grade it on Word and then print it out" by inserting comments or highlighting passages.

Technology was also used as a time saver and tool that made life easier. Patricia believed that she had saved time and relieved students of boredom with her use of technology in class. She said,

> It actually saves time in the classroom. I get through more if I am using my InterWrite tablet or things like that. I am getting through more curriculum and I think the kids get more out of it than if I was on the board the whole time putting up problems.

Maggie, also at Lincoln High School, thought teachers "can go more in depth and conquer a topic on a higher level because of technology. Because [the students] can see

more of things that you couldn't just see in a classroom and experience more things virtually."

To summarize how a new generation of teachers was thinking, Christine shared that she began teaching with technology and did not know any other way. She never wrote in a lesson plan book and had only kept her plans on the computer. In fact, she stated, "I have always worked with computers so that is just how I have always organized everything in my life."

*Increased Motivation*

Through the interviews, observations, and submitted material, the teachers indicated and demonstrated that incorporating technology into assignments and class lessons increased their own interest and motivation and made their students want to learn more. If for no other reason, technology offered a little variety and a change of pace to a schedule often dominated by a traditional pedagogical approach.

Christine was "blown away" by what the students could produce when they used various software products for writing assignments. Students produced creative and professional presentations rather than collages on posterboard (Cuban, 2001). She described the student output of work for her class with a parent comparison,

> It is kind of like hiding vegetables in food to give to little kids. [The students] know that they are writing a really good paper and doing really good research but they think that they are just making a fun video...So sometimes that is really nice that I can sneak [a project] in there and they are learning.

Maggie found that technology helped her less motivated students (Cuban, 2001; Reynolds, Treharne & Tripp, 2003). Many times she found these students "like doing projects or expressing themselves differently because that's where they shine…they are actively in charge of their education." Christine believed the key to student motivation

was choice. “Student ownership in the creation of their own project facilitates independence and ownership and provides them a sense of control over their own learning” (Goddard, 2002, p. 24). She often gave the students a choice of using Keynote as a visual aid, creating a podcast, or using iMovie when completing projects, and was very pleased with the results.

Increasing student motivation was important to the teachers. “Teaching in the traditional way works,” according to Beth Ann, but she felt it was important to have her students publish their work in a different way by posting their finished products on a Web site. She said, “It’s really important for me to infuse variety into the instruction of the curriculum to keep [the students] on their toes, keep them interested, and keep pushing them to do other things rather than the same old program or mode of operating every day.”

Another way Beth Ann found effective for students to become more motivated was to have them create their own blogs. As opposed to writing a personal essay and placing it in a physical folder, she believed it was “more of a way for the students to respond personally and have his or her own space to do that.” She got a “high” when her students were actually reading and writing in class. She felt she had set higher goals because she required her students to work with technology. She commented, “Sometimes I have to stop myself and say that this is actually really good. You have really high goals but the fact that your students are reading the *New York Times* about a war somewhere and writing a response is something good that you did.”

All of the teachers tried to find different approaches to reach the students and engage them in their lessons. Christine used Get a Clue to assist her students in studying vocabulary. Contrary to the traditional way of looking up the definition of a word and

then use it in a sentence, her students learned their vocabulary through this interactive video game application. She found this software very useful for the less motivated students. This lesson illustrated one way that technology helped teachers create more diverse lessons that were more multimodal.

Technology helped Christine achieve her educational goals by enhancing what she wanted the students to learn. In her estimation, many of her English "students are reluctant readers and writers." To better differentiate instruction, she offered her students different kinds of assessments and activities other than the typical paper and pencil format. This allowed them "to learn and be somehow interested and engaged…[and] it allow[ed] me to get to every student, which is definitely one of my main goals."

From a teacher's point of view, Hagan believed that high school classes are more interesting today because of technology. To this point, she tried "to bring in as much enthusiasm and as much interest into the class as I can using technology." This was observed with her creation of the iMovie regarding the war in Iraq. She believed that technology, such as iMovies, PowerPoint, and Word, reinforced and enhanced what was learned in class. She said, "We'll take notes one day and then we'll reinforce this by using some of this technology." When asked whether students were researching more on their own, Hagan responded that the students would "go onto the Internet at home and say, 'Guess what I'm learning.' Because you know I might have said it to them in class, I might have taught it to them. But then I reinforce it. It triggers something within them. I think they get excited about it."

*Environmental Consciousness*

Several times throughout the interview process, the teachers brought up the fact that one of the consequences of using technology was that they were environmentally

conscious and trying to cut down on the waste of paper. This attempt to reduce waste was intrinsically motivated by an awareness of global concerns. Shea encouraged her students to cut and paste assignments into e-mail and send them to her "instead of wasting all that paper." Hagan felt the same and reflected that having the postings online for students to print out on their own if they wished was a more "environmentally friendly" approach. She posted many assignments, notes, and PowerPoint slides on Study Wiz for her students to access. Christine used her students' access to their laptops to reduce paper waste. Students were expected to download information from her Web site instead of receiving handouts. Beth Ann wished all her students had laptops like at Washington. "I would love it if the students had their own laptops so they could take notes on them and I wouldn't have to hand out so much paper all the time."

Along this same line of thinking, Shea approached the use of e-mail from an environmental angle. She had students cut and paste assignments in an e-mail and send them to her "instead of wasting all that paper." Similarly, Christine posted all her class schedules, handouts, and project due dates on her Web site not only for better communication but also so she did not use a lot of paper.

## Perceived Frustrations of Technology Use

Along with the benefits that accompanied technology there were also frustrations that teachers perceived. Analogous to Cuban et al.'s (2001) findings, teachers were constantly frustrated by the lack of time they had to prepare for their classes, the lack of access to the technology or Internet, and technical problems when using the software and hardware. Each school did invest in their teachers by giving them release time or paid for professional development, however, with all of the responsibilities upon a teacher's shoulders such as lesson preparation, grading, and student and parent meetings, the

teachers felt that they could always benefit from more time to "sit and play" and work toward creating "ideal" lessons (Hernandez-Ramos, 2005). In addition, teachers were frustrated by the misleading information on the Internet and the ease of student plagiarism. The successful implementation of technology into the student learning environment depended upon time, student independence, open-minded and flexible teachers, and how well the teacher, students, task, process, and context interact with each other (Liu, 2003)

*Lack of Time*

The biggest enemy of teachers incorporating more technology into the curriculum was time. "Teachers do not have the time to find and evaluate software" (Cuban et al., 2001, p. 826). Since the teachers were educators in their subject field first, they readily admitted they lacked an expertise in technology. The teachers stated that they did not know what was out there nor did they have the time to fully investigate or experiment how they could incorporate technology into their lessons (Cuban, 2001). For example, Hagan spent a couple of hours creating a five-minute iMovie for her class. "[T]ime is essential in becoming a technology using teacher, but also…technology use may predict time commitment to teaching" (Vannatta & Fordham, 2004, p. 261).

Shea had not found too many limitations to using technology "except my own not using it as much as I wanted." It was mostly a time factor that she felt limited her from developing great ideas for her lessons. Her frustration came from knowing that other people were doing wonderful things with technology and not having the time to further develop her lessons because of having to cover the curriculum. Patricia felt the same way,

> I still don't know all the functions and everything I can do with [the InterWrite tablet]. I think I use it on a very basic level. It does its job for what I want it to do and I'm sure I could do a lot more. I just haven't had the time to learn.

Robyn felt that if the lesson could be taught effectively without technology then, although it may be exciting, it was not necessary as an integral part of the lesson. She admitted that maybe she had only scraped the surface of using technology in class but by adding "a bell and whistle" to a lesson may only engage the students a few times and if it was not working within the first few minutes of class "you've lost their interest." Therefore, technology could be a "hindrance." However, she continued, "it can enhance instruction but I think it takes teachers a lot of time in preparation to use technology in meaningful ways."

Whether it was to set up a lesson or plan for one time was always a factor. Unfortunately, Christine felt the *Hamlet* podcast project required much class time to complete the assignment. To record the group voices for the podcast properly without any background noise she allowed students to go to the media center or stairwell to record in a quiet place. This solution, while not ideal, was the only one she had for now. Previously, she had her students try to record their podcast separately and then combine them into one project but that option ended in a "nightmare" when the students tried to cut and paste their voices in the correct sequence and appropriate areas. It became a logistical problem that required more student time than Christine thought the project warranted.

Maggie wished she had more time to "play and experiment to put things together. I mean I spend a lot of time putting things together and it is just time consuming and you don't always have time for it all." So instead of writing a personal essay, Beth Ann gave her students the option to create video and audio clips for students who were interested. She said, "I thought this would be a great way to pilot [the concept] this year and

depending on how they do or what I learn I can maybe roll it out much more [and] you know, integrate it more with my teaching next year."

*Lack of Access*

Judy used the computer carts for her classes quite often. However, as observed during her class, many times the students could not log on to the laptop computers or they simply were not working properly. When asked how these problems were overcome she replied, "They're not. You just have to grin and bear it and complain. It is really frustrating." The alternative, to go to one of the computer labs, was not always feasible because, "they are shared by everybody in the school and it only has twenty-two computers for my twenty-five students…One of my biggest sources of frustration is getting technology and having technology that works effectively."

Beth Ann echoed her colleague's frustration regarding the use of computer labs. She said, "We often have a hard time getting use of the desktops because so many teachers want to use them." As observed in one of Robyn's lessons,

> Two attempts were made to procure a technology lab but they were unavailable. Robyn had to adjust her original lesson plan to a chalk and talk about the project. She showed the students different Web sites of interest, i.e. a bbc.com Web site for pictures and current events regarding President Obama's visit to Mexico. The students were moved into groups of three to discuss different topics with no technology being used this period.

