Impact of Instructional Technology Professional Development on Teaching Practice and Student Performance

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ABSTRACT

NELLIE REN HEWITT BRYAN: Impact of Instructional Technology Professional Development on Teaching Practice and Student Performance
(Under the direction of Dr. Barbara Day)

In the United States billions of dollars have been spent on instructional technology with the expectation that the expenditure would have an impact on student achievement. Professional development provides teachers with the skills that they need in order to effectively use the technology in ways that will impact student performance; however, there is little research about the implementation of strategies learned during professional development. This research used qualitative methodology to examine the professional development implementation of fifty teachers from six schools a year after they attended the same professional development session. A theory was developed that explains the relationship between several factors that impact the ability of teachers to implement instructional technology professional development. Results indicated that the ability of teachers to implement strategies in ways that affect student performance are impacted by the level of support that teachers receive from administrators and colleagues, the technology available to the teachers, and the strategies that are included in the professional development. The results of the research led to the creation of a professional development planning framework for teachers to use to carefully examine their professional development needs as a factor that contributes to changing student performance.

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I thank my colleagues who work diligently to design professional development that will help teachers acquire the skills that they need in order to impact student performance.

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CHAPTER I

INTRODUCTION

During the mid-nineties, schools were rushing to find ways to place computers in classrooms across the nation, only to find that the teachers did not know what to do with them. A handful of visionaries explored the ways to implement the technology into instruction, taking into consideration the skills that teachers would need in order to fully use the equipment in instruction. Professional development provided opportunities for teachers to learn how to use the equipment only to find that when they had learned to use the equipment, it was replaced with something else.

Professional development for teachers in instructional technology required a second set of skills, however. In order to integrate the technology several things needed to occur. First, teachers had to have a strong curriculum background and knowledge of the curriculum goals for their students. Second, both students and teachers needed to have a common set of technology skills and an understanding about how the technology would be used. Third, teachers had to be willing to believe the new strategies would be successful in helping them reach their goals. After more than a decade of widespread technology integration into instruction, questions still focus on the ways that professional development leads to change in teacher practice.

In order for technology integration to occur, there has to be available technology, as well as an infrastructure to support it. By the turn of this century the United States Department of Education estimated that more than 60 billion dollars had been spent on equipment, wiring, software, and support for technology in schools. While that money has not been spent in a way that ensures equal resources in all schools, the United States Department of Education Office of Educational Technology (2005) reports that nationwide there is a computer ratio of 4.4 students to 1 computer and the North Carolina 2005-2009 Technology Plan (2004) reports a student to classroom computer ratio of 6.2/1. Additionally 100% of schools in North Carolina currently have internet access.

The technology can be in place, but remain unused unless the teachers have the skills needed to use the equipment; therefore, staff development must be provided for the faculty. The United States Department of Education Office of Educational Technology has encouraged schools to designate 25-30% of all technology funding for professional development. In 1998 the North Carolina State Board of Education established a technology requirement of three Continuing Education Units for each five year renewal cycle for North Carolina teachers and evidence of mastery of technology competencies for education students seeking licensure in any certification area in North Carolina (McColl, 1999). The professional development and training however, must be delivered in a meaningful way in order for the teachers to make the connection to the curriculum. Teachers must also be willing to change their past instructional practices.

When examining the factors that contribute to the success of students, the single consistently most important factor is the quality of the teacher (Haycock, 1998). Professional development contributes to the growth of teachers' skills and effective use of instructional

technology depends on the teacher's skills (Grove, Strudler, & Odell, 2004). In the area of instructional technology, ongoing professional development is even more necessary because the technology tools change so rapidly and the pedagogical skills that the teacher needs are different from the traditional pedagogical skill set. Teachers need to change roles from experts who provide information to facilitators or coaches, allowing students to assume more responsibility for their own learning. Teachers need to be willing to take risks and evaluate the learner outcomes to determine the most effective tools for the instruction (Impact, 2005).

The growth in the importance of technology in the classroom, as evidenced by the amount of spending for equipment, infrastructure, and professional development, has led to close scrutiny about how the emphasis on technology has changed student performance. The results are mixed (Bork, 1995; Kulik, 1994; Mann, 1999; Schacter, 1997; Sivin-Kachala, 1998) and indicate that the outcome of improved student achievement is directly related to the choice of the tools or equipment, the expected outcomes, and the skill with which the teacher organized and orchestrated the learning environment.

After a focused emphasis on the acquisition of computer skills for both teachers and students for more than fifteen years, the conversation between educational leaders, business leaders, and political leaders today is about the skills that students will need in order to be productive citizens in the 21st Century (Impact, 2005; Patrick, 2005; Partnership, 2005). The 21st Century Forum created a framework to define technological literacy as a component of 21st century skills and to identify best practices for applying these skills in the classroom.

In order to guide students toward the mastery of 21st century literacy skills, which include collaboration, technology literacy, strong communication skills, and global awareness, teachers must be able to provide students with learning experiences that engage

students in ways that make meaningful use of the technology that they will have access to, not just the use of a word processor to write a paper or the use of the internet to locate information that could be found just as easily in print text. Professional development provides teachers with the skills that they will need in order to make the transition in instructional practice; however, the professional development must be directly linked to the curriculum with clearly identified outcomes (McKenzie, 1999).

Purpose

The purpose of this research is to investigate how instructional technology professional development impacts the classroom instruction skills of secondary teachers, and therefore, their ability to enhance student performance.

Statement of the Problem

There is extensive research about the way that effective use of instructional technology has impacted student performance, as well as research on the impact that an effective teacher has on student performance. However, there is little research about the type of professional development required to help teachers acquire the skills necessary to engage students in higher level learning with the use of the available instructional technology or the ability of teachers to implement the skills learned in professional development.

Research Questions

How have the instructional technology professional development experiences of secondary teachers in North Carolina schools impacted teacher practice and therefore, student performance? The research questions that will guide the study are:

1. How has technology professional development of teachers impacted their instructional practice?
2. How have teachers integrated technology into their instructional practice as a result of professional development?
3. How has the use of instructional technology in classrooms where teachers have had professional development impacted student performance?

Definition of Terms

Instructional Technology

Educators have used tools to enhance student learning, including pencils, chalkboards, filmstrip projectors, televisions and other tools. For the purpose of this study, instructional technology is synonymous with information technology, defined by the Milken Exchange and refers to current computer technology and tools such as peripheral equipment like digital cameras, handheld computers, and activeboards, "as well as the effective use of digital information to extend human capabilities" (Schacter, 1999, p.3) .

Professional Development

No Child Left Behind federal legislation defines professional development as high quality, sustained, intensive, and classroom focused activities that have a positive and lasting impact on classroom instruction and the teacher's performance in the classroom and are not one-day or short-term workshops or conferences. (United States Department of Education, 2004)

Secondary teachers

The North Carolina Department of Public Instruction defines secondary teachers as teachers of ninth through twelfth grade students. For the purpose of this study, the definition has been expanded to include the United States Department of Education definition of secondary teachers to include teachers of students in grades 6-12. (United States Department of Education, 2004)

Student Performance

Observed student behavior of demonstration of North Carolina K-12 Standard Course of Study (http://www.ncpublicschools.org/curriculum/computerskills/scos/04philosophy)

CHAPTER II

REVIEW OF THE LITERATURE

This chapter examines the current research about how instructional technology is used in K-12 classrooms, the kinds of professional development the classroom teacher needs to have for technology to be used effectively, and the impact the use of technology has on student performance. School systems are faced with difficult budget decisions related to use of space, reduction in class size, and the purchase of instructional materials and equipment, among other things. In the last decade of the twentieth century the nation invested more than $66 billion in school technology (QED, 2004). Policy makers who spent these funds on computers and technology want to know if the money has been spent effectively (Ringstaff & Kelley, 2002). Students today have grown up in a technology-rich environment and are comfortable with the digital age of multimedia information that is interactive and abundantly available. These students, referred to by such names as Millenials, Gen-Y, Echo Boomers, because they are the children of Baby-Boomers, or Digital Natives (Prensky, 2005) come to school with the skills to interact with technology in a way that educators may be unable to offer. High expectations for the use of technology to transform teaching and learning in America's classrooms have been largely unmet. The literature reviewed in this chapter helps to define the area of instructional technology, the kinds of professional development

educators need to effectively use technology, and the impact technology has had on student performance in the classroom and the acquisition of new skills.

Description of Instructional Technology

Technology has historically been viewed as a way to solve educational problems and to improve schools. After the launch of Sputnik in 1958, Congress passed the National Defense Education Act (NDEA) in an effort to improve math and science education in America's schools. While creating a framework for federally funded student loans, such as the Pell grant, it also provided federal funding for equipment for K-12 classrooms under Title III of the Act. In 1958, instructional technology included an overhead projector in some classrooms and filmstrip projectors that could be checked out of the library, but the law was revised in 1964 and modified the type of equipment that could be purchased with Title III funds to broaden the category (Cohen, 2005). The North Carolina Educational Technology Plan (2004) defines technology as "a tool that helps every teacher and every student master basic skills and develop critical thinking and problem-solving abilities" (p.2). In addition to computers and networked wiring, the variety of those skills and resources include online learning opportunities, school television, calculators, and other handheld devices. The increase in the amount of technology needed in the schools and the cost of building an infrastructure to support universal internet access has led to federal funding for educational technology through grants and reimbursements for schools through e-rates. With the federal funding, there have been guidelines to direct the way that the technology should be used.

Federal Guidelines for Technology Integration into Instruction

The United States Department of Education Office of Educational Technology 2004 National Education Technology Plan has the core purpose of maximizing the use of

technology to improve education and support the goals of No Child Left Behind. It has adopted four national technology goals, with funding plans to help schools acquire the equipment and train the teachers in the use of technology in order to meet the goals. The goals are:

1. All teachers and students will have modern computers in their classrooms.
2. Every classroom will be connected to the information superhighway.
3. Effective and engaging software and on-line resources will be an integral part of every school curriculum.
4. All teachers will have the training and support they need to help all students learn through computers and through the information superhighway.

In order to meet the four national technology goals, seven action steps have been developed that will lead to the implementation of the goals.

1. Strengthen Leadership
2. Consider Innovative Budgeting
3. Improve Teacher Training
4. Support E-Learning and Virtual Schools
5. Encourage Broadband Access
6. Move Toward Digital Content
7. Integrate Data Systems (p. 14)

The third action step in the national technology goals relates to improved teacher training, identified as a critical element to achievement. John Bailey (2002), Director of Educational Technology for the US Department of Education, explains that because of the emphasis on strong leadership in developing technology plans, professional development must include

school administrators, as well as teachers. The Enhancing Education through Technology grant program requires recipients to use at least 25% of their funding for professional development, a funding standard that has consistently been suggested by the Department of Education. Federal funding for professional development and teacher training has led to a discussion about what skills teachers should have in the area of instructional technology.