This lack of technological infrastructure, e.g., shortage of computer access–influenced the implementation and effectiveness of the project (Zhao et al., 2002).

Although Judy's room was equipped with a widescreen TV, computer, and video projector, she still found it inconvenient to use technology in "this great new classroom." The problem stemmed from the fact that her desktop computer could not run the equipment in the room. She needed to go into the classroom closet and "play all these

games to be able to control the technology." She commented that it was really frustrating "when you mess around for ten minutes and [the technology] still doesn't work and then you've lost [the students'] interest."

Access to the server or Internet was also an inconvenience. Beth Ann commented on how her students had storage issues on the server when they created digital stories for her class. In fact, at Roosevelt High School, the server was down for two days prior to the researcher's observation, which caused Beth Ann to rush and make photocopies of the assignments for the students and modify her lesson "on the spot." She lamented, "The worst is when you have an assignment you need the network for and you don't have access to it." Hagan agreed. "Sometimes for some reasons students can't access the Internet. Sometimes they can't access [certain] words…You never have a time when everything goes smoothly with technology and that's frustrating, very frustrating."

Technical glitches or problems accessing the Internet seemed to occur frequently. As observed in Patricia's math class, one student exclaimed that his laptop was not working. To rectify the situation, Patricia handed the student paper copies of the assignment. Remembering back to the first two years of the laptop rollout to all teachers and students, Maggie stated that it "was a painful couple of years starting up" but most of the issues surrounding integrating technology have been worked out by now. In fact, many of the upperclassmen are experienced enough "to organize their own folders of schoolwork and troubleshoot issues that come up and fix problems on their own."

One problem with having many computers and the software on them was trying to keep the machines up to date and working properly. Beth Ann was upset with the laptops on the cart not always being updated and working slowly, which caused issues with her lessons. She guessed, "The machines maybe are not getting all the proper software

updates that they need. We have trouble logging on and logging off. Stuff like that can really slow down the [teaching and learning] process."

Zhao et al. (2002) found that projects that were distant from existing technological resources would end in failure. Likewise, the previous year, Hagan had an experience that left her exasperated. She was encouraged by her supervisor and others to conduct a lesson on podcasts. After the lesson was set up, a technical support staff member brought in for help, and the students psyched up for this new venture, she was "dumbfounded" to find out the computer labs did not have the software to create podcasts. Not unlike Christine, she said she did not mind switching to Plan B when there were problems, but was frustrated when precious class and student time was wasted when it could have been avoided. To summarize the exasperation experienced by the teachers, Christine simply stated, "It was a major bummer when we had a full Internet-based lesson planned and then it is not working." In fact, Sean felt that "technology was unreliable. Therefore, I need to doubly prepare for class and this takes more time."

*Technology Problems*

To make technology work there were many components and services that needed to be in place. The biggest worry of all participants was having their computer crash and lose all the stored data. Beyond computer crashes, teachers were equally frustrated by the computers and Internet not being fast enough. The last technology problems experienced by all were issues associated with incorporating the various software systems used. These issues, such as not having the correct software on the computers and not having enough memory for storage of the finished products, caused much frustration and forced the users to find a work-around or abandon the software altogether.

Although the teachers seemed to be very self-reliant when it came to incorporating technology into their lessons they did depend on others or on technological resources. As a result, the success of a lesson depended upon others (Zhao et al., 2002). Hagan commented how the "biggest problem is time when trying to get students to do or use technology…because programs are not working or the Internet is down." These types of problems caused a high level of frustration for the most technology-willing teachers and was a major reason why Robyn believed other teachers had not incorporated technology into their lessons. The teachers thought of themselves as content specialists who should not have to take time out of the already limited school year and sacrifice curriculum time to teach software applications to students and offer technology support. Hagan lamented, "I have to take time out of the classroom to teach them [software], which is not what I think a Social Studies teacher should be doing. But we have to do it if [the students] are going to complete a project. So we have to teach them."

Judy experienced this same frustration when one of her classes was observed. The observation read as follows,

> The class went to the Dell computer cart for laptops to begin work at their desks. It took at least ten minutes for some students to log on which resulted in lost instructional time. Some students had to reboot several times and some had to leave class to have their account reset by the technology department so they could access their files for class. The students whose computers were not working had to double up on a classmate's computer. During the remaining fifteen minutes, the class finally settled down to work on their projects. Judy told the class she will need to find a computer lab tomorrow to continue the project. Many students may have to complete work on their own.

Problems like this were especially true when Lincoln's servers could not handle the size of student files. A few years ago, teachers started piloting projects through digital storytelling. A digital story is when students use a software program such as Movie Maker to tell a story about their assigned project through video clips, sound, and recorded

voices. After students began working on their projects it was discovered that the school could not store all the student work since the school's servers were not large enough to save the projects. This left the teachers and students very upset and frustrated. Since that time the server issues had been fixed. For problems like these to be solved, schools need to develop a strong human infrastructure, such as technology support staff, that can assist the teachers to fix these issues (Zhao et al., 2002).

Shea and Hagan indicated that their students were lacking in technology skills. For example, when Hagan helped her students in the computer lab when they were working on an in-class project she noticed, "They'll have the simplest questions that I learned in high school and they'll say…'How do I do this?' and it's just…click, click, click and it's done and it's over. To me they should already know how to do that." When asked what skills her students were coming to school with, Hagan replied that they know the basics of Word, e-mail, instant messaging, and downloading music but they have not been pushed to the next level.

Sean admitted, "Students will always be ahead of the curve in terms of knowing what technology is out there in terms of being tech savvy…[but] do they know how to use it so that they learn from it or how to learn about a particular subject?…I don't think so." Christine even saw a decline in her students' grammar as a result of instant messaging and e-mail. She said, "their essays, my goodness, it's just conversation talk in their essays…I can't believe how many times I have to correct children on their capitalization. They don't capitalize anymore."

*Security*

The ideal situation for Judy was to be able to walk from group to group to monitor an in-class assignment. However, since students had to each get their own laptop from the

computer cart, boot up the machine, and log on correctly, Judy felt, "there has to be pretty much constant supervision." She reflected that it was "very frustrating to police the kids from being on the Internet and from playing games. They're supposed to be working, so that's frustrating because I hate being a policeman. I hate being a babysitter." In an observed lesson, Beth Ann was confronted with the issue of her students not being able to connect to the wireless system and some of the laptops not being fully charged after use by the previous class. She commented that she did not have time to "monitor all the machines every day to ensure they were up and running. I have many other responsibilities during the day."

Teaching the students what were reliable sources and Web sites had become part of the job. Because there were so many Web sites and many looked legitimate, it was difficult to differentiate between informative sites and those that may have misleading or wrong information. To address this problem, Shea previewed Web sites in advance to determine if they were credible. She said, "If I have them search for things, it's more of a guided search. I will tell them to go to a certain site…I don't like having them go on their own and search." Therefore, she suggested for her students to access NPR, PBS, and certain university Web sites. Christine had her students fill out an evaluation form to determine if a Web site was reliable. This was determined by the extension of .org or .edu after the name or whether a Web site had a posted author.

Cheating and plagiarism are problems that have plagued education, and technology only makes it easier and more convenient. Shea stated, "The cheating is rampant because it is so easy." To combat this problem, each of the three schools subscribed to Turnitin. Prior to submitting their papers, students were required to enter their work into the antiplagiarism software to determine whether their work was correctly

cited. Passages found from other sources were highlighted by the software. If these passages were not cited, the teacher would then determine whether the passage was plagiarized. Teachers also "Googled" words or passages to determine their authenticity. For this process, a teacher would enter a few words or sentences into the Google search prompt. Web sources with the entered words would then be listed. The teacher would then determine whether the words were plagiarized. Judy was up front with her students,

> I don't lie to them. They post their papers themselves. They have to have an account with turnitin.com. They're responsible for electronically submitting the paper, so they know from the word "go" this is what's going to happen and I still catch kids every year just totally plagiarizing. It's very sad.

# CHAPTER V

# DISCUSSION

Technology has been infused into education throughout the world. Many previous studies focused on the incorporation of this technology or tested the results of computers as related to a specific task (Culbertson et al., 2004; Wallace, 2004). However, "merely introducing technology to the educational process is not enough. The question of what teachers need to know in order to appropriately incorporate technology into their teaching" (Mishra & Koehler, 2006, p. 1018) was an area lacking in the literature and one that needed investigation. In addition and more important, "Our primary focus should be on studying how the technology is used… [because] most educational technology research consists of case studies, examples of best practices, or implementations of new pedagogical tools" (Mishra & Koehler, 2006, p. 1018). While the findings confirm what others have previously said, this study used a different methodology to describe what is happening in the classrooms. A focus of this study was to provide "detailed examples of some best practices, and the design of new tools for learning [that] are important for building understanding" (Mishra & Koehler, 2006, p. 1018).

The findings do indicate that innovators and early adopters, or "mavericks" as Cuban (2001) also called them, were using technology and having their students use technology to further their goals. There were pressures both at the school and global level that pushed the teachers to stay current with the technology and alter their pedagogy. The administrators applied a blend of pressure and encouragement to help facilitate the early

adopters' incorporation of technology in their classes. They used a constructivist approach to teaching and modified their lessons and requirements of the students to reflect this. Becker (2000) found that teachers "who use most types of software on a frequent basis have consistently more constructivist philosophies than the average teacher" (p. 18). Finally, they continued to incorporate technology into their lessons because the perceived benefits outweighed all the frustrations and setbacks.

## Factors for Adopting Technology

Over the years, the majority of teachers were not afraid to incorporate new technologies into their classrooms. Overhead projectors, periodic tables, typewriters, and videocassette recorders were all types of technologies that teachers in general found ways to incorporate into their classroom instruction. Most of these technologies were not even regarded as such because they were so commonplace (Mishra & Koehler, 2006). Technology today refers to hardware, software, and digital tools that require teachers to learn how to apply them to teaching (Mishra & Koehler, 2006). "These new technologies have changed the nature of the classroom or have the potential to do so" (Mishra & Koehler, 2006, p. 1023). However,

> An entire organization does not change until each member has…the rate of making the change and of developing skill and competence in using it will vary individually. Some people will grasp the new way immediately, while most will need some additional time, and a few will avoid making the change for a very long time. (Hall & Hord, 2006, p. 7)

Cuban (2001) concluded that computers in the classroom have been oversold by promoters and policymakers and underused by teachers and students. He believed that spending our limited educational funds to sustain technology would not bring us closer to our goals. Nonetheless, although schools are very stable institutions, they should change somewhat to reflect the changes in society. Yet, "technological changes take far longer to

implement in formal education than in businesses because schools are citizen-controlled and nonprofit" (Cuban, 2001, p. 153). However, schools that incorporate societal legitimated rationalized elements–e.g., technology–in their formal structures maximize their legitimacy and increase their resource and survival capabilities (Meyer & Rowan, 1977). For example, Washington High School believed that the expensive investment of giving every teacher and student a laptop was the cost of doing business to prepare the students for college and beyond. The community supported this stance and, therefore, the costs were absorbed into the annual operating budget.

Cuban (2001) stated that a teacher's beliefs and attitudes factored into technology use. Teaching is a difficult profession and "teachers at all levels have to manage groups in a classroom while creating individual personal relationships; they have to cover academic content while cultivating depth of understanding in each student; they have to socialize students to abide by certain community values, while nurturing creative and independent thought" (Cuban, 2001, p. 167). For technology to be of use to teachers it must be integral to helping them achieve their teaching goals and reduce the expenditure of a teacher's time and energy (Cuban, 2001).

The teachers in this study all accepted and embraced the infusion of technology into their practice. In fact, they were constantly trying to find new ways to challenge their students and incorporate the latest software into their assignments. Because change is a process and not an event, and it takes three to five years to implement new practices to a high level (Rogers, 2003), the teachers were still in the transformation stage of incorporating technology into their lessons.

The teachers interviewed and observed were the innovators and early adopters of the school. They fell into these two combined categories, typically 16 percent of the

population, because they were more venturesome, integrated into the social system in the school, looked to by others for advice and information about an innovation, usually considered by others to be the individual to check with before adopting a new idea, and were not too far ahead of the average individual in the school regarding innovativeness (Rogers, 2003). These teachers displayed great empathy with the ability to project himself or herself into the role of the student and were able to adopt a new idea largely on the basis of rather abstract concepts and use the most effective means to accomplish their objectives (Rogers, 2003). They were at times the very first to adopt an innovation in the school, were always looking for new ideas, and were ready to try them. Patricia, the only teacher in the study and her school to incorporate the InterWrite tablet into her lessons, was a good example of being the first to innovate. The early adopters also tended to see themselves as having control over their destiny rather than being the victim of circumstances (Hall & Hord, 2006). Finally, they had a more favorable attitude towards change and were able to cope with uncertainty and risk (Rogers, 2003).

The traditional view of teaching was that the content to be taught dictated which pedagogical goals and technologies would be used (Mishra & Koehler, 2006). However, new technologies, such as the Internet, drove the decisions teachers made when deciding about content and pedagogy (Mishra & Koehler, 2006). Incorporating technology into lessons forced an educator to rethink and possibly reconfigure the relationship between content, pedagogy, and technology (Mishra & Koehler, 2006).

The difficulty and complexity of incorporating technology into schools and a teacher's pedagogy was that

> Innovations are not usually singular but rather bundles of innovations...the integrated use of technology in the curriculum and instruction might entail the use of word processing, spreadsheets, e-mail, laptops…each an innovation with its

> own requirements for implementation, training, and user supports. (Hall & Hord, 2006, p. 5)

Many of the frustrations felt by teachers were because the innovations came in bundles. As observed in Judy's lesson, the lesson did not come off as planned because some students were not able to log onto the laptops, some computers were not charged properly, and some students had to leave for the technology department to get their password restored while Judy was trying to troubleshoot the other laptops. On the positive side, Hagan's lesson of the creation of a Wiki WebQuest was an example of 21st century and higher-order thinking skills in action. For this lesson, the technology skills were bundled when the students needed to work collaboratively within a group, search legitimate Internet sites and find relevant information, make decisions on what was to be published on their site, and know how to use Word and Wiki software.

Cuban (2001) found two main reasons why teachers sustain old teaching practices and not innovate. First, time was not available to find relevant software and applications, judge its worth, and try out the products in classrooms; second, the training in relevant software and applications was seldom offered at the times they were needed. Therefore, professional development was key to successfully integrating technology into classroom lessons.

Despite each school's heavy investment in technology, not all teachers embraced the new technologies for a range of reasons, including a fear of change and lack of time and support (Mishra & Koehler, 2006). Traditionally, teachers attended workshops or sat through professional-development days to learn technology or other such topics. It was then incumbent upon them to find ways to incorporate this newfound information into their lessons. Mishra and Koehler (2006) argued that these traditional types of

professional development were ill-suited to produce deep understanding on how to incorporate technology into a teacher's pedagogy due to (a) the rapid rate of technology change, inappropriate design of software for educational purposes, the situated nature of learning by subject and grade level; and (b) an emphasis on technology skills and not on how to achieve or use these skills for education. "[M]erely knowing how to use technology is not the same as knowing how to teach with it" (Mishra & Koehler, 2006, p. 1033).

Although each one of the teachers in the study attended professional development for some type of technology at one time or another, most of their learning, inspiration, and acquiring of technological skills was the result of trial and error and networking. But to succeed with the trial-and-error method takes time. Time seemed to be one of the biggest issues with the teachers. Robyn summed it up by stating that she "just needed more play time."

Each school made a considerable investment into professional development of the teachers and as with Roosevelt High School, hired a dedicated staff member whose job responsibility was to assist teachers with their technology integration. "In order for change to be successful, an implementation bridge is necessary. Each member of the organization has to move across the bridge. As they change their practices, there should be changes in outcomes" (Hall & Hord, 2006, p. 10). Consistent professional development was that bridge.

Each one of the schools involved in the study had a strategic plan for change. As in the case of Roosevelt and Washington, the school system decided in a singular event to purchase laptops–Roosevelt for teachers only and Washington for teachers and students. However, each of the three schools over several years budgeted the necessary resources

for support and collected data to make adjustments to the plan to better inform future decisions during the implementation phase (Hall & Hord, 2006).

## Technology Integration

> When the entire staff is involved in investigating its own performance, it is highly probable that the staff will give more commitment to changes intended to correct a distressful situation. An external impetus can be effective in promoting change in an organization, if the leaders of the organization seize the opportunity and bring the external idea home in such a way that makes sense to the organizational members. (Hall & Hord, 2006, p. 276)

Although the teachers did not feel as though there were any mandates, partly because they embraced the changes of technology being thrust upon them, there were. Whether it was directly issuing laptops to teachers and expecting them to be used in the classroom, or indirectly offering technology professional-development opportunities to influence classroom practice, the teachers did have to use technology at each school, such as laptops at Washington, Study Wiz at Roosevelt, and online grading at Lincoln. Therefore, the teachers were technically forced to "adapt the new technology and buil[d] their goals and procedures for adoption as school rules" (Myer & Rowan, 1977, p. 348) and classroom policies and procedures. After the school or teacher made the decision to incorporate a certain technology, teachers had to learn all the steps and actions on how to use the software or hardware and then create, test, and package the lesson (Hall & Hord, 2006).

> The beliefs and values that teachers hold drive many of the choices they make in the classroom. The satisfaction they gain from student learning and the interpersonal relations that grow daily are high on most teachers' lists. In a 1996 national poll, for example, 76 percent of teachers said that it is essential for students to display "curiosity and a love of learning." (Hall & Hord, 2006, p. 169)

Two of the main reasons the teachers embraced and incorporated technology into their pedagogy was to create this curiosity and love of learning in their classroom and "help

make subject matter more accessible to the learner" (Mishra & Koehler, 2006, p. 1023). The difficulty with using technology was that unlike previous stable technologies such as movie projectors, newer digital technologies required teachers to learn new techniques and skills as previous versions became obsolete (Mishra & Koehler, 2006). As a result, "knowledge of technology [nowadays] becomes an important aspect of overall teacher knowledge" (Mishra & Koehler, 2006, p. 1024).

Teachers have always struggled with striking the balance of instructional depth and content coverage. "These decisions have a ripple effect by defining, or in other ways, constraining, instructional moves and other pedagogical decisions" (Mishra & Koehler, 2006, p. 1025). As a result, Mishra and Koehler proposed a new conceptual framework for educational technology. Their "framework emphasizes the connections, interactions, affordances, and constraints between and among content, pedagogy, and technology" (Mishra & Koehler, 2006, p. 1025). The observed teachers continually agonized over balancing content, pedagogy, and technology because, as Mishra and Koehler believed, there was a complex interplay between these three bodies of knowledge that cannot be treated separately.