International Society for Technology in Education Standards

The International Society for Technology in Education (ISTE) NETS for Teachers Project, supported by a US Department of Education grant, facilitated a series of activities and events resulting in a national consensus on what teachers should know about, and be able to do, with technology. In 1993 the International Society for Technology in Education developed computing and technology standards that have been adopted by state boards of education and departments of public instruction, including North Carolina, with recommended or required levels of competency for both students and teachers. The 1997 revision of the competencies for teachers included eighteen indicators organized into three categories: (a) basic computer/technology operations and concepts; (b) personal and professional use of technology; and (c) application of technology in instruction. A primary goal of the ISTE/NETS Project has been to enable everyone in Pre K-12 education, including students, teachers, and administrators, to have national standards for educational uses of technology that promote school improvement in the United States (ISTE, 2000). The broad standards evolved into twenty-three standards grouped into six categories: (a) technology operations and concepts; (b) planning and designing learning environments and experiences; (c) teaching, learning, and the curriculum; (d) assessment and evaluation; (e) productivity and professional practice; and (f) social, ethical, legal, and human issues. The complete

standards are found in Appendix D. Just as with curriculum standards for students, "the use of technology standards allows teachers to strive for a common goal agreed on by a wide variety of fellow educators" (Descy & Forcier, 2002, p.7). The implied outcome of a common set of goals for both teacher and student use of technology is the uniform integration of those skills into the curriculum. Critics of the use of computers in education examine current technology use and suggest that those skills are not being taught and used. The next section focuses on some of the criticisms of the uses of technology in the classroom.

Critics of Current Technology Use

Morrison and Lowther (2002) explain that two of the reasons for the lack of technology integration currently in the schools are the type of technology available and the way that it is used. Technology has been used to deliver instruction, frequently using drill and practice software, which focuses on memorization (Archer, 1998; Becker, 1991). Alfred Bork (1987), a proponent of the use of microcomputers in education, reflected that

> the results of computers in learning are disappointing; studies might even show that computers are doing more harm than good. Effective use of computers in learning will not occur automatically. A reasonable chance exists that it will not occur at all unless we readjust our current directions. Just because computers and other modern technology are widely present in schools is no guarantee that this equipment will be wisely employed. (¶3)

Bork, Professor of Information and Computer Science at the University of California at Irvine, remained optimistic about the future of computer use in the classroom. Five years later, however, his outlook was bleak. He found that too much emphasis was placed on the

number of computers found in schools, rather than the use to which those computers were put. The North Carolina Educational Technology Plan 2005-2009 (2004) reinforces Bork's observation of the importance of obtaining equipment by stating that "technology is being used to differentiate instruction and enhance student achievement across the state" (p.8). Support for this statement in the NC Educational Technology Plan is that students have access to an average of 3.9 computers per classroom based on 24 students per classroom; 100% of schools have Internet access, and 91.7% of the classrooms are connected to the Internet. The statement emphasizes hardware and the number of computers with little or no consideration for the specific role that they will play in the learning environment of the school or university. There seems to be a belief in the magic that will occur with the use of the technology by parents, administrators, and teachers. Planning for learning, however, should precede *any* hardware purchase (Bork, 1995).

Todd Oppenheimer (2003) is an outspoken critic of the current trend in instructional technology use in schools. Rather than an educational researcher, Oppenheimer is an investigative journalist who has published extensively about what he sees as the false promise of improvement in education as a result of the use of computers in the classroom. He argues that the schools have purchased expensive equipment that is under-used because teachers are poorly trained and people who have made the decisions to purchase the equipment have been influenced by faulty research conducted by the computer industry. One of his primary arguments is that schools have limited funds with which to provide educational support for children. By making the decision to purchase expensive equipment, schools have had to do away with programs such as art, music, or physical education. He

also argues that effective pedagogy is lost in the glitter of the new technology, which is outdated before teachers even learn to use it.

Oppenheimer's opinion is supported by the PEW Internet /American Life Project which reports that in schools where technology is available for student use, there is a disconnect between what students do with the internet outside of school and what they do with the internet at school under the direction of a teacher. Most students reported that they had more significant interaction with the computer outside of school for a number of reasons, including limited numbers of computers at schools, inadequate leadership to drive the use of computers, and the skill level of the teachers (Levin & Arafeh, 2002).

Constance Mellon (1999), in the *Journal of Research on Computing in Education*, stated that although the integration of appropriate technology into education can enhance student learning in the appropriate learning environment, these effects will not have the same impact as an effective teacher using effective teaching strategies. Mellon also refutes the commonly held assumption that just the presence of technology implies more learning. This attitude is supported by the states like North Carolina that report progress in technology as increases in numbers of computers and related hardware in their schools, rather than learning outcomes as a result of technological use. While there is criticism about the ways that technology has been integrated into instruction, there has been a body of research that supports the effect that technology has had on student performance.

Improved Student Performance as a Result of Technology Integration

Early studies demonstrate that students with exposure to computers are doing better academically than their peers without computers (White, Ringstaff, & Kelley, 2002; Lance, 1992). White, Ringstaff, & Kelley found that the use of computers and other technology

were the most effective in increasing student achievement when they were integrated into the curriculum. The authors found that students performed better on standardized tests for reading comprehension if they were in schools that had well equipped media centers and well trained media specialists.

In a survey conducted for the Milken Exchange on Education Technology in 1997, John Schacter analyzed five large scale studies in order to identify both the positive and negative effects of technology on student achievement. James Kulik (1994) reviewed the impact of computer-based instruction such as tutorial or drill and practice software in 500 separate studies and reached several conclusions. He concluded that students were able to complete more work in less time, while enjoying the class more. When compared with students in control groups, student performance was higher on standardized tests; however, the computer-based instruction was not more effective in every area that was studied. Jay Sivin-Kachala (1998) completed a meta-analysis of 219 research studies from 1990-1997 in order to examine the effect of technology on student achievement in all grades and in all content areas. He found that increased student achievement and better attitudes toward learning were consistent with technology-rich environments; however, the level of effectiveness depends on the level of access that students have to the technology, the student population, and the role of the teacher.

The impact of interactive computer technology on the way that teachers teach and students learn in the Apple Classrooms of Tomorrow (ACOT) program was evaluated by Baker, Gearhart, and Herman (1994) using five different school sites across the United States. The initiative lasted five years with the intent of helping teachers develop innovative instructional methods that would increase student collaboration using available computer

technology. The study examined three different factors: (a) ACOT students' basic skills on nationally normed assessments; (b) ACOT students' achievement over the five year period of the study; and (c) ACOT teacher practices. The findings of the research indicated that there may have been higher level thinking activities that involved problem solving for students in ACOT classrooms. Students had a better attitude toward school and teaching practices involved more collaborative activities. On basic skills standardized tests such as vocabulary and math concepts, students in ACOT schools did not perform any better than students who did not have access to computers, however, the studies have revealed that in classrooms where technology is used, students interact more with their peers and teachers than in traditional classrooms.

David Mann et.al. (1999) studied a sample of 950 West Virginia fifth graders from 18 elementary schools across the state that were using the West Virginia Basic Skills/Computer Education. The practices of 290 teachers were also included in the study. Mann found that the more time the students spent with the program, the more the students' scores increased. On the Stanford 9 assessment, the students who had the lowest scores showed the greatest amount of improvement. Findings also indicate that teacher training in the technology led to higher student gains. Teachers reported that they became happier about using BS/CE over time.

Harold Wenglinsky (1998) examined the effects of using simulations and higher order thinking software in a national sample of 6,227 fourth graders and 7,146 eighth graders on the National Assessment of Educational Progress. By controlling for socioeconomic status, class size, and teacher characteristics, he was able to see the educational outcome of the use of technology. He found that eighth graders who used simulations showed gains

higher than grade level in math as measured by NAEP. The students whose teachers had computer professional development scored up to thirteen weeks above grade level. Higher order uses of computers and professional development for teachers were related to increased student achievement in both fourth and eighth grades. The students who used the technology only for drill and practice activities performed worse than their peers who did not have access to computers. His research has continued for each subsequent administration of NAEP assessments across all content areas, most recently with the US History assessment in 2004, and his earlier findings have been substantiated (Wenglinsky, 2006).

While the findings of these studies suggest that student performance improves with the use of computers and other instructional technology in the classroom, the ways in which the technology has been used are significant. The research suggests that in different learning environments the results may vary, depending on how the teacher creates learning opportunities for the students, including both drill and practice for remediation and also higher order simulations and problem-based activities.

Twenty- First Century Literacy

While the importance of the integration of instructional technology on student performance has been a focus of research for more than two decades, the current emphasis on twenty-first century literacy skills reinforces the level of impact on student performance that occurs when technology is fully integrated into instructional practice. Research by Cheryl Lemke and Ed Coughlin of the Metiri Group (2001) in collaboration with the North Central Regional Education Laboratory (NCREL) reveals that technology serves as a bridge to more engaged, relevant, meaningful, and personalized learning, all of which can lead to higher academic achievement. Research indicates that when technology is used appropriately,

children learn more, even as measured by conventional tests (Newmann et al., 2001; Wenglinsky, 1998, 2006). After years of research, a group of twenty first century literacy skills were identified by the Metiri Group which include specific technology skills, but which also have an expectation that technology will be used appropriately in all areas of literacy. The skills include:

• ***Basic Literacy:*** Language proficiency and numeracy at levels necessary to function on the job and in society to achieve one's goals and to develop one's knowledge and potential in this Digital Age.

• ***Scientific Literacy:*** Knowledge and understanding of the scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity.

• ***Economic Literacy:*** The ability to identify economic problems, alternatives, costs, and benefits; analyze the incentives at work in economic situations; examine the consequences of changes in economic conditions and public policies; collect and organize economic evidence; and weigh costs against benefits.

• ***Technological Literacy:*** Knowledge about what technology is, how it works, what purposes it can serve, and how it can be used efficiently and effectively to achieve specific goals.

• ***Visual Literacy:*** The ability to interpret, use, appreciate, and create images and video using both conventional and 21st century media in ways that advance thinking, decision making, communication, and learning.

• ***Information Literacy:*** The ability to evaluate information across a range of media; recognize when information is needed; locate, synthesize, and use information effectively;

and accomplish these functions using technology, communication networks, and electronic resources.

• ***Multicultural Literacy:*** The ability to understand and appreciate the similarities and differences in the customs, values, and beliefs of one's own culture and the cultures of others.