As voiced through the interviews and seen in the observations, the difficulty for teachers with this interplay continually occurred. Mishra and Koehler (2006) stated that their "model of technology integration in teaching and learning argues that developing good content requires a thoughtful interweaving of all three key sources of knowledge: technology, pedagogy, and content" (p. 1029). The teachers in this study continually overcame this struggle to varying degrees because of their professionalism and personal desire to get better at their craft and provide the optimal experience for their students. The types of quality teaching observed were the result of the teachers having a "nuanced

understanding of the complex relationships between technology, content, and pedagogy, and using this understanding to develop appropriate, context-specific strategies and representations" (Mishra & Koehler, 2006, p. 1029).

Teachers "still exert substantial discretionary authority in their classrooms" (Cuban, 2001, p. 167). They were the gatekeepers of knowledge to be disseminated and decided which best instructional tools met their goals for learning (Cuban, 2001). Yet, when "teachers adopt technological innovations, these changes typically maintain rather than alter existing classroom practices" (Cuban, 2001, p. 71). Cuban's findings were not surprising. They actually paralleled most new technologies in society, such as the introduction of radio or television. It was only over time that a new medium developed its own language and transformed society and, in this case, education (Hokanson & Hooper, 2000).

One of Cuban's (2001) concluding statements was that there was no consensus on what digital literacy was with the schools he visited. Although a consensus among teachers had not been reached, the teachers observed in this study taught the computer skills they thought were interesting and necessary for students to know and learn. These skills were all similar and along the lines of 21st century learning. In addition, although no real set of computer skills was required, once the students knew one software package they easily picked another one up with very little time devoted to teaching basics.

Cuban (2001) further stated that schools cannot claim full credit for growing student technological literacy when so many students picked up computer knowledge and skills at home and in part-time jobs. While this may be true, many of the skills the students exhibited to the teachers were limited to e-mail, texting, and such. Consequently, the teachers felt they needed to teach their students additional skills, such as how to

search the Web and find reliable sources. The teacher assignments pushed the students beyond the basics of Word, PowerPoint, and other software and introduced them to new software or capabilities that expanded their horizons. These assignments taught the students adaptability and gave them a base and ability to figure out problems and learn new software (Cuban, 2001).

The issue of whether the costs associated with incorporating technology in schools were producing results to justify the expenditures revolved around what results parents were seeing for their investment. Cuban (2001) argued that there had not been a "technological revolution in teaching and learning in vast majority of American classrooms, teachers [we]re infrequent and limited users of the new technologies for classroom instruction" (p. 178). His research reflected that technology was mostly used for student database managements such as grades, communication of e-mails, preparing and delivering lectures, and Web sites for homework, and not as much project-based teaching and learning. While this may be true for many teachers across the country, the lessons observed in this study had the students as the primary researchers of their own knowledge, working collaboratively on projects, using multiple software packages to produce a project and then deliver it. The students were actively engaged and enjoying their learning through rigorous and relevant lessons.

According to the history-and-contexts explanation, school structures and historical legacies, stressing overall stability in teaching practices, carried so much weight that unless changed, they would retard widespread use of technology and hinder substantial changes in classroom practices (Cuban, 2001). The history-and-contexts explanation challenges the slow-revolution assumption.

According to the slow-revolution explanation, small changes accumulating steadily will create a gradual transformation in how teachers teach. Therefore, "It is premature to call the investment in computers in schools a failure because of lack of evidence for increased productivity and transformed teaching and learning" (Cuban, 2001, p. 179). It is extremely difficult to systematically reform schools as a whole (Zhao & Frank, n.d.). "[I]nnovations cannot be implemented oblivious to the internal social structures of schools or other pressures schools must face…Thus we suggest an evolutionary rather than revolutionary approach to school change" (Zhao & Frank, n.d., p. 48).

The schools visited had a high DFG and were early adopters in regards to including technology. As a result, in support of the slow-revolution explanation, these schools had, over the past several years, tried to speed up the process of making computers readily available to students in each classroom, invested in more online curriculum and distance learning, and added more professional development to incorporate technology in the classroom. They had challenged the norms and traditional teaching practices and made wholesale changes in the way teachers delivered their content. "Without such major changes in the basic structures and processes that have influenced both urban and suburban teaching practices for many decades, only minor alterations in classroom practice will occur, no matter how much money is sunk into information technology" (Cuban, 2001, p. 181). In short, the schools in this study had accelerated the change.

## Technology Utilization

"Diffusion is the process in which an innovation is communicated through certain channels over time among the members of a social system" (Rogers, 2003, p. 5). The

focus of technology in the schools had brought about a kind of social change. The Districts' investment in the software and hardware was deliberate, while technology's absorption into the daily classroom lessons had sometimes been planned by the teachers but was often times spontaneous. The best prospect for technology to be accepted and effectively used was when teachers could model and imitate other colleagues who had previously adopted the technology in their practice (Rogers, 2003). When she looked for new ideas for a lesson, the first thing Judy did was "go to the Internet and search for lesson plans to see what others have done and pick up ideas. Of course I share them with my colleagues and then it just grows."

Once the investment of technology was made at the schools, each teacher had to go through the five stages of the innovation-decision process: knowledge–exposure to the innovation's existence and gaining an understanding of how it functions; persuasion–forming a favorable or unfavorable attitude toward the innovation; decision–engaging in activities that lead to a choice to adopt or reject the innovation; implementation–putting the innovation into use; and confirmation–seeking reinforcement for a decision already made but may reverse the decision if exposed to conflicting messages about it (Rogers, 2003).

As an example of this process, Judy stated that she would not be using Wikis and blogs in her classes yet. She said, "my colleagues in the English department are using those and they like it. It's definitely something I need to learn more about before I use, but I would be happy to use them." Only after listening to other teachers did she gain knowledge about the software programs, form a favorable opinion about incorporating them into her classes, and decide that this was something to implement. She stopped short of the fourth stage, actually implementing blogs and Wikis, because of time constraints.

Similarly, Beth Ann also had not incorporated blogs or digital storytelling into the class setting but would have liked to. She commented, "I haven't really assigned a blog assignment yet but I made it an option." After demonstrating a blogging Web site, Beth Ann allowed her students to use this type of source to complete the assignment. Her knowledge of blogs as well as digital storytelling came from a recent professional-development workshop, however, she too had stopped just short of the implementation phase, which will most likely happen next year. Beth Ann said, "I am just trying anything that I can. Anything that I have heard positive things about I try to put on my list of things to do and try out." Shea would agree. She liked to "experiment and see what others were doing and would get excited to try them because it made me a better teacher."

Mishra and Koehler (2006) believed that the best approach for teachers, and in turn students, to learn technology was by design. Teachers needed to be immersed in their content area using relevant technology to solve their problem. Many of the lessons observed throughout this study had the students investigating or working with data that they were finding. The design-based activities led to many project-based learning lessons. The lessons typically involved the students working in collaborative groups to use technology for researching, designing, and presenting products that (Mishra & Koehler, 2006) solved authentic and engaging real-world problems. The teachers had to make appropriate choices for each lesson because "not every topic can be shoehorned into any technology and, correspondingly, any given technology is not necessarily appropriate for every topic" (Mishra & Koehler, 2006, p. 1040). The teachers had to resolve "contradictions and tensions by looking at all the components that played into their design. They have to weigh alternatives and make decisions factoring the differential effects of their choices" (Mishra & Koehler, 2006, p. 1040).

In general, a teacher would ask germane questions as to how the technology would be incorporated into their current teaching practice as well as the consequences, advantages, and disadvantages. Teachers would change their pedagogy when they believed there was a relative advantage over their current practice. When a change, such as incorporating technology into the classroom, was perceived as providing greater outcomes, profits, or consequences when compared to what was currently being done, teachers would incorporate this change into their lessons (Hall & Hord, 2006). For a teacher to begin using a technological innovation it usually had to have some degree of benefit. However, the potential adopters were not always clear about the advantages and were seldom certain that the innovation represented a superior alternative to the previous practice that it would replace at least when they initially learned about it (Hall & Hord, 2006). Therefore, it was the potential advantage the new technology offered that impelled an individual to exert effort to learn more about the innovation (Hall & Hord, 2006).

"In the past, the implicit assumption was that initial training plus materials equaled use" (Hall & Hord, 2006, p. 159). Research and practice have shown this is not true (Hall & Hord, 2006). The real question regarding technology integration was not whether a teacher was using technology in the classroom but how that teacher was using it. Teachers would adopt innovations into their teaching based on their perception of the following five criteria: relative advantage–the degree to which an innovation was perceived as better than the idea it superseded; compatibility–how compatible the innovation was with the teacher's values, needs, and concerns; complexity–very complex innovations would be adopted more slowly; trialability–the easier the innovation was to try out increased its adoptability; and observability–innovations seen in use with visible results were more favorably adopted (Hall & Hord, 2006). In particular, the teacher

would adopt the new technology faster if there was a perceived greater relative advantage and compatibility to their existing practice. “The change or innovation can be characterized by either products such as computers, curriculum texts…or processes such as constructivist teaching techniques (Hall & Hord, 2006, p. 8).

In Cuban’s (2001) research, he found that “most teachers continue to see the computer as an add-on rather than as a technology integral to their classroom content and instruction” (p. 164). This, however, was not true with the teachers observed and interviewed for this study. It was true that the teachers always needed a backup plan and were frustrated by technical problems and limitations, but these problems did not dissuade them from continually trying to improve their pedagogy and incorporate technology into their lessons. Cuban (2001) further suggested that technology used in schools was originally sold to businesses and was very complex to use and learn. He continued that the teachers only used a fraction of the total software package’s offerings. All of the teachers in this study would agree with this statement, however, many of the software packages used by the teachers and students were simple enough to use and the extra components were not necessary for completion of the task or assignment. In fact, Beth Ann learned how to use a Wiki the period before she introduced it to the class for their assignment.

These early adopters welcomed computers with open arms because they sensed that computers fit their pedagogical beliefs about student learning and would add to the psychic rewards of teaching (Cuban, 2001). As observed in this study, although the early adopters used computers to support existing ways, they also embraced the new technologies and saw them as tools for advancing their student-centered agenda in transforming their classrooms into places where students could actively learn (Cuban,

2001). The early adopters found in Cuban's (2001) and this study organized their classes differently, lectured less, relied more on securing information from sources other than textbooks, gave students more independence, and acted more like a coach than a performer on the stage. Technology was beneficial by granting the students "direct access to facts, ideas, and primary sources; by linking images and concepts to sound and film, allowing students to produce creative professional presentations rather than collages on poster board; and by motivating students, especially those who would otherwise be engaged (Cuban, 2001, p. 69). Overall, the teachers stated they made fundamental changes in their pedagogy because of the inclusion of technology and their lessons were more student-centered. To illustrate this point, Sean commented,

> As a science teacher, I always felt very strongly that our job really should be doing science with the kids in the classroom. Not teaching science concepts out of the textbook but actually doing science. The technology we have, the probeware, the software, the analysis tools that we have technology for, really has enhanced and made the lessons much better. Science is much easier to do–broader, more meaningful and the investigations we could not do otherwise. Either with the probeware or virtual labs online, we actually now can do some interesting science rather than just read boring stuff from the textbook.

As a third-year teacher, Patricia reflected that she was still working on the benefits of technology to her teaching. She liked that she was "able to go further with a concept and do applications in mathematics. Technology is going to allow us to be able to do more, but it is a matter of learning and being able to take time to develop it on our own and then be able to introduce it [to the class]." In addition, Patricia agreed literally and metaphorically that technology was changing learning from one dimensional to three dimensional. For example, by illustrating points and planes on the computer the students actually saw the line intersect through three planes as opposed to a picture in their textbook.

Sean contemplated and struggled with the idea of how to take his incorporation of technology to the next level. Now that he had organized his notes in PowerPoint and felt comfortable with many of his lessons, which involved technology, he pondered, "How do I get [the students] to think critically about this material? What activities can I do to make them really process the information? This is where I am finding a little bit of success using the technology, which is what I want to explore more."

## Technology Results

In Zhao et al.'s (2002) research, one of the subjects believed that technology had finally caught up to the way humans think. As a consequence, the teachers in this study were thinking and requiring their students to think in nonlinear logical thought patterns to complete their assignments (Hokanson & Hooper, 2000). In these classrooms learning was becoming dynamic and nonlinear (Hokanson & Hooper, 2000). Believing this, Sean tried to get his students to think critically about the material, create strong links to the topics, and map the information. Similarly, Judy had her students research in groups information on the Web regarding aspects of *The Canterbury Tales* and create a PowerPoint presentation to share their findings to teach the class. "Learning involves stimulation of the mind to create, organize, structure, analyze and hypothesize…The computer may be a tool, but the act of computing itself is a medium for thought" (Hokanson & Hooper, 2000, p. 547). The teachers in this study had shifted their focus regarding the use of technology in their pedagogy from a representative use–delivery system–to a generative use for construction (Hokanson & Hooper, 2000).

Instead of teacher-centered instruction, the teachers in this study, for the most part, engaged the students in learner-centered instruction. For example, Sean had his students collectively create notes together as a class when the answers were revealed

through a class discussion. Shea and Hagan had their students create a Web site based on self-discovery. This type of constructivist approach was not designed to control student thinking; rather, it attempted to engage students in activities that supported knowledge construction through technology use (Hokanson & Hooper, 2000). These constructivist teachers were more likely to have their students do meaningful work with technology (Hernandez-Ramos, 2005). Many of the projects and assignments given to the students developed student responsibility for selecting and carrying out learning tasks, emphasized group work involving discourse, and required the final product to be published for outside audiences (Becker, 2000). For example, Shea's class was assigned to design, create, and construct a virtual museum of an anthropology topic that included PowerPoint, artifacts, hyperlinks, and information regarding the items.

Kearsley and Shneiderman (1999) simply described the learning process of the students who were meaningfully engaged in learning activities through participation with others on worthwhile tasks as "Relate-Create-Donate." A majority of the projects seen in this study required students to Relate–communicate, plan, manage, and socialize; Create–learn in an creative and purposeful activity; and Donate–contribute their finished product to fellow students, community, and the Internet (Goddard, 2002; Kearsley & Shneiderman, 1999).

Although students did not use computers throughout the entire class period, Christine believed that after years of trial and error the teachers have struck a balance. Word and e-mail were constants for the students to effectively communicate their work and questions with their teachers. Because students were publishing their work for wider audiences and conducting research and communicating electronically, the students' academic effort transcended beyond class time to their own free time resulting in greater

student engagement (Becker, 2000). Beth Ann would agree, as her students were using technology for assignments outside of class on average of three to five hours per week.

Hagan summed up the view of the teachers: "Overall, technology is really important and I love to use it. I think it's necessary in a classroom but at the same time it is very frustrating, so I think that schools still have a long way to go when it comes to technology." At times Hagan was frustrated because

> There are still a lot of things that we need to tweak to help fix and I don't know if there will ever be a time when we don't have to tweak anything because that is the problem with technology–sometimes our computer freezes and then you don't have a PowerPoint. [Then I say,] "All right, we are using the chalkboard today." So, I think the biggest aggravation for me is not with myself not using technology but when I take the kids to use it and it doesn't work quite the way I planned.

Problems aside, Maggie believed technology helped break down the previous limitations to learning in the classroom and "kind of opened up a whole new environment from the previous learning style…Concepts that were previously only theory are now brought to life in chemistry class and the students can see them in practice and their applications in real time."

Despite the frustrations with technology not working as expected, the teachers believed technology was a tool that added value to the lessons, student learning, and motivation (Angers & Machtmes, 2005). The key to the lessons and assignments was that technology was integral to student learning and not merely an add-on (Angers & Machtmes, 2005). The lessons were enhanced because of technology and as a result the curriculum and student learning went in new directions. The teachers believed that technology was a tool that lent itself to better student-learning outcomes (Angers & Machtmes, 2005).

As the schools expanded and increased their dependence on and usage of technology, "the relational networks in a given domain become more complex and differentiated, and organizations in that domain must manage more internal and boundary-spanning interdependencies" (Meyer & Rowan, 1977, p. 342). Therefore, more coordination was a must between the administration, teachers, and technology department. However, the schools in the study did evaluate themselves and the technology used and made future decisions based on these data (Meyer & Rowan, 1977). For example, Washington High School administrators decided to forgo the Sony laptops they had been using for a few years after experiencing numerous technological problems and determining the laptops could not handle the student use. They switched to Apple laptops.

One main reason the teachers felt it necessary to incorporate technology into their lessons was to prepare their students for life beyond high school. They felt the skills they were emphasizing would help them succeed in college and the workplace. Whether it was researching information, creating a presentation, finding out answers to labs, or discovering information for the first time, the teachers believed that the skills being used to complete the assignments would additionally benefit their students at a later date. Developing 21st century skills, digital-age literacy, inventive thinking, effective communication, and high productivity (CEO Forum on Education and Technology, 2001) were valued by the teachers. For example, Sean wanted his students to "do real science" in class, Maggie had her students complete projects in a format similar to what she did in the workforce prior to teaching, and Shea required her classes to produce Web sites that allowed her students to interact with anthropologists regarding their archeological digs. Technology should be used "to support models of teaching that incorporate real-world

applications, using research, design, analysis, composition and communication" (Goddard, 2002, p. 25). Because the teachers valued ICT literacy, most of the assignments were structured for students to learn, think critically, solve problems, use information, communicate, innovate, and collaborate (Partnership for 21st Century Skills, 2006).

## Limitations and Recommendations

Although the study was limited to a small group of early adopters and relatively affluent three high schools in one geographically defined area, the results shed light upon the thinking and activities related to computer technology integration. Because these schools were relatively affluent, however, the results cannot be generalized to high schools in other socioeconomic strata. Yet the data "may provide a glimpse into the near future for other schools who will soon invest in technology" (Zhao & Frank, n.d., p. 44). To validate the findings in this study and further develop areas of related interest, future investigators should focus on all the teachers in a school, include multiple schools from all socio-economic backgrounds, interview and observe students, and track the effectiveness of professional-development workshops.

To further the literature field, future studies should focus not just on the high technology users in a high school but also interview and observe the less technology-savvy teachers and determine if they are incorporating the technology into their classes but at a different rate. This broad-based approach will further enhance and strengthen the findings of this study.

Second, it is suggested that future researchers study early adopters in more diverse settings, to determine if there are common themes and patterns. The early adopters in this study were creatively engaged in teaching, which may or may not be

what every high school in the country is experiencing. One of the limitations of this study was that the schools selected were all from the same DFG. A sampling of schools from multiple socioeconomic contexts would help to determine how much DFG plays a role in technology utilization and how early adopters may differ in their thinking and activities to cope with specific environments. The term digital divide has become more commonplace in discussions of technology integration. However, comparable studies of early adopters in more diverse settings would help to specify what the term digital divide means going forward.

Third, in most of the studies found in the literature the voice of the students was continually lacking. As found in the pilot study, the students have strong opinions and experiences of how best to reach them for their own learning. They provided valuable insight in the pilot study to contradict or corroborate what the teachers were saying or trying to accomplish. This missing piece needs to be more fully explored to determine the future path of educators.