• ***Global Awareness:*** The recognition and understanding of interrelationships among international organizations, nation-states, public and private economic entities, sociocultural groups, and individuals across the globe. (Lemke & Coughlin, 2006)

The authors of *Digital Transformation*, a recent report published by the Educational Testing Service's Center for Global Assessment, define today's literacy as the ability to use "digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (International ICT Literacy Panel, 2002, p. 2). In other words, although reading, writing, listening, and speaking are necessary, today's students must be able to create meaning and express ideas through a variety of media, most of which is digital.

According to Howard Lee, Chair of the North Carolina State Board of Education, "in the years since 1985, we have witnessed a dramatic shift in the needs of business and industry and society in general. These changes have been collectively heralded as the Information Age. The 21st century will bring new challenges in preparing students for the demands of an Information Age. While students must attain enabling skills such as reading, writing, and computing, they must also attain the new basics which include creative thinking and problem solving, interpersonal skills, negotiation and teamwork." (NC Standard Course of Study, 2002)

Professional Development Necessary for Effective Technology Integration

One of the most significant factors leading to the effective use of computers in the classroom is the training that teachers have had prior to the introduction of the technology. Thomas Kuhn (1962) examined the manner in which a scientific community changes its practice when a shift occurs in shared assumptions. These same shifts may occur in the social sciences, including education, when there is new information or technology that leads to changes in assumptions. These shifts have come to be widely referred to as paradigm shifts. A paradigm may be considered a set of lens through which to view a set of data and the corresponding shift occurs when a new set of lens is used to view the data. The paradigm within which a group operates guides and informs the way facts are gathered because research tries to support the current paradigm. The use of instructional technology in a classroom may be considered a paradigm shift in traditional education and requires a new skill set that a veteran teacher may not have or with which a beginning teacher may not have practical experience. In order to determine the type of professional development that a teacher needs, the researcher works within one of two different paradigms. In one paradigm, the teacher needs to develop skills to use the technology to enhance prior pedagogical skill. In a second paradigm, the teacher's role in the classroom changes and not only does the teacher need to develop technology skills, but a new set of pedagogical skills as well.

Bernie Dodge (1995) recognizes that there is a challenge inherent in the changing needs of classroom teachers that can be viewed as a continuum of learning that begins with college courses for education majors and continues with professional development for current teachers. He states that "the most fundamental element in education is change. This is implicit in its very definition. All learning requires change. Education as a process must proceed or move ahead" (p.1). He suggests that the computer is not the only solution to

issues that are facing schools today, but that computers can be one of the solutions, given the appropriate training.

Some of the earliest research in the type of professional development that classroom teachers need was conducted by the Apple Classrooms of Tomorrow (ACOT). The studies by ACOT identified five stages of teacher development: entry, adoption, adaptation, appropriation, and invention (Sandholtz, Ringstaff & Dwyer 1997). In order for teachers to integrate technology into their instruction, they first had to develop the technology skills at the entry and adoption levels.

Teachers are recognized as change agents who have the power to make a difference in classroom practices (Hurst, 1999). In a seminal study on pedagogical content knowledge, Schulman (1986) determined that pedagogical content knowledge required both knowledge of the content area and knowledge of the pedagogical skill needed in order to teach that content area, which he identified as Content, Pedagogy, and Knowledge (CPK) skills. Koehler and Mishra (2004) extended that concept to add the technology skills necessary to teach a specific content area. Technology pedagogical content knowledge (TPCK) is the skill set that teachers need to know in order to effectively integrate technology into their instruction. The authors described it as a useful frame of reference for researchers working in the area of teacher use of technology. TPCK can help a teacher determine the best technology to use in the instruction of math, social studies, science, or language arts, because the integration of the technology will vary from one subject to another. Teachers therefore need to have training that focuses on the instructional technology that will best enhance the content specific instruction. Research on classroom use of technology has determined that teacher skills are fundamental for effective use of instructional technology and that

professional development is the catalyst to transform teaching practices that effectively use technology (Grove, Strudler, & Odell, 2004).

Koehler, Mishra, Hershey, & Peruski (2004) suggest that current research on teacher learning, teacher adoption of technology, and cognitive sciences as well as personal experiences have led them to the conclusion that the ability to teach with technology is much more complex than mere acquisition of mechanical skills. Viewing teacher knowledge for technology integration as being a transaction between the three factors of content, pedagogy, and technology has significant implications for teacher education and teachers' professional development. They further argue that an overemphasis on skills-based training (e.g., workshops) puts too much focus on the Technology (the "T") in their model, without developing knowledge about its relationships to Content and Pedagogy (the "P" and "C" in their model). Therefore, the development of an understanding of and the ability to use technology requires intensive, meaningful, and authentic interactions with technology.

The TCPK framework is based on four principles.

> Principle 1. Teachers' ability to use technology must be closely connected to their ability to teach; that is, good-teachers-with-technology must first be good teachers. Their understanding of technology must be grounded in their understanding of teaching and learning in subject-specific and learner-specific contexts.
>
> Principle 2. Technology, like language, is a medium for expression, communication, inquiry and construction that can help teachers solve pedagogical problems in classrooms. The most effective environment for teachers to learn to teach with technology is one that provides ample opportunities to engage in authentic uses.
>
> Principle 3. The implementation of technology is the reinvention of technology. The realization of technological potential in educational settings is socially constructed and highly situational. Therefore, teachers should actively participate in the construction and reinterpretation of technology in their own teaching within a visible community of practice

> and inquiry that is both dedicated to and engaged in standards-based teaching and learning.
>
> Principle 4. The relationship between technological innovation and established educational practices is dialogical. Technological innovation pushes pedagogical change, but it is also selected and redefined by existing pedagogy. Technological innovation should be anchored in thoughtful pedagogical practices while serving as a catalyst for change. (Koehler, Mishra, Hershey, & Peruski, 2004)

Alfred Bork (1995) examined the problems he perceived with professional development for teachers and the failure of teacher education programs, which resulted in several observations. He argued that the problem of poor quality teacher education is important when one considers the new technology, changing curricula, or new theories and pedagogy in education. Those changes are usually covered by in-service education, frequently delivered by giving lectures to the teachers. Additionally, technology professional development is not effective if it is lectured about and must be delivered in a hands-on venue. For this reason, Bork found that most technology professional development was ineffective at the time of his research.

While there have been improvements in the delivery of professional development, critics argue that if the professional development occurs in isolation it is not effective. A significant body of research has found that teacher knowledge, including knowledge about how to use technology, is situated and local (Ball & Cohen, 1999; Borko & Putnam, 1996; Lampert & Ball, 1999; Putnam & Borko, 2000). The knowledge is not only about what technology can do, but also what technology can do for them in their own school or instructional setting. The process of learning to use technology is a process whereby teachers understand the meaning and implications of a technology and translate it into a solution for a local problem within their school or classroom. Teachers need opportunities to apply what

they are learning in a variety of contexts over time, including classroom contexts, in order to develop sufficient confidence and skill to adapt new ideas to future situations (Bosch & Cardinale, 1993; Willis & Mehlinger, 1996). They also need opportunities to tackle authentic pedagogical issues related to standards-based subject matter teaching, and explore potential technological responses to issues (Rosaen, Hobson & Khan, 2003). Koehler, Mishra, Hershey, & Peruski, (2004) explain that "it is essential for teachers to engage in experimenting with technology in response to authentic problems that they are likely to encounter in their teaching" (p. 30). Given these realities, professional development must be evaluated in order to determine if the intended outcome has been achieved.

Models of Professional Development Evaluation

The Success Case Method (SCM) developed by Robert Brinkerhoff (2003) is an evaluation model for business that can help leaders quickly find what is happening with new initiatives. Brinkerhoff defines evaluation as the general methodology that is available for finding out how well things are working. The Success Case Method is based on story-telling as a means of conveying information about what is happening in an organization. The stories are combined with other evaluation methods to "lend credibility to the emotional impact of the stories" (p.xi). In an SCM evaluation, there are four basic questions that should be answered: (a) What is really happening?; (b) What results is the program helping to produce?; (c) What is the value of the results?; and (d) How could the initiative be improved? Those questions can be modified and extended to deal with issues specific to each individual situation. The benefits of using an evaluation such as the Success Case Method include the speed with which information can be gathered, the ability to identify best practices and increase the general knowledge about what is happening in the classroom, and

the ability to provide models of what is working in order to motivate others. There are two parts of the Success Case Method. First, through a survey, success cases are identified by those individuals who have had success in implementing the identified strategy. Second, the successful individuals are interviewed to identify the actual level of the success that they have reported and to verify or document evidence of the success.

An evaluation model introduced in 1959 by Donald Kirkpatrick and later republished in1994 identifies four distinct phases of professional development evaluation: reaction to the training, learning that occurs, changes in behavior as a result of the training, and results of the training. These four phases are well known and widely used to evaluate training in a variety of organizations. Reaction to the training can be gathered using feedback forms, either on paper or online, and can be gathered quickly. Learning can be evaluated by administering pre and post tests to the participants to determine if they learned the intended skills. Changes in behavior of the participants cannot necessarily be determined immediately after the training because the purpose is to determine if the participants have put the training into practice. Changes in behavior can be documented through observation or self-reporting. The fourth phase measures changes in performance indicators as a result of the training. The measurement instrument for teacher training might vary from the amount of time logged onto the internet, if increased online activity is a training goal, or increased student performance on standardized tests, if increased student achievement on specific learning objectives is a goal.

Thomas Guskey (2002) defines evaluation as the "systematic investigation of merit or worth" (p. 46). In Guskey's evaluation model, he believes that every activity that contributes to a teacher's bank of skills is considered professional development, whether it is a

workshop, a study group, action research, or collaborative planning, and that all of these are important. Therefore, evaluation should be able to determine if they have achieved their purpose. Guskey has added a fifth dimension to the Kirkpatrick model by looking at the organizational structure that needs to be in place to support implementation of the new skills. Guskey has five critical levels of evaluation: (a) participant reactions; (b) participant learning; (c) organizational support and change; (d) participant use of new knowledge; and (e) student learning outcomes. Guskey further indicates the type of instrument that most appropriately provides data at each of the five levels.