Fourth, professional development played a large role in teacher exposure, comfort, and utilization of technology in the class. Future researchers may want to conduct a study on specific technology professional trainings and observe how all teachers are incorporating the newly learned technology into their lessons. This can be further developed to investigate how teacher leaders influence their colleagues. It is possible that collegiality may be more influential than traditional professional-development workshops.

Finally, to understand the phenomenon of the change process; that is, technology integration, Hall and Hord (2006) created the diagnostic dimension of “levels of use” to document observations and studies for a number of different behavioral patterns for

nonusers and users. Users could be classified from those who have little or no knowledge of the innovation to renewal–users who re-evaluate the quality of use of the innovation to achieve increased impact upon students. “Facilitators who understand and apply the level of use concept and its measures are able to provide appropriate interventions that will be relevant and helpful to those involved, or expected to be involved, in change (Hall & Hord, 2006, p. 159). In addition, to understand teachers’ feelings and perceptions about the change innovation, a future researcher may investigate the “stages of concern” (Hall & Hord, 2006). Although these two approaches would allow the researcher to understand how to refocus an idea and explore the behaviors of people, this type of research would require the researcher to commit to multiple days of training in order to be able to interview the subjects properly to record the data accurately.

## Implications

Although the study was limited and the findings cannot be generalized on a larger scale, the research does have implications for both teachers and administrators. This case study can serve as a model for how teachers may incorporate technology into their classrooms. There were many benefits of technology to teachers and students in schools, yet few qualitative studies exist to support this and actually show how technology’s integration has been successfully and meaningfully accomplished. The findings can assist administrators with ideas of education reform and help accelerate technology incorporation and constructivist teaching practices. Zhao et al. (2002) found “eleven salient factors that significantly impact the degree of success of classroom technology innovations” (p. 482). Each factor was placed in one of three interactive domains, the innovator (teacher), the innovation (project), and the context (school) (Zhao et al.). The key to successful classroom technology integration depended on the balance between the

three domains. Leu et al. (2004) also found that successful integration of digital technology into the classroom was determined when students used technology to identify important questions, navigate complex networks, critically evaluate and synthesize information, and communicate answers. This study provides insight and knowledge regarding how teachers may successfully integrate technology and assist in replicating the success in other schools and classrooms. To achieve this success, three domains need to be balanced in order to successfully integrate technology in classrooms: teacher, project, and school.

The teacher is the key to successful technology implementation. To begin, the teacher needs to have the correct philosophy and objectives in mind to enhance the students' learning experience. Teachers with a more constructivist teaching philosophy allow students to engage in their learning differently than that of a transmission pedagogy of conventional lecturing and delivery of content (Becker, 2000). According to the teachers in this case study, the students were more engaged and took greater initiative in their learning. The lessons were more authentic and aimed to increase "academic understanding rather than going through the more superficial traditional practice of schooling: surface coverage of a massive and externally mandated curriculum" (Becker, 2000, p. 27).

The objectives of these teachers were to provide meaningful 21st century skill assignments that also prepared their students for life beyond high school. The lessons incorporated real-world applications and placed students in situations where there was no one way to answer. Technology was not used every minute of every period, however, it was incorporated for students to research, collaborate, communicate, and produce authentic work. To accomplish all this, the teachers were very comfortable using

technology to achieve their goals or were willing to learn new applications to benefit their classes.

The second component to successfully integrating technology into the classroom was the actual assigned projects to the students. Many of the projects could not be completed to the level or degree they were without the incorporation of technology. Students were required to search the Internet for sources, communicate with experts or other students in other parts of the world, and produce a product that was published on the Internet for the global community. These assignments brought a different level of authenticity to the projects, which resulted in the students extending their learning beyond the classroom.

The third component to technology's successful integration was the school infrastructure and culture. The schools in this study all financed the necessary equipment to support a technological environment. Building on this infrastructure, the teachers were then trained on how to use the equipment and incorporate it into their lessons. While updates to the software and hardware were continuous and new ideas and models of how to incorporate technology into lessons constant, the teachers nonetheless used the latest technology and ideas available to enhance their classroom experience. In addition, the observed teachers were the early adopters and, therefore, willing to take more risks and experiment more in the classroom. Since technology is a dynamic innovation, learning to use it requires a willingness to make mistakes and learn from them, and an ability to take risks; essentially, teachers have to have an openness to change (Vannatta & Fordham, 2004). Initially, the emphasis to incorporate technology into class lessons was primarily from the administration. Some teachers tended to use technology just to use it. However, over time they seemed to have been getting better at using technology for the sake of

improving teaching and learning. Professional-development experiences definitely played a role in this transition. Therefore, schools should continue to develop these early adopters by training them on the latest technology and aiding them with ways to successfully implement technology in the 21st century environment.

## Conclusion

The U.S. Department of Education's National Commission on Excellence in Education warned in *A Nation at Risk* (1983) that "the educational foundations of our society are being eroded by a rising tide of mediocrity that threatens our very future as a nation and a people" (p. 1). In an attempt to combat this erosion, the Federal Government passed the No Child Left Behind Act with powerful goals for the education community (National Education Technology Plan, 2004). These goals included the incorporation of technology in the classroom. The National Education Technology Plan (2004) compared today's goals of technology integration in the schools and expertise exhibited by the students to the quest to put a man on the moon. The National Education Technology Plan (2004) boldly predicted that because of this integration, within ten years the United States could be looking at the greatest leap forward in achievement in the history of education.

The early adopters in this study have made the paradigm shift to incorporate technology into their curricula. Promoters of technology integration into schools, as well as the teachers in this study, believed that technology utilization prepared students for work, allowed them to be more efficient and productive, and engaged them in an active process that connected to the world beyond the doors of schools. The teachers constantly stated throughout the interviews how they believed the incorporation of technology into the daily lessons and assignments was preparing their students for college and the workplace. They were also cognizant of the fact that the actual software applications

would most likely change in the future, but the skills and ways of thinking how to use the software was more important for student success. The teachers were using technology to enhance the learning experience of their students by incorporating 21st century skills into their assignments. Judy said, "I don't know where it would come from, but if we are not allowing for technology to reach the classroom I think we are really doing a disservice to the students."

To successfully integrate technology into the classroom, three domains have to be balanced. First, the teacher must have a philosophy toward teaching that allows for the use of technology utilization. Of all the factors influencing technology integration– teacher beliefs about teaching and learning–may be the only one under a teacher's control (Hernandez-Ramos, 2005). The teachers in this study had more of a constructivist philosophy and proficiency toward computers (Becker, 2000; Hernandez-Ramos, 2005) and the objectives of the student tasks and assignments reflected this. Knowing this, administrators are encouraged to hire future teachers with a similar mind-set. For existing teachers, administrators can move faculty toward technology integration and constructivism through professional-development workshops and follow-up discussions during post-observation conferences.

Second, the projects assigned to the students must allow themselves to be worked on and completed in a format other than what can be done within the four walls of the classroom. Students need to be challenged to complete projects that require them to collaborate with others using technology but also recording and producing these products so that they can be published for a wider audience. As Beth Ann stated, "It's not about what I am doing, it's about what they are doing in the classroom." To foster an atmosphere that encourages technology projects, administrators can model this type of

technology-use format through internal professional-development activities, create their own school-wide blogs, or require teachers to incorporate certain types of technology projects within the curriculum.

Last, the school must develop a culture that supports technology integration. Schools have to devote the resources needed so that teachers can incorporate technology into their lessons. Teachers need to be trained in various types of software but, more important schools need to train teachers on the skills and outcomes that are desired of their students since software and technology is ever-changing. One way to help the teachers develop the skills needed, as well as get "buy in" from the faculty, is to have teacher leaders facilitate workshops for their colleagues on certain software packages or model lessons previously taught. Teachers also require time to become familiar with the technology and create ideal lessons. Administrators can provide this time during faculty meetings or by hiring substitute teachers for a day. Moreover, for technology to be successfully integrated into a school, administrators have to devote time and money to proper training on and purchasing of hardware and software.

The very nature of the way teaching and schools are set up constricts the learning opportunities for teachers to further develop their pedagogy. Except for occasional professional-development days and workshops, it is primarily incumbent upon the teacher to intrinsically want to learn more and find ways to incorporate technology. This time is limited to home use, preparation periods, and discussions with colleagues about their latest attempts of technology inclusion. This all has to be balanced with the latest curriculum initiatives, content coverage, and test preparation.

Adding technology to schools is not enough. It needs to be seamlessly intertwined into the curriculum, instruction, and assessment. Changes in teaching and learning as a

result of technology can emerge only from deep reform in schools' organizational, political, social, and technological contexts (Conlon & Simpson, 2003; Cuban, 2001). Administrators need to find the balance between soft and hard pressure upon the teachers regarding technology integration. The situation may require administrators to mandate that all teachers use the online gradebook system the school subscribes to or that each teacher have students post one project on the Internet. A softer approach may be for administrators to model faculty expectations during a meeting using the type of software they would like to see in the classrooms. Either way, the best way to get teachers to incorporate technology into their lessons is to provide encouragement and the necessary support needed to make them successful. The schools researched were on their way to achieving this goal. Similar to the findings in the NCES (2002) study, Maggie summed up the level of seamless technology incorporation that schools, teachers, and students should be striving toward:

> The technology becomes the curriculum. I guess that it is kind of hard for you to probably understand, not having technology as an everyday item, but what I am saying is that it has just become a part of us…it becomes such a part of who we are now that it is hard to look at education differently.

*Appendix A.* **Northeast Public School Technology Survey**
(Northeast Department of Education, 2007)

1. Identify the number of teachers in your school at each skill level in the use of technology in instruction.
___ Beginner: uses computer systems to run software; and access, generate and manipulate data and publish results.
___ Intermediate: applies tools for professional growth and productivity and uses it to communicate, conduct research and solve problems.
___ Advanced: uses computers and related technologies to support instruction; plans and delivers instructional units that integrate applications and learning tools. Lessons developed reflect effective grouping and assessment strategies for diverse populations.
___ Instructor: teaches the items above.

Are these levels resultant from ___observation or ___ assessment?
Assessment method used: _____

2. Does your district have a technology coordinator/director? Yes No
3. Does your school have a technology coordinator? Yes No

4. Is there someone at your school whose responsibilities include providing leadership and support for teachers in integrating technology into the curriculum? Yes No

5. Who is responsible for the supervision and evaluation of the integration of technology by teachers in your school? Check all that apply:

| | |
|---|---|
| ❒ Principal | ❒ Curriculum Coordinator |
| ❒ Assistant Principal | ❒ Technological Literacy Coordinator |
| ❒ Academic Content Supervisor | ❒ Other (please specify): |

6. How does your school address and evaluate if technology has been effectively integrated into the curriculum? (Check all that apply.)
__ Conduct needs assessments
__ Teacher attendance at professional development opportunities where technology is integrated into the offerings
__ Evaluate use of technology in lesson plans
__ Observe classrooms
__ Include technology use in professional improvement plans
__ Conduct site-based research
__ Use of rubrics that include the use of technology
__ Conduct student and teacher surveys
__ Review of relevant research
__ Make use of totally digital curricula
__ Support curriculum with digital resources

__ Use tools that assess the level of technology implementation in the classroom, such as LoTi www.loticonnection.com, EnGauge www.ncrel.org/**engauge** , Taglit www.**taglit**.org etc.
__ Other: _____

7. When technology problems (hardware/software) arise teachers are supported by the following means:
(Check all that are applicable.)
__Technician __Help desk __Hotlines __Electronic monitoring __Troubleshooters
__ Parent volunteers __Technology Coordinator __ Student Assistants __Others

8. Do teachers participate in online professional development? Yes No
Subject Area: Number of teachers: Provider /Vendor of the course:

9. Does your school have an Acceptable Use Policy (AUP) that addresses Internet usage as well as other information technology use by teachers and administrators?
Yes No

10. Your school has:
__ a specific curriculum for computer literacy
__ computer literacy is infused through other curricular areas

11. Check the statements that best describe the way most teachers (greater than 50 percent) use technology in the classroom.
__ Use tools to enhance productivity (e.g., e-mail, grade books)
__ Use the Internet to provide student activities that support the curriculum
__ Use assessments to evaluate student use of technology in their learning process (e.g., e-portfolios, multimedia projects, NETAP-IN)
__ Offer opportunities for authentic student centered, project-based learning
__ Make use of videoconferencing, video streaming, podcasting etc. for the delivery of specialized or rigorous academic courses and curriculum
__ Use technology to modify the delivery of instruction
__ Use electronically-based data to modify instruction to meet the needs of students
__ None of the above

12. School-wide use of technology: (Check all those that apply to your school)
__ All instructional and administrative rooms have functioning multi-media computers with network access
__ All instructional and administrative rooms have functioning multi-media computers with Internet access
__ All instructional and administrative rooms have access to an online attendance system
__ Faculty news/announcements are shared throughout the building by e-mail
__ Classrooms and administrative offices have access to online student records as appropriate for guidance counselors, faculty, administration and the transportation office
__ Food service office has access and uses online information on student lunch eligibility
__ All staff make use of an online student grade book
__ Electronic student report cards are issued

__ Library has automated systems for card catalogs
__ All students have access to relevant electronically delivered learning materials
__ Library has high-speed access to the Internet for student access/research
__ There is a school-wide electronic media distribution system

13. Do any students participate in online courses Yes No
a.) If yes, then identify subject, grade, number of students and provider:
Subject/Title: Grade: Number: Provider /Vendor of the course:

b.) What other subject areas (and grade level) courses are needed:
Subject: Grade:

14. Does your school have an Acceptable Use Policy (AUP) that addresses Internet and other information technology use by students? Yes No

15. Do you have the capability and bandwidth to have video conferencing reach the individual desktops of students? ___Yes ___No

16. How does your school support students who do not have access to technology in their homes?
__ Before school, after school, or lunch time open labs
__ Community centers with hours open for use outside of normal school hours
__ Libraries with hours open for use outside of normal school hours
__ School has equipment that can be checked out
__ Other: _____

17. Do you need to use a bridging service or portal to connect outside of your district to do a video conference? ___Yes ___No

18. What type of connectivity do you use for your video conferencing: ___ ATM, ___IP, ___Fiber, ___ satellite, ___IDLS or ___Internet2

19. Does your school have one or both?
LAN (Local Area Network) Yes No
Wireless network? Yes No

20. Is your school connected to other buildings in your district through a WAN (Wide Area Network)? Yes No

21. Indicate the number of rooms and Internet connections for each location.

| | Classroom/ Instructional | Library/ Media Center | Computer Labs | Administrative Offices |
|---|---|---|---|---|
| Number of rooms | | | | |
| Number of individual students who can simultaneously access the internet by a computer in each location (one to one) | | | | |

22. Does your school have Internet filtering/monitoring software currently in use? Yes No

23. Enter the number of students in your school that use technology tools such as desktop or laptop computers, PDAs, probes, etc. in the curriculum and learning activities on a daily basis? (i.e. 5 students use technology tools 0-30% of the day)
__ 0-30% __ 31-55% __ 56-80% __over 80%

24. Enter the number of students in your school use the Internet on a daily basis as part of the curriculum in school. (i.e. 5 students use Internet 0-30% of the day)
__ 0-30% __ 31-55% __ 56-80% __over 80%

25. ___ What number of students collaborate in school on projects on an international level through electronic means?

26. Most students in our school: (Check all that apply)
__ Develop or complete grade appropriate assignments using word processing, database, spreadsheet, presentation software, or graphic organizers that support higher order thinking skills as demonstrated in their work
__ Have access to engaging software that supports students' curricular activities
__ Use digital materials when acquiring information and knowledge
__ Have access to distance learning technology to obtain information and collaborate with peers and experts
__ Are self-sufficient in their use of individually appropriate technology tools in their classrooms to support their learning styles

27. How many technicians on staff support your school's technology infrastructure? ____

28. Multimedia computers (for purposes of this survey) are defined as Pentium IV or Mac G4 and above. Identify the total number of multimedia computers that are in use in the following locations:
    ___ All computer labs
    ___ All classroom/instructional rooms
    ___ Library media centers
    ___ Administration offices and other

29. Of the computers listed above,
__ How many are connected to the Internet?
__ How many are thin clients?
__ How many are laptops?
__ How many are connected by wireless?
__ How many are single computers on a mobile cart?
__ How many are multiple computers on a mobile cart?
___ How many hand-held computers, such as PDAs, Danas and Alpha Smarts, etc. are used in instruction?

30. How many years is a computer in use in instruction before it is considered obsolete? _
    How many years is a computer in use before it is replaced? __
    How many computers are currently in use but are considered obsolete? __

31. Indicate the number of administrators, staff and students provided with school-based connectivity for each group within the school building.

| | Administrators | Instructional Staff | Students |
|---|---|---|---|
| Internet Access | | | |
| E-Mail | | | |

32. Of the students enrolled in your school, please enter the number of students who have and can use the following in their homes:
    ___ Multimedia computer with Internet access, basic software (word processing, database, spreadsheet, presentation) and a printer

33. Does your school offer educational technology activities/programs to families and community members? __ Yes __ No
    If yes, then check all those below that apply.

    __ Access to e-mail
    __ E-mail accounts
    __ Training
    __ On campus adult access to school equipment
    __ Off-campus adult access to school equipment
    __ Web site hosting for community organizations
    __ Online parent resource section on the school's Web site.

34. Is outreach to parents is accomplished using electronic means (e.g., Web site, e-mail, announcements, schedules, lunch menus, permissions slips? __Yes __No

*Appendix B.* **Teacher Survey**

(ISTE General Preparation Profile for Prospective Teachers Survey &
ISTE Technology Competence Survey, 2003)

Select one level of agreement for each statement to indicate how you feel.
SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree

1. I have a strong understanding of the nature and operation of technology systems.
2. I am proficient in the use of common input and output devices; I can solve routine hardware and software problems; I can make informed choices about technology systems, resources, and services.
3. I can use technology tools and information resources to increase productivity, promote creativity, and facilitate academic learning.
4. I can use content-specific tools (e.g., software, simulation, environmental probes, graphing calculators, exploratory environments, Web tools) to support learning and research.
5. I can use technology resources to facilitate higher order and complex thinking skills, including problem solving, critical thinking, informed decision-making, knowledge construction, and creativity.
6. I can collaborate in constructing technology-enhanced models, preparing publications, and producing other creative works using productivity tools.
7. I can use technology to locate, evaluate, and collect information from a variety of sources.
8. I can use technology tools to process data and report results.
9. I can use technology in the development of strategies for solving problems in the real world.
10. I have observed and experienced the use of technology in my major field of study.
11. I can use technology tools and resources for managing and communicating information (e.g., finances, schedules, addresses, purchases, correspondence).
12. I can evaluate and select new information resources and technological innovations based on their appropriateness to specific tasks.
13. I can use a variety of media and formats, including telecommunications, to collaborate, publish, and interact with peers, experts, and other audiences.
14. I understand the legal, ethical, cultural, and societal issues related to technology.
15. I have a positive attitude toward technology uses that support lifelong learning, collaboration, personal pursuits, and productivity.
16. I can discuss diversity issues related to electronic media.
17. I can discuss the health and safety issues related to technology use.