Participant reaction is measured through a questionnaire at the end of a session that includes both rating scales and open-ended questions. The information that this type of questionnaire provides is very general, and therefore, may be obtained using a generic questionnaire that is the same for all professional development. Participant learning can be demonstrated through the development of instructional activities that participants develop. At level three, questions must address the characteristics of the organization that will make implementation of the new skills possible. Interviews can be conducted in order to gather information about the organization, as well as examining the records of the organization. In order to evaluate level four, teachers have to be given enough time to use the new skills. This information can be gathered using structured interviews or questionnaires. For level five student learning outcomes, Guskey cites the work of Joyce (1993) which explains the importance of using multiple measures of student learning because there are often unintended student outcomes. In North Carolina, the primary measures of student achievement are the standardized testing results for End of Grade or End of Course tests, however as indicated

earlier the North Carolina Standard Course of Study recognizes the importance of problem solving and use of information to create new meaning. (2002)

Guskey explains that an important distinction exists between evidence of the impact of professional development and proof of student achievement as a result of the professional development of the teacher. Professional development takes place with teachers who do not work in a controlled setting; therefore many variables may effect student achievement and can occur simultaneously (Guskey, 1997; Guskey & Sparks, 1996). While it is virtually impossible to isolate the impact of a professional development program on student achievement, evidence can be gathered that indicates whether professional development has contributed to student gains. For this reason, it is important to gather evidence of student work products, anecdotes, and stories such as those gathered in Brinkerhoff's Success Case Method.

Guskey's work has formed the basis of the Backmapping model of evaluation that is currently supported by the National Staff Development Council. JoEllen Killion (2002) of the National Staff Development Council has developed a model of planning staff development in order to improve student performance. The five steps of her plan include:

(a) analyzing student performance data to identify student learning needs

(b) identifying target(s) for educator learning and development

(c) identifying results-based staff development interventions aligned with targets

(d) designing and implementing staff development intervention(s) and evaluation

(e) providing ongoing support for learning and implementation of new skills

Killion takes the position that "beginning with the end in mind is the first step to insuring that students will benefit from staff development" (p. 31). Beginning with a close

examination of current student levels of performance and an examination of what needs to happen in order to move them forward, helps teachers to seek the professional development that will help them to move the students in the direction that they intend.

While professional development is planned with the intent of helping students make gains in achievement by providing teachers with the skills that are needed, as all of the models of evaluation discussed here imply, there may be barriers to the implementation of the skills that teachers learn.

From Professional Development to Instructional Implementation

Charles Claxton and Patricia Murrell (1987) described the adult learning cycle in four steps: concrete experience; where the learner engages in new information through personal actions or observation, reflective observation; where the learner processes and transforms the experience to fit his or her classroom needs; abstract conceptualization, where the learner forms generalizations about the new learning and is able to use the learning in classroom teaching; and active experimentation, where the learner tests the concepts in other situations or content areas. If the adult learning cycle is associated with the desired outcome of implementation, then the professional development sessions must include a variety of activities that engage the learner and provide opportunities to develop and demonstrate the learned skills, which according to Pamela Nevills (2003) include:

- observing demonstrated lessons;
- studying the use of instructional materials;
- collaboratively planning lessons;
- modeling and critiquing lessons;
- observing other educators in the classroom;

- problem-solving scheduling concerns.

When the professional development involves the acquisition of technology skills there must also be consideration for the variety of skill levels of the participants. The individual needs and concerns of learners must be considered when planning professional development for later implementation (Hord, Rutherford, Hunling-Austin, & Hall, 1987). If teachers are introduced to skills beyond their level of comfort, they will be frustrated and will not move beyond the specific skills that they may master during the professional development. One strategy that has shown success in helping teachers overcome the anxiety about skill implementation with technology has been the addition of a school-based technology facilitator or technology coach. (Saylor & Kehrhahn, 2003) The role of the technology facilitator is varied, but includes such responsibilities as direct instruction, support, resource coordinator, collaborator, and mentor.

Another critical component for the successful implementation of professional development into instructional practice is strategic administrative support (Boe (1989) Persky (1990), and Stager (1995). Administrators can articulate the vision for the use of technology in the school then provide a level of expectation that the entire learning community works toward that vision. When administrators participate in learning sessions, develop their own goals for technology use, and provide the support that teachers need in order to implement the skills, there is a greater likelihood that the skills will be implemented. Ways that administrators can support the implementation of new skills include: establishing flexible schedules so teachers can practice what they learned, encouraging team teaching and peer coaching, allowing teachers to visit each other's classrooms to observe technology

integration, and scheduling opportunities for teachers to plan and discuss using technology in instruction (Persky, 1990).

Finally, peer collaboration provides collegial support for teachers to implement new skills, especially in the area of instructional technology, where a teacher may lack confidence in his or her skill level. Technological professional development must provide a safe environment which is aware of the individual teacher's level of experience (Browne & Ritchie, 1991). During the professional development, collaborative problem solving and project development, along with cooperative learning, provide the support that reluctant learners will need to implement the new skills (Persky, 1990). Peers within the learning community remind individuals to focus on and achieve goals (Wexley & Baldwin, 1986). Reluctant learners may observe in classes where instructional strategies are being implemented successfully (Broad, 1997; Browne & Ritchie, 1991). While research indicates that there are factors that support the implementation of new skills, there is also research to support barriers to the implementation of those newly acquired skills.

Barriers to Technology Integration

Strehle, Whatley, Kurz, & Hausfather (2001) examined the ability of teachers to integrate technology into their courses and found that there were four themes that were common to the teachers surveyed: (a) teacher commitment to change; (b) barriers such as time to plan and inadequate equipment and software; (c) difficulty in using the technology in instruction; and (d) teacher attitude about technology. In schools and classrooms where technology is available, the teacher is no longer the primary source of information and, especially where internet access is available at school or at home, students can access information independently. Students can check on the veracity of information provided by

the teacher and can seek information to answer virtually any question posed by the teacher. The role of the teacher must change from information provider to a role of facilitator who sets up tasks and poses problems for students to solve with the information that is available (Healey, 2001). This reflects a significant change in the paradigm of a teacher and creates a barrier to the implementation of the technology if the teacher is unwilling to change.

In 2003 Edwina Spodark identified five obstacles to technology integration at Hollins University, a small liberal arts university, which can be generalized to other educational institutions. Her study examined the lack of integration in a situation where there was neither a lack of technology available nor a lack of technology support for the staff. Spodark's staff position was that of instructional technology/integration facilitator. Decisions about the hardware and the software that would be used at the school could be made in the absence of a vision about how the equipment would be used in instructional settings. The first obstacle that she identified was the lack of a clear vision for the use of the integration. Secondly, leaders cannot only give lip-service to the use of technology; they must model the technology use and seek input from others who have more experience. The third obstacle that Spodark identified was the lack of critical mass in technology available in classrooms. This may also be a result of a lack of vision and leadership in deciding how to spend instructional funds. If the resources that are available must be transferred from one classroom to another it "adds another layer of work on top of the educator's regular teaching duties." (p. 20) The fourth obstacle was a lack of extrinsic incentives for the additional efforts that were involved for successful integration to occur. Finally, limited faculty participation in the integration of technology was a barrier. There were faculty members who will integrate the technology

regardless of what the obstacles were, but more than 80% of faculty in her research would wait until they were driven to the use of technology in instruction.

Spodark's findings at Hollins University are consistent with the work of Jamie Mackenzie (1999) who suggests that integration will not occur in K-12 classrooms unless learning goals are very clear. Teachers have to be shown the connection between the curriculum and the tools. He suggests that in order to drive this connection, technology goals must be written into curriculum guides. Unlike others who suggest that there should be universal access to technology, Mackenzie advocates for extensive placement of equipment in the classrooms where teachers intend to use the equipment. Those teachers will model effective use of the equipment that other teachers will emulate later. He suggests that the placement of a single computer in every classroom is futile.

Conclusion

In the United States billions of dollars have been spent on instructional technology for K-12 schools, with the expectation that the impact of that spending would have created a changed instructional landscape. The use of instructional technology has received mixed support after more than a decade of focus on the use of the technology for instruction. Critics have argued that teachers have not been effective in integrating technology for a number of reasons, including lack of skills, lack of a clear vision, and lack of an understanding of the pedagogy required to change what happens in a technology-rich classroom. In order for teachers to use the technology that has been placed in their classrooms in ways that will have a positive impact on student performance, a professional development framework needs to be developed. The professional development framework must create a vehicle for determining the student learning outcomes, determining the most appropriate instructional strategies,

determining the best integration of technology into the instruction, and determining what professional development must take place in order for this to occur.

A number of studies have been conducted on the factors that impact student performance in the classroom including, but not limited to, facilities, teachers, and the curriculum that is taught. Since the inception of the widespread use of computers and other instructional technology in the classroom in the 1990s there has been close scrutiny about the way that the technology is used and how it impacts student performance. Ongoing studies have provided evidence of mixed results about student performance including a meta-analysis of the 5 largest scale studies of educational technology for the Milken Exchange (Schater, 1997). The studies examined the use of instructional technology in a variety of settings and were generally positive about the ways that technology has impacted student performance. There is not universal support however that the impact computers have had on students has been positive. The research of Bork (1995) and others suggest that the use of technology has fallen short of engaging students in meaningful ways that will bring about long-term changes in instructional practices in the classroom.

Two of the factors that determine the way in which the computer is used in the classroom are the teacher and the instructional goals for the student. Research (Bosch & Cardinale, 1993; Willis & Mehlinger, 1996) indicates that in order to use the technology effectively in the classroom, the teacher must have training and continuous support, along with curriculum goals that can be supported using technology. Training should include both the skills required to use the technology tools as well as pedagogical practice that integrates technology in order to drive the changing practice in the classroom.

Conceptual Framework of the Study

Figure One

Factors Impacting the Relationship between Instructional Technology and Student Performance

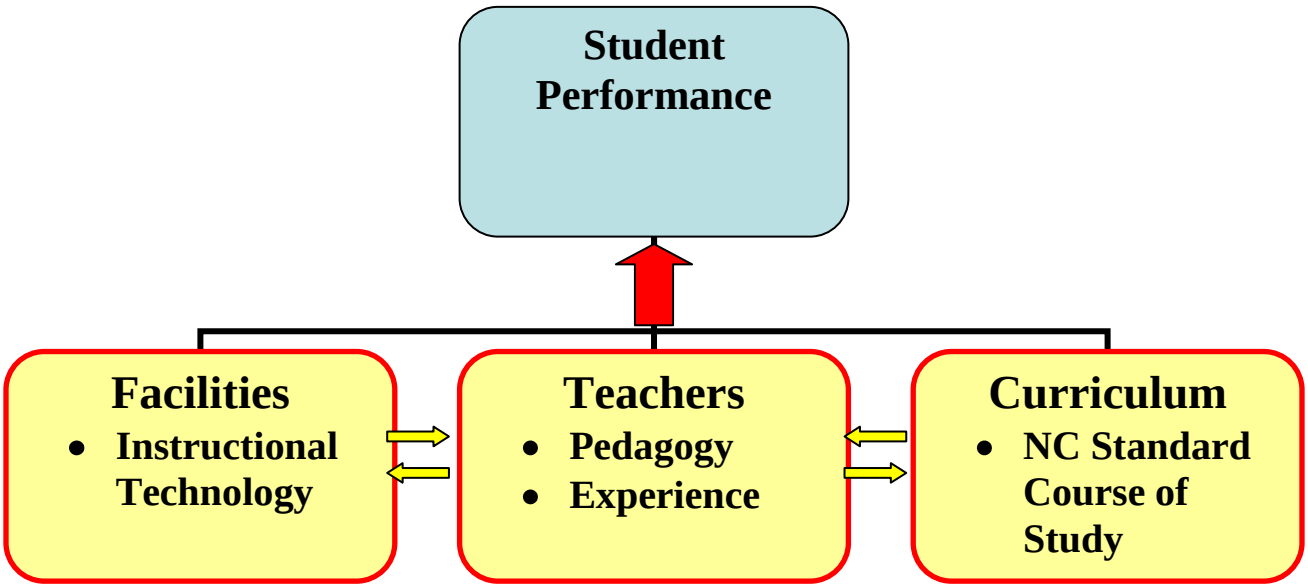


Figure One represents a conceptual framework to begin this study of the impact of instructional technology professional development on student performance. Three primary elements contributing to student performance are facilities, teachers, and curriculum. For the purpose of this study the facilities that will be examined are instructional technology and the infrastructure that supports it, such as networked computers and technology support. The curriculum in this study is the North Carolina Standard Course of Study. The teachers are the instructional personnel at the classroom level that guide student learning. Teachers have professional development in all three areas including instructional technology professional development, pedagogical professional development, and curriculum professional development. This study seeks to identify the factors of instructional technology

professional development that lead to the change in teacher practice in ways that impact student performance. This study will examine whether a specific instructional technology professional development program, *The Wired Classroom*, is helping secondary teachers understand ways to adapt pedagogy in order to effectively use technology to guide student learning.

The significance of this study is that evidence gathered from this study will lead to improved professional development that will guide more effective use of instructional technology in classrooms and will positively impact student performance. There is a limited amount of both time and money devoted to professional development for teachers, and therefore decisions must be made by teachers to make the most effective use of professional development opportunities. Organizations that plan professional development must develop effective professional development that will lead to positive changes in teaching practice, which will therefore lead to improvement in student performance.

CHAPTER III

METHODOLOGY

The purpose of this research is to investigate how instructional technology professional development impacts the instructional practice of secondary teachers and therefore their ability to impact student performance. Qualitative methods have been widely used in educational research and Johnson (1995) suggests that technology educators enter into research that probes for deeper understanding instead of reviewing superficial features. He notes that qualitative methodologies are powerful tools for enhancing our understanding of teaching and learning, and that they have "gained increasing acceptance in recent years" (p. 4). A method that has gained attention is grounded theory. Grounded theory is concerned with the development or generation of theory from data, rather than verification of theory, by discovery of what the world appears to be in the eyes of the participants. According to Glaser (1998) grounded theory is “trying to understand the action on a substantive area from the point of view of the actors involved.” (p. 115) In their text *Discovery of Grounded Theory*, Glaser and Strauss (1967) describe the primary goal of qualitative research to generate a theory which is an “ever-developing entity” or process (p. 32). They claim that grounded theory must be general enough to be applicable in diverse situations. That is what makes grounded theory an appropriate tool to use in situations that lead to examination of teaching and learning.

The primary reason that grounded theory was selected for this research model is that grounded theory emphasizes understanding the voice of the participants in building theory about the phenomena of changing classroom practice. Strauss and Corbin (1990) state that "theory is discovered, developed, and provisionally verified through systematic data collection and analysis of data pertaining to that phenomenon" (p. 23). In this study interviews with teams of teachers were analyzed to develop a theory that explains the impact of instructional technology professional development on teaching practice and therefore on student performance. This theory addresses the ability of teachers to implement strategies as well as the barriers to implementation of new skills acquired during the professional development sessions.

To review, the major research question is: how have the instructional technology professional development experiences of secondary teachers in North Carolina schools impacted teacher practice and therefore, student performance? The research questions that will guide the study are:

1. How has technology professional development of teachers impacted their instructional practice?
2. How have teachers integrated technology into their instructional practice as a result of professional development?
3. How has the use of instructional technology in classrooms where teachers have had professional development impacted student performance?

Role of the Researcher

The role of the researcher in this study was to develop open-ended questions that were used for interviews in focus groups of faculty members within a school, to conduct

the research, and to analyze the data. The researcher in this study was a former developer and facilitator for *The Wired Classroom* professional development, the program in which the participants were learners. The researcher was a member of a team of teachers who developed the professional development and delivered it during one week summer sessions between 1994 and 2005, and therefore was very familiar with the professional development that was provided. The researcher was not a facilitator for the participants' teams and had no contact with them prior to the interviews. The researcher is currently a staff member of the organization that delivered the instructional technology professional development in which the teachers were participants.

Participants

A purposeful sampling technique was used to select participants for this research. Purposeful sampling is the process of selecting "particular subjects to include because they are believed to facilitate the expansion of the developing theory" (Bogdan & Bilken, 1998, p. 65). Because the purpose of the study was to develop a theory of the ability of teachers to implement specific instructional strategies in their classrooms after participation in specific professional development, the participants included secondary teachers who had been participants in *The Wired Classroom* professional development summer sessions provided by the North Carolina Teacher Academy.

The Wired Classroom professional development is a five day professional development session that is offered in a residential campus setting to teams of teachers from schools selected for participation in the sessions. Teams of teachers, including an administrator, are selected to attend the session based on their application which includes their plan for incorporating the new skills into their school at the conclusion of the session.

The summer session is followed by two follow-up sessions in the fall and the spring to review the success of implementation and introduce new skills. Participants for this research were selected at the conclusion of the school year following the professional development in order to have a full year in which to implement the skills that were learned. Appendix C provides an overview of the professional development session.

Procedure for Soliciting Participants

Fifty secondary teachers from six schools who attended *The Wired Classroom* during summer sessions in 2006 served as the participants in the study. The majority of the participants were females; 36 participants were female and 14 participants were male. Participants represented several racial-ethnic groups; 19 were African American, 1 was Asian, 23 were Caucasian, 2 were Hispanic, and 5 were Native American. Participants reported years of teaching experience ranging from 5 to 30 years in a variety of different content areas including English/Language Arts, Social Studies, Math, Science, Fine Arts, and Exceptional Children. Secondary participants taught at both middle and high schools, with 22 teachers from high schools and 28 teachers from middle schools.

Specific criteria for participation in the research project included membership in a team that had applied to and participated in *The Wired Classroom* North Carolina Teacher Academy summer residential professional development session. Team selections were made by the North Carolina Teacher Academy based on selection from a field of applicants that represented demographic diversity, an intent to implement the skills acquired during the training, and a self-reported need for the specific training as identified in their School Improvement Plan. While the professional development sessions included teams from both elementary and secondary schools, a decision was made to focus on secondary teams for this

research. The decision to include all of the members of a team from each school was made as a result of the Teacher Academy philosophy of training a team of teachers from a school, rather than individual teachers, in order for them to support each other in the implementation of new strategies. Each school team selected by their peers to attend the North Carolina Teacher Academy is representative of the faculty at the school and makes a commitment to return to the school the following year and share new skills with their colleagues.

The researcher contacted the team contact for each school via email to request that they participate in the research. The purpose of the research was explained to the team leaders. They were told that they would receive a letter requesting the participation of members of the team from their school. A letter was mailed to each school explaining the research and requesting participation. The team leader from each school determined a time and location for the focus groups to meet.

Prior to the focus groups held at each school, the nature of the research was explained so that an informed decision about participation could be made. Participants were informed about their selection as participants and that their names, as well as the name of their school would not be revealed. Prior to participation in the focus group participants were asked to sign an informed consent that outlined their participation in the research project. The informed consent explained that participation was voluntary and confidential outside of the group. Group members were asked to respect the confidentiality of the comments made during the focus group. Appendix A provides a copy of the informed consent.

Participant Profiles

Prior to participating in the focus groups, participants completed a questionnaire that provided background information about demographics, teaching experience, and

participation in professional development, which can be found in Appendix B. Teachers were asked to report about the computers, internet access, and other technology available in their schools for instructional purposes. Information provided on the questionnaire and gathered from the North Carolina Department of Public Instruction is reported below. The schools were identified with alphabetic codes (A, B, C, D, E, F) and team members from each school were identified numerically (for example A-1, A-2, B-1, B-2).

Team A was composed of five teachers from a high school in the central piedmont section of the state in a district that has three Local Education Agencies, two city districts and one county rural district. Team A is from one of the high schools in the predominantly white rural district. The school has total of 66 teachers who work with 933 students. African American students (N=6) scored significantly below the state average on End of Course tests, while the other demographic groups scored at the state level on all End of Course tests. Twenty seven percent of the school's teachers have earned advanced degrees. Within the focus group, three members have earned advanced degrees.

Team B was composed of ten teachers from a new middle school in the south central section of the state near a rapidly growing urban area. The school has a total of fifty teachers and serves 1030 students in grades 6-8. Students in the school score on the average 8-9 points above the state average on every End of Grade test disaggregated by every student group with the exception of Limited English Proficient students (N=27). Approximately one half of the school's teachers have earned an advanced degree. Within the team that participated in the focus group, each member of the team had earned an advanced degree.

Team C was composed of six middle school teachers from a large district in the southeastern part of the state. The school has a total of 90 teachers in a school that serves

443 students. The number of teachers in the school with advanced degrees is 31. The school is approximately one half white and one half African American and American Indian. In all demographic categories, students are performing below the state average on End of Grade tests.

Team D was composed of seventeen teachers from a high school in the eastern part of the state with a total staff of 52 serving 630 students. Twenty one percent of the teachers have advanced degrees and the students in all demographic areas score near the state average on End of Course tests.

Team E was composed of seven teachers from a middle school in the north central part of the state with a faculty of 49 teachers who work with 760 students. Sixteen percent of the teachers have an advanced degree. The students in every demographic area score significantly below the state average with the exception of the American Indian students (N=29).

Team F was composed of a team of five teachers from a middle school of 49 teachers serving 687 students. Eighteen percent of the teachers have advanced degrees. Students score significantly below the state average on End of Grade tests in all demographic areas.

Data Collection

Sources of data for the project included focus groups conducted with the teams of teachers from the schools that had been selected. The focus groups were used to gather data that would be used to develop the proposed theory. Focus group questions gathered information about the teaching practice of the participants as a result of attending the professional development sessions. Specifically, questions inquired about ways in which the teachers had changed their teaching practices, the ways in which instructional technology

was integrated into instruction, and the ways in which student work was completed in their classrooms as an indication of student performance. A secondary focus of the questions was any barrier to implementation of the instructional strategies and speculation about how teaching practice would change if barriers were overcome.

Interview

The primary data collection technique involved focus group interviews. Participants completed the interviews, which lasted approximately 60-90 minutes. Responses in the interviews were written and audio-taped. A semi-structured format was used in the data collection, which allowed the participants and the researcher the flexibility to expand upon the specific questions proposed on the interview protocol.

The researcher had no previous experience conducting focus group interviews, therefore a pilot focus group was held with a group of teachers who met the criteria of the identified participant teams. The purpose of the pilot focus group was to test the interview questions and to provide interviewing practice. Conducting the pilot interview allowed the researcher to receive feedback on interviewing skills and the focus group format. After the pilot interview, questions were added to the protocol however no significant changes were made to the protocol.

The final focus group protocol consisted of twenty open-ended questions. In addition to the questions, probes were used to ensure that all topics were included. The interview questions and probes are listed at the end of this section. These questions can be grouped into five main themes: how technology professional development impacted instructional practice, how teachers have integrated instructional technology into their teaching as a result of the professional development, how student performance has been impacted by the use of

instructional technology, what additional support was needed to implement the strategies learned in the professional development, and what barriers to implementation the teachers faced.

The focus groups began with introductory questions. Participants were asked non-threatening questions to make them feel comfortable in the focus group setting. The first group of questions asked participants about how technology professional development has impacted their instructional practice. Specifically questions were intended to determine if teachers believed that their instructional practice had been impacted by the professional development. The second set of questions focused on the integration of technology into instruction in the teachers' classrooms. The questions related to instructional technology differed from the instructional practice questions in that the professional development may have impacted the instructional practice without integrating technology.

The third set of questions focused on student performance in the classrooms as a result of teacher skills and the integration of instructional technology. Teachers were asked to assess student performance by observing changes in student behaviors that are not measured in traditional End of Course/End of Grade tests. The fourth set of questions asked teachers about any additional support that they needed in order to implement the new instructional strategies. Instructional technology requires technical support that may or may not have been available to the teachers. The final set of questions asked teachers which strategies they would have implemented, but were unable to implement because of barriers that they could not overcome.

Interview Protocol for Focus Groups

1. How has technology professional development of teachers impacted their instructional practice?
    a. What are you doing differently in your classroom now as a result of the technology professional development?
    b. What would you like to do differently that you haven't tried?
    c. What has prevented you from trying the activities that you haven't tried?
    d. How have you modified your instructional planning and practice?
    e. What skills have you learned that enabled you?
    f. What role did the assistance of your colleagues play in implementing new skills?
2. How have teachers integrated technology into their instructional practice as a result of professional development?
    a. What technology are you integrating into your instructional practice?
    b. What technology would you integrate if you had access to it?
    c. How would it change what is currently happening in your classroom?
    d. How is this an outcome of the professional development that you participated in?
    e. What additional professional development was necessary?
    f. How did you acquire these skills (conference, peer coaching, journal article, lesson plan database)?
3. How has the use of instructional technology in classrooms where teachers have had professional development impacted student performance?

    a. What difference has there been in student performance as a result of the professional development in the period since the teacher participated in the professional development?
    b. If students have improved can there be an association between the improvement and the skills learned in professional development?
    c. If there has not been an impact on student achievement, what factors would you identify that have contributed to that?
4. In order to implement the strategies that you learned in the instructional technology professional development, what additional support would be necessary?
    a. Observing a class when instructional strategies are used
    b. Access to equipment
    c. Time to collaborate and plan with teachers who use technology effectively
5. Do you think that if you were able to implement the strategies that you learned in the instructional technology professional development, there would be an impact on student achievement?
    a. What impact on student achievement do you think would have occurred if you had implemented the strategies?
6. How could you overcome the barriers that you have indicated might have prevented you from using technology in your classroom in ways that you had planned?

Data Analysis

Data analysis is described by Strauss and Corbin (1998) as a process of breaking down, organizing, and reassembling data in order to develop a different understanding of a topic. Following the procedures of Strauss and Corbin for data analysis in grounded theory

research, three coding procedures were applied: open coding, axial coding, and selective coding. This section describes how data was broken down and then reorganized in order to develop an understanding about how instructional technology professional development impacts instructional practice.

In order to illustrate the coding process, examples of coding focus group data are included in this chapter. While it may appear that the coding took place in different phases, some of the coding occurred simultaneously. Table One provides examples of focus group responses and coding.

Table One

Example of Focus Group Response and Coding

Passage	Concepts	Categories	Main category	Relational statement
I am more willing to let students work collaboratively than I was before the training.	Change in teaching practice	Teaching strategies Student collaboration	Pedagogy	Staff development leads to change in teaching practice
Support from the team was essential to the success of the team	Teachers support each other	Support for change	Support	Teachers receive support for change from colleagues

Open Coding

The "first step in theory building is conceptualizing" according to Strauss and Corbin (1998, p. 103). Open coding begins the process of breaking down data into concepts. After the focus group interviews were transcribed, they were reviewed and broken down into

segments that represented the main ideas of the participants. Transcripts and main ideas were reviewed by a peer editor to ensure that the research had accurately captured the concepts that the participants had thought were important. (Further information about this process is discussed in the section "Trustworthiness" later in this chapter).

Review of the data from the focus group interviews resulted in a list of more than seventy concepts and meaningful experiences. An example of concepts taken from the first example above "students work in different ways as a result of the training" and "teachers acquired skills necessary for changing student activities." Concepts involving the training that teachers received were categorized under "Teacher Training." The process of grouping concepts into categories comprises the second step in the coding process. In this phase of the process, the goal was to develop a list of categories regarding the changing teaching practices. As a result of comparing these concepts for similarities and differences a list of more than thirty four categories was constructed.

The process of coding interviews using the category list was the next step. Two people coded each of the interviews, the researcher and the peer debriefer. The debriefer assigned categories independently from the researcher, then worked with the researcher to reach consensus about the categories. Non-representative categories were eliminated and notes were written that examined the properties of each dimension.

Axial Coding

The purpose of axial coding according to Strauss and Corbin (1998) is to "begin the process of reassembling data that were fractured during open coding" (p. 124). Category notes were grouped into main and subcategories representing the experiences of the majority of the participants. Eighteen main categories emerged from the process. The Teaching

Strategies category previously referred to was grouped into a main category labeled Pedagogy that included all of the needed areas of understanding discussed by the participants. Notes and raw data were studied to determine the characteristics of this broader category. The Pedagogy category included information about what type of training had the greatest impact, how teaching practices were impacted, what additional training would have been needed. Based on participants' experiences that indicated a relationship between professional development, teaching practice, and support available in the schools, a relational statement was developed linking the main categories of Pedagogy and Support.

Selective Coding

Selective coding "is the process of integrating and refining categories" according to Strauss and Corbin (1998, p. 142). The primary goal of this step was to develop a theoretical scheme that explains how each of the categories related to each other and to identify a core category explaining the participants' experiences. The main categories were examined for similarities and differences. Passages representing each of the main categories were sorted and reviewed with a peer debriefer. As a result of this process three theoretical categories emerged. One of the categories that emerged was labeled "Teaching Strategies" and involved the main categories that identified the elements that teachers contributed to instructional practice. The organization of the data is located in Appendix E.

The analysis of relational statements resulted in the development of a scheme that linked the constructs. For example, one of the relationships proposed in the theory involves the relationship between the skills that the teachers acquired and the ability of the school to provide teachers with the technology support needed to implement the skills.

A diagram and a narrative describing the emergent theory were developed to explain the factors involved in the impact of the professional development on teaching practice in secondary schools. The story of each of the participants was reviewed to determine if it fit into the proposed theory. The specific components of the theory will be shared in the next chapter.

Trustworthiness

The trustworthiness, or validity, of any research study is a primary concern (Creswell, 2005). In qualitative research studies, the researcher must consider the data collection, the analysis, and the interpretation methods. Questions asked in the focus groups involved the degree in which they represent the participants' perceptions, whether other researchers would reach similar conclusions based on the data, whether the analysis process is flexible enough to allow for variations in experiences, and the degree to which study elements were described to allow for comparison to other populations and other studies. Some of the techniques that were used to ensure trustworthiness in this research study included triangulation, member checking, peer debriefing, and thick description.

Triangulation

Lincoln and Guba (1985) describe triangulation as a technique used to increase the trustworthiness of qualitative research by comparing the results from different sources to validate findings. In the present study, multiple focus groups were included and their experiences were compared to identify similarities and differences. The theory that was developed was based on the accumulation of common experiences, rather than data from a single team of participants.

Member Checks

Member checking according to Maxwell (1996) is the process of soliciting feedback from participants and is the "single most important way of ruling out the possibility of misinterpretation of the meaning of what they say and perspective they have on what is going on" (p. 94). In this research study, each focus group received the transcript of the interview. As main ideas were interpreted by the researcher, focus groups were asked to review the documents to determine if the researcher accurately captured the participants' perceptions and identified the main ideas appropriately. The participating focus groups indicated the need for no major revision.

Peer Debriefing

Maxwell (1996) indicates that "soliciting feedback from others is an extremely useful strategy for identifying validity threats, your own biases and assumptions, and flaws in your logic and methods" (p. 94). A single peer debriefer was part of the current research study. She filled several roles during the data analysis and interpretation including coding data and providing feedback on interpretations. The debriefer received background information about the study and about grounded theory methodology. After the peer debriefer became familiar with the raw data, the debriefer provided feedback on category lists and coding.

Thick Description

A rich, thick description of the elements of a study allows readers to decide if the results of the research are transferable according to Creswell (1998). In this study, detailed information about how the participants were selected was included in this chapter. A demographic questionnaire was administered to each participant and background information about the participants in each of the teams was reported. Information about the interview setting and the school in which each team of teachers was located was included which

documented the available technology equipment and support available to the teams of teachers. Records were kept throughout the data analysis process that documented the emerging theory.

CHAPTER IV

RESULTS

In this chapter the findings from the research are shared. The purpose of this research is to investigate how instructional technology professional development impacts the instructional practice of secondary teachers and therefore their ability to impact student performance. Grounded theory methodology was used in this research to analyze data gathered from focus groups of teachers from six schools that had attended *The Wired Classroom* professional development. The study explored how those teachers used skills learned in the professional development to change their instructional practice and student performance.

The emergent theory proposes that changes in instructional practice are best understood as the interaction between the professional development that teachers receive, the technology available in the classroom, and the support that the teachers receive to implement new skills. Analysis resulted in one comprehensive category, entitled "Technology Integration Pedagogy", which describes how teachers responded. Under this central category are four main supporting categories labeled "School Support", "Technology Available", "Teaching Strategies", and "Impacting Variables". More specific categories are organized under each of these.

The next section of this chapter provides a comprehensive examination of the constructs that comprise the emergent theory. The section begins with an exploration of the construct labeled "School Support." This construct describes the factors that teachers reported when working with elements which would support instructional practice and facilitate the implementation of new strategies. Following this is a description of the "Technology Available" and its impact on the emergent theory. The instructional skills and strategies developed through experience are examined in the section named "Teaching Strategies." The external variables affecting the implementation of instructional practice are explained under the "Impacting Variables" section. The chapter concludes with the examination of the central category called "Technology Integration" and a description of the emergent theory. Placement of the central category at the end of the chapter facilitates the understanding of the proposed relationships within and between the categories.

Direct quotations from the participants are included in the discussion of each construct in order to help with the development of the emergent theory. The Participant section in the methods chapter explains that each of the members of individual focus groups was given an identification code and quotations are coded using this identity. Richie et al. (1997) discussed a format using terms to indicate the frequency of comments. The phrases "many" and "most" were used to discuss concepts expressed by a majority of the participants. The words "several" and "some" were used to show that 10-20 of the participants supported a comment. "A few" was used to indicate a concept that was mentioned by fewer than 10 of the participants.

For each of the constructs and main categories, the number of focus group participants that supported the importance of the construct varied. Table 2 provides an

outline of the constructs and main categories of the theory along with an indication of how many participants supported the importance of each. To be included as a main category a minimum of 35 participants indicated the importance of the category.

Table Two

Endorsement of Main Categories (N=50)

Main Categories	**Number of Participants Endorsing Category**
School Support	
Administrative Support	40
Collegial Support	43
Technology Support	48
Technology Available	
Computers, labs, and laptops	50
Internet access	50
Availability of labs for instructional use	40
School level instructional technology coach	38
Teaching strategies	
Essential question framework	35
Multimedia presentation	45
Collaborative assignments	45
Impacting variables	
Student prerequisite skills	48
Student access to computers outside of school	45
Teacher transience	35
LEA/School Technology Plan	40

School Support

Professional development participants in the focus groups expressed a broad range of factors related to school support which varied both inter and intra school team.

Characteristics of administrative support are discussed first because an administrative team member, within the team of participants, was a common feature for each of the schools. Support for implementation of professional development can also come from colleagues and/or from a technology facilitator in the school, therefore each of these three areas of support will be discussed separately.

Administrative Support

One of the tenets of the North Carolina Teacher Academy professional development model is that a team of teachers recommended by the school faculty attends professional development, with required participation of a school level administrator. The school administrator participates in the identical professional development as the teacher, therefore learning the skills as well as what the implementation of the skills will look like in the classroom. The administrator also collaborates with the team during the week-long session to determine what will be necessary in order to transfer the new skills into the school and to create an Action Plan for the transfer of skills into instruction, both for the team members and perhaps for the rest of the staff.

Most of the focus group participants acknowledged the importance of having both administrative support and administrative leadership in the area of instructional technology. The administrator in a school makes recommendations for the purchase of new equipment and software, either develops or approves the school master schedule, including planning time for teachers, and participates in the development of the School Improvement Plan, as well as the School Technology Plan. The administrator can influence pedagogical shifts by encouraging specific behavior in instructional settings, such as the integration of technology into instructional practice. Administrative support can also include support from school

leadership planning and policy committees or teams. Leadership teams in most of the schools included specific technology planning teams that made decisions about the use of available technology resources, as well as the acquisition of new technology resources as money became available. In most schools, the principal or assistant principal is a member of the Technology Team or Committee, but other members of the team include the Media Coordinator, a representative from each grade level or curriculum area, and the Technology Coordinator or technology support staff if such a position is a member of the faculty in the school.

At School C the focus group reported that the Action Plan developed as part of the staff development was shared with the entire administrative team at the school. The principal then shared the plan with the Performance Improvement Council and the Technology Goal Team, which has begun to implement the Action Plan that was developed during the summer session. While the teachers who attended *The Wired Classroom* from School C are not members of the Technology Goal Team, the Technology Goal Team has been in continuous contact with the participants and has been involved in the implementation of plans to support the staff members. In School D, teacher D-2 had been appointed to the Technology Committee after returning from the summer break and was given the task of helping to spend school funds for computers. As a result of sharing the training that the team received in *The Wired Classroom* and the potential for effective integration of technology, the team made a decision to include the purchase of specific equipment. The team members from both Schools A and E reported that the members of the summer professional development team are also on the school technology team, leading to a school technology team that had all participated in the same professional development.

Collegial Support

Teachers attended *The Wired Classroom* professional development as a member of a team of five to fifteen members of the faculty from their school. While at the summer institute they developed instructional activities collaboratively that they could use when they returned to their schools at the end of the summer. Teachers were encouraged to plan time to share their new skills with the faculty of their schools at the beginning of the school year. The focus group from School B stated that "We scheduled several staff development sessions from January through March. At these sessions we taught other teachers how to use the programs that we learned at the professional development." In School E teachers returned from the summer session and gave an overview of the new skills learned during *The Wired Classroom,* including one or two examples of ways that the skill could be integrated in any classroom. Following that whole group presentation, individual team members went to grade level meetings and had grade level discussions about the use of the applications with the small groups.

The team from School A returned to school in the fall and presented staff development for the entire faculty by setting up stations for each of the skills that they mastered. Teachers rotated through the stations and received information in small groups. During the summer, this team met in the evenings and planned the ways in which they would share the information with the faculty, so they were prepared when they returned to school. The team that attended *The Wired Classroom* from School A was the entire technology team from the school and therefore had a good knowledge about the technology resources available to the teachers both in the school and in the district. They also developed a realistic action plan for implementation when they returned to their school.

Most of the teams reported returning to their schools and planning school level professional development to be offered during the subsequent school year. School E indicated that teachers who attended the professional development offered by the team members encouraged teacher participants to develop a lesson plan or instructional activity to be shared with other members of the staff at their school. In School F, teachers returned to the school and shared information gained informally with peers and invited other staff members to visit their classrooms when specific activities were modeled. Teacher D-2 indicated that with the new ways of managing data that she learned during the summer professional development, she could easily make multiple copies of instructional materials and units that she created so that they could be shared with colleagues.

The policy of attending *The Wired Classroom* with a team of teachers from the same school contributed to the ability of the teachers to implement the strategies that they acquired within their own classrooms, as a factor separate from sharing information with colleagues who did not attend the professional development. The team from School B indicated that the support from other team members was essential to the success of the group, because if there were a degree of difficulty in implementing a strategy, then the team encouraged a colleague to try to implement the skills or offered suggestions about ways that they had been able to implement the skill in their own classrooms. During the summer session teachers collaborated with team members to create curricular projects. This collaboration during the summer contributed to continued collaboration during the next school year unless their colleagues transferred to a different school. That barrier to implementation will be discussed later in this chapter.

Technology Support

Instructional technology, unlike other areas of pedagogical practice, requires support outside of the control of the classroom teacher. In order for the computer to work effectively the equipment must be maintained, the network must be maintained, and software must be installed, among other things. All of this support is prioritized, with system-wide priorities taking precedence over the needs of teachers in individual classrooms.

The focus of *The Wired Classroom* professional development is the integration of technology into instructional practice, however there is some direct instruction in the use of specific software programs as needed. Software decisions are based on the availability of the programs in North Carolina secondary classrooms. Software that was used during *The Wired Classroom* included Microsoft PowerPoint, Internet Explorer, Inspiration graphic organizer software, United Streaming video, and several free graphic editing programs. A trial version of both Inspiration software and United Streaming video were given to the participants in order to allow them to explore the available resources that could be used in their schools. The choice of software in the professional development sessions was determined by the software that is available in the greatest number of schools in North Carolina. Several school teams reported that the school had purchased a license for United Streaming video for the faculty to use. Teacher D-2 reported using United Streaming video clips in developing instructional activities, along with the blackline resources and the cross curricular resources that were provided to support individual video clips. In North Carolina, a number of school systems have purchased system licenses for Inspiration software, but teachers may have been unaware of the availability of the program in their system until they used the program in the summer session then returned to their districts and inquired about the availability. Most of

the focus group members reported returning to their schools and identifying software and equipment that was currently available to them, either at their school or at the district office.

Summary of School Support

Most of the teachers agreed that support from a variety of sources was essential in order to implement new skills learned during staff development. The support provided by the administrator could take the form of assigning members to technology or leadership teams within the school, as well as providing direct leadership that supported the purchase of new equipment, software, or creative scheduling that enabled teachers to plan and coach each other. Support from the administrator also depended on the emphasis that the administrator placed on the use of technology. Collegial support enabled teachers who attended professional development together to understand how to implement strategies, therefore enabling them to provide suggestions when a strategy might not work. A critical support position, in the opinion of all of the groups, was the role of technology support. In a school where the computers do not function effectively or remain unavailable a large part of the time, teachers do not have the ability to implement the strategies. Conversely, effective support for installation of new software, support for lab time, or instructional support with students enables teachers to focus on the content rather than the technology specific issues in an instructional setting. Teachers reported a variety of types of support and levels of support at individual schools.

Technology Available

In order for teachers to implement instructional strategies that integrate technology, there must be equipment, software, networking, and support available for the school. Teachers reported on a variety of technology resources available to them from classrooms

with a single computer with intermittent internet access to classrooms with multiple internet accessible computers to wireless laptop carts. Teachers returned to schools after their professional development experiences with the expectation that they could use the strategies that they learned. Their ability to implement the strategies depended in part on the technology available to them.

Computers, Labs, and Laptops

Every team indicated that there were computers available in their schools, both in labs, in the media center, and in individual classrooms. Two of the teams reported that they have instructional laptop carts that teachers can use for classroom instruction. The focus group from School B reported that one of their team members was appointed to the school technology committee. Member B-1 explained that his role on the technology committee was to help to determine how to spend school technology funds for computers and other resources. As a result of the summer training, he was able to persuade the team about the effectiveness of whole group instruction using computers and multimedia presentation software. The barrier to implementing that in the classroom previously had been the lack of data projectors; therefore the school technology committee ordered projectors for the entire school. The committee also decided to purchase a projector and large screen for use in the school cafeteria for large group presentations with faculty, parents, or large groups of students.

All of the schools in the focus groups indicated that all classrooms in the schools were equipped with at least one computer with internet access. Several schools indicated that the classrooms in their schools had more than one computer, with School A indicating that there are seven computers in the Yearbook Classroom that are available for student use

before school, after school, or when the Yearbook advisor makes the computers available. The team from School B has two computers in every classroom and teachers collaborate to allow students from other classes to come into their classrooms to use the computers when doing research or completing a project.

Most of the schools indicated that the Media Center in the school had multiple internet-ready computers available for student access. In those schools, the Media Coordinator provides some technology support for the faculty and students who use that equipment. Many teachers in the focus groups indicated that while they were not happy during the summer about having to share a computer with a colleague during the professional development, that is the reality of the school setting and collaboration with a partner is the way that students frequently use technology in their schools.

Internet Access

The availability of instructional resources and curriculum materials continues to grow exponentially with the rapid expansion of the internet. Teachers report that they do not have time during the instructional day to locate and evaluate the wealth of resources that are available. As a result, most of the teachers attending *The Wired Classroom* indicated that they learned about resources, of which they were previously unaware, that they could use in their classroom

Every team reported that there was internet access in their schools, both in classrooms and in instructional labs. Problems with internet access include lack of bandwidth for streaming video and restrictive firewalls that limit access to instructional resources. During *The Wired Classroom* teachers located internet resources to support their curriculum project, bookmarking those files using an online bookmarking program, iKeepBookmarks. Some of

the teachers were disappointed to find that their bookmarked files in iKeepBookmarks were blocked from their access at their school. Most of those teachers reported that they had not accessed their resources from their home computers or exported the bookmarked files to a different location. Focus groups from two of the schools in more rural areas in the state identified limited internet access as a barrier to their instruction which will be discussed later in this chapter.

Availability of Labs for Instructional Use

While every school reported computer labs within the schools, not every school had computer labs available for teachers to use with students for instructional purposes. At the high schools, the computer labs were used for vocational programs, online courses, and remediation. At the middle schools, labs that were available were restricted from instructional use frequently during the year because of mandatory testing and remediation before further testing. Many of the teachers reported that while there is an instructional computer lab in the school, scheduling conflicts prevented frequent availability for classes.

School A reported that a solution to the problem of inability to schedule lab time was to purchase laptop computers and mobile carts that could be transported to individual classrooms. The school faced a problem with shortage of space, even though the school was relatively new. After the school was built, the community grew rapidly and now even though the school is only seven years old it has already added several mobile classroom units to accommodate the growth. While there was not an empty classroom in which to create a lab, the school was able to purchase several mobile laptop carts and wireless internet hubs with the same amount of money, therefore creating a lab-like learning environment in any classroom.

School Level Instructional Technology Coach

One of the factors that contribute to the integration of technology strategies into daily instructional activity is technology support, either full-time or part-time, in the position of a technology coach, technology facilitator, or technology resource position. Some of the schools reported sharing a technology support position with other schools in their region, while some of the schools indicated that they had a full-time technology support person within their school. Two of the teams however reported that there was not a technology support position in any school in their district.

The role of the technology facilitator or coach in a school setting is a flexible position with a variety of responsibilities. Some of the responsibilities that focus group members indicated a school level technology position fills include:

- collaborating with teachers and other instructional staff to develop curriculum materials and specific lesson plans that integrate technology
- modeling the integration of technology in all curriculum areas
- facilitating school participation in technology programs and activities
- conducting staff development in the areas of technology integration, the North Carolina Computer/Technology Skills Curriculum, and the North Carolina Technology Competencies for Educators
- collaborating with the school library media coordinator to provide leadership in the school's use of instructional technology resources to enhance learning
- working with teachers and technology staff in the selection of resources that are compatible with the school technology infrastructure

- assisting with planning the design of the technology infrastructure so that information resources are continually available to the school community
- assisting in maintaining hardware, software, and network infrastructure

When schools that have a technology facilitator position on the staff apply to attend *The Wired Classroom*, they may include the technology facilitator as a member of their team. Of the teams that were included in the focus groups, only one school included the technology facilitator as a member, however two of the schools included the media coordinator as a team member. In schools where there is no technology facilitator, the media coordinator frequently assumes that role. In School A the focus team reported that "our technology coordinator is using the software programs and internet resources that we located this summer in all of the classrooms within our school."

Summary of Technology Available

The amount of technology available to each school is varied and changes within the school year depending on the demands that the school has for instructional resources. All of the schools reported a minimum of a single networked computer per class, as well as a minimum of a single instructional computer lab. In place of a fixed computer lab, some of the schools instituted a wireless laptop cart program that allowed each of the classrooms to become a computer lab for instructional purposes. Some schools had much more equipment available and a plan to purchase additional equipment as a result of the summer professional development. The role of a technology resource position provided both instructional support as well as minimal maintenance for the equipment in the school.

Teaching Strategies

The Wired Classroom professional development framework is organized around the North Carolina Standard Course of Study K-12 Computer/Technology Skills which identifies essential knowledge and skills that students should have in order to be successful in a technology-rich environment. Teams of teachers ranging from kindergarten to high school attend the week-long sessions, therefore the organization of the professional development models effective instructional integration regardless of the grade level in which the teachers work. Instruction during the week focuses on the three computer skills strands of telecommunications, multimedia presentation skills, and societal ethical issues. Word processing skills, spreadsheet skills, and database skills are taught at the district or school level using the applications that are available in each district and unique to each school, therefore they are not emphasized in *The Wired Classroom*. In order to focus on these three topic strands, teachers are asked to come to the sessions prepared to develop instructional activities that they will be able to teach within their school setting when they return in the fall. The unit development begins with an introduction to the concept of Essential Questions, or an organizational framework within which to work. Teachers use Inspiration, a graphic organizer tool, to develop the essential question into themes for a unit of study and further develop the graphic to include specific technology tools that will support the instruction. Teachers are encouraged to use the essential question framework when they return to their classrooms.

Teachers collaborate to design instructional activities including a multimedia WebQuest that uses PowerPoint as the vehicle for the delivery of a web-based authentic task. The development of the WebQuest models the way that students work collaboratively when

there are a limited number of computers available. In the development of the WebQuest teachers locate and evaluate appropriate internet resources, cite those resources appropriately, and use those resources to solve authentic tasks identified in the WebQuest. These activities model appropriate instructional practice for teachers to use when they return to their own classes with the resources that they have developed during their summer session.

Essential Question Framework

The North Carolina Standard Course of Study directs the instructional practice in every classroom in the schools. The revised *Standard Course of Study* has moved from a detailed, prescriptive curriculum guide to a more flexible guide to instruction, emphasizing what students should know and be able to do as they progress through various levels of proficiency and ultimately exit from high school. The revised curriculum focuses on themes and concepts rather than isolated facts. It emphasizes thinking skills and problem solving more than the memorization and recall of information. Efforts to improve thinking within a school or school system should be guided by a conceptual framework and comprehensive plan. The framework that was introduced to the teachers in *The Wired Classroom* professional development was the essential question framework as developed by Jamie McKenzie and incorporated into the Intel *Teach to the Future* model, which helps teachers understand the value of inquiry and develop effective questions which drive instructional planning.

Essential Questions are questions that help to develop higher order thinking skills by centering on broad issues and by creating a framework that encourages further questioning. Essential questions form the basis for inquiry-based learning. They are generally open-ended questions that lead to collaboration between students and teachers in an effort to serve as a

"hook" to engage students in the learning process. Essential questions require students to develop a course of action that leads to knowledge construction. They may be illustrated graphically or verbally and should become part of the student's course of action in solving a problem or completing a learning task.

The team from School E indicated that they developed essential questions about topics that they thought would "spark the students' imagination and make the best use of the technology available to them." Teacher D-2 emphasized the importance of teachers being able to ask the right kinds of questions that force students to compare, contrast, analyze, and interpret information. She indicated that in order to engage students they had to feel challenged. Teachers indicated that by designing a unit around an essential question the necessity of using technology-rich instruction became clear because students would have to locate and manipulate information in a variety of ways to solve problems or try to find answers.

Multimedia Presentation

The multimedia presentation program that was used in *The Wired Classroom* was Microsoft PowerPoint because that is the multimedia presentation program that is the most commonly used in North Carolina secondary classrooms. The multimedia program Hyperstudio was previously used in the Teacher Academy summer sessions when the majority of North Carolina schools were purchasing Apple computers; however when Microsoft Office became accessible on the Apple desktop and more and more schools purchased Windows operating system computers, the program decision was made to use PowerPoint. The instructional session during the professional development includes some instruction in the program; however the focus of the instruction is the use of any multimedia

presentation tool to create a WebQuest. PowerPoint is used to create a template for the development of a WebQuest program, an authentic learning model designed by Bernie Dodge from San Diego State University. During *The Wired Classroom* teachers collaborate, design WebQuests that integrate curriculum concepts, and develop the instructional activities on the PowerPoint template. The PowerPoint template was developed for use with WebQuests in an effort to solve the problem of teachers having limited ability to publish webpages directly to a school web server, or the problem of school level firewalls that restrict teachers from accessing resources that they published on public web servers like Geocities.

Most of the focus group members reported that they returned to their schools and used the WebQuests that they developed during the summer session. Team C reported that they not only used their activities with their students, they also shared the presentation with faculty members, along with providing additional examples about how the type of activity could be used in other curriculum areas. Teacher E-3 explained that the WebQuest developed in the summer was more appropriate for the curriculum taught by his colleague; however he has created several WebQuests that integrate math objectives for use in his classroom. Individual teachers from three of the schools have had technical problems in their classrooms that have limited their ability to use this tool. Those difficulties will be discussed further in this chapter.

Collaborative Assignments

When students work in classrooms where technology is a part of the instructional landscape students change the way in which they interact with each other. Students collaborate to solve more complex problems, using collaboration as a learning strategy rather than as an opportunity to chat with their friends. Part of this is related to the shortage of

technology or the inability to schedule classes for an extended period of time in a school computer lab. It is not unusual for students who are using computers to complete a research task to eagerly share the examples that they find with their peers. Students work together to complete assignments, including WebQuests and multimedia presentations.

Teachers from School B agreed that they are more willing to allow students to collaborate on projects as a result of their collaboration with colleagues during the professional development. When students work collaboratively they develop improved skills in the areas of organization, planning, and communication. Students learn to take more responsibility for their work. Teachers from School A echoed that and indicated that throughout the school, students were working collaboratively on more digital projects in all content areas and for all teachers.

Summary of Teaching Strategies

Teachers reported a variety of changes in their teaching strategies as a result of the professional development sessions. Some of the teachers indicated