I feel competent:

18. operating a computer using a variety of software packages.
19. using terminology related to computers and technology appropriately in written and oral communications.
20. describing and implementing basic troubleshooting techniques for computers.
21. using devices such as scanners, digital camera, and/or video cameras with computers and software.
22. using work processing applications.

23. using the Internet for research (Web-based information retrieval).
24. using computers for information management (databases).
25. using spreadsheet applications.
26. creating multimedia presentations.
27. using computers to enhance my teaching and learning.
28. using computers for planning and organizing activities.
29. using computers for online communication (e.g., e-mail).
30. using adaptive assistive devices for students with special needs.
31. demonstrating knowledge of equity issues concerning use of computers and technology.
32. demonstrating knowledge of ethical and legal issues concerning use of computers and technology.
33. designing Web pages.
34. using distance learning hardware and software.
35. describing instructional principles and research related to the use of computes in teaching.
36. designing student learning activities that integrate computers.
37. delivering student learning activities that integrate computers.

*Appendix C.* **Teacher Interview Questions**

1) Describe and demonstrate your favorite lesson that incorporates technology.

2) Explain how you use technology to enhance the classroom.
   Prompts:
   a) Prepare lesson plans
   b) Create class assignments
   c) Create tests, quizzes, and assessments
   d) Research information for class instruction and assignments

3) Describe the types of technology you use for class instruction. How and why are they used?
   Prompts:
   a) PowerPoint, Word, Excel
   b) School licensed databases like: Ebsco, Proquest, Lexis Nexis
   c) Grading program
   d) Video equipment
   e) Audio equipment
   f) Podcasts
   g) Blogs
   h) Other

4) Describe the types of technology you use to prepare for class instruction. How and why are they used?
   Prompts:
   a) PowerPoint, Word, Excel
   b) School licensed databases like: Ebsco, Proquest, Lexis Nexis
   c) Grading program
   d) Video equipment
   e) Audio equipment
   f) Podcasts
   g) Blogs
   h) Other

5) How many hours per week are spent using technology for schoolwork?

6) Describe the internal and external factors that influenced you to incorporate technology into the classroom.

7) Explain what, if any, technology classes or professional development workshops were beneficial for you.

8) Explain how your students are using technology to complete class assignments.

9) Constructivism: (Teachers will be asked to explain their most successful lessons and what contributed to their student's learning. The following questions will probe teachers to explain their lessons in greater detail.)
    a) Explain how your students learn through your lessons (e.g., reception of facts and repetitive practice of discrete skills or through effortful integration of new ideas with those previously believed).
    b) How do you plan a set of activities to achieve you lesson objectives (e.g., teacher presentation of new information or students answering questions in textbook)?
    c) Explain what types of procedures are in place for independent student work (e.g., procedures are defined in detail so that student work can efficiently be accomplished with as few errors and as little confusion as possible).
    d) How do mistakes and confusion sometimes provide the engagement that is needed for effortful learning?
    e) Describe the natural starting point for instruction of your lessons (e.g., not the material to be taught, but student interests, prior experiences, and current understandings).
    f) Explain how your students understand the objectives from the lesson (e.g., student understanding comes from listening and reading, and from receiving explanations from the teacher directly).
    g) Describe the different class activities that are employed in your class (e.g., student understanding comes from result actively working with and applying ideas in a social context such as debates between students, cooperative group projects, and other activities involving the articulation of students' own ideas in concrete contexts).

10) Explain the technology requirements you require students to use to complete assignments.

    Prompts:

    Do students use computers (and if so, explain):
    a) weekly or more?
    b) To get information or ideas
    c) To express self in writing
    d) To communicate electronically
    e) To present to an audience
    f) To learn to collaborate
    g) To analyze information

    Prompts of types of technology use:
    a) PowerPoint, Word, Excel
    b) School licensed databases like: Ebsco, Proquest, Lexis Nexis
    c) Video equipment
    d) Audio equipment
    e) Podcasts
    f) Blogs
    g) Other

11) Describe any setbacks to using technology. How are they overcome?

12) Describe the limitations to teaching and learning you experience from technology use.

13) Explain how technology is helping you achieve your educational goals.

14) Describe the benefits/rewards to learning you experience from technology use.

15) Describe how technology has changed or you have used technology differently in the past four years.

*Appendix D.* **Classroom Observation Tool**

The **ISTE Classroom Observation Tool** (ICOT®) is a free online tool that provides a set of questions to guide classroom observations of a number of key components of technology integration. ICOT was developed by staff and consultants in the Education Leadership Department at the International Society for Technology in Education (ISTE) with support from Hewlett-Packard Company. For free access to the ICOT software and online tools, visit **http://www.iste.org/icot**.

**1. Setting**
Date: _____ School: _____
Project/Program: _____ Site Code
_____
Observer: _____ Teacher: _____
Grade: _____ Subject: _____
#Students: _____ Observation Start time: _____ End time: _____
*(You can track technology use by three-minute intervals throughout the observation using the three-minute chart at the end of this form.)*

**2. Room description and student characteristics:**

**3. Student groupings (check all observed during the period):**
____ Individual student work
____ Student pairs
____ Small groups
____ Whole class
____ Other (please comment):

**4. Teacher roles (check all observed during the period):**
____ Lecturing
____ Interactive direction
____ Discussion
____ Facilitating/Coaching
____ Modeling
____ Other (please comment):

**5. Learning activities (check all observed during the period):**
____ Creating presentations
____ Research
____ Information analysis
____ Writing
____ Test taking
____ Drill and practice
____ Simulations
____ Hands-on skill training
____ Other (please comment):

**6. How essential was technology to the teaching and learning activities?**
____ 1. Not needed; other approaches would be better.
____ 2. Somewhat useful; other approaches would be as effective.
____ 3. Useful; other approaches would not be as effective.
____ 4. Essential; the lesson could not be done without it.
Comment:

**7. Technologies used by teacher (check all observed during the period):**
____ Calculator
____ CD-ROM
____ Database
____ Desktop Computer
____ Digital Camera
____ Drill/Practice
____ E-mail
____ Graphics
____ Handheld Computer
____ Laptop Computer
____ Library Database
____ Outliner
____ Podcast
____ Presentation
____ Science Probe
____ Shared Editor (wiki)
____ Simulation
____ Spreadsheets
____ Tablet Computer
____ Video Camera
____ Videoconferencing
____ Web Authoring
____ Web Browser
____ Web Log
____ Word Processing
____ Other (please comment):

**8. Technologies used by students (check all observed during the period):**
____ Calculator
____ CD-ROM
____ Database
____ Desktop Computer
____ Digital Camera
____ Drill/Practice
____ E-mail
____ Graphics
____ Handheld Computer
____ Laptop Computer
____ Library Database

____ Outliner
____ Podcast
____ Presentation
____ Science Probe
____ Shared Editor (wiki)
____ Simulation
____ Spreadsheets
____ Tablet Computer
____ Video Camera
____ Videoconferencing
____ Web Authoring
____ Web Browser
____ Web Log
____ Word Processing
____ Other (please comment):

**9. NETS Teacher Standards Addressed:**
____ 1A.1. operating system procedures
____ 1A.2. routine hardware and software problems
____ 1A.3. content-specific tools
____ 1A.4. productivity tools
____ 1A.5. multimedia tools
____ 1A.6. interactive communication tools
____ 1A.7. curriculum-based presentations/publications
____ 1A.8. curriculum-based collaborations
____ 1A.9. appropriate technology selected
____ 2A.1. developmentally appropriate learning activities
____ 2A.2. technology-enhanced instructional strategies
____ 3A.1. learning experiences address content standards
____ 3A.2. learning experiences address student technology standards
____ 3B.1. technology supports learner-centered strategies
____ 3C.1. technology applied to develop students' higher order skills
____ 3C.2. teacher applies technology to develop students' creativity
____ 3D.1. class management facilitates engagement with technology
____ 3D.2. technology integrated as a teacher tool
____ 3D.3. technology integrated as a student tool
____ 3D.4. student grouping varied as needed to facilitate learning
____ 4A.1. student learning of subject matter assessed with technology
____ 4A.2. teacher assesses student technology skills
____ 4A.3. teacher employs a variety of assessment strategies
____ 6A.1. teacher models legal and ethical technology practices
____ 6A.2. teacher explicitly teaches legal and ethical technology practices
____ 6B.1. diverse learners enabled and empowered.
____ 6D.1. safe and healthy use of technology promoted
____ 6E.1. equitable access to technology for all students.
Comments:

**10. Three-Minute Chart.**
During each 3-minute period, was technology *in use* by students and/or teachers, and was the time spent with technology *used for teaching and learning* (as opposed to recreation or routine tasks such as boot-up and log-on)?

| Tech is: | :00-:03 | :03-:06 | :06-:09 | :09-:12 | :12-:15 | :15-:18 | :18-:21 | :21-:24 | :24-:27 | :27-:30 | :30-:33 | :33-:36 | :36-:39 | :39-:42 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| In use students | | | | | | | | | | | | | | |
| Used for learning | | | | | | | | | | | | | | |
| In use teacher | | | | | | | | | | | | | | |
| Used for learning | | | | | | | | | | | | | | |

**11. Estimated time technology used (if 3 minute chart is not used)**
Total minutes technology used by students _____
Minutes students used for learning _____
Total minutes technology used by teachers _____
Minutes teachers used for learning _____

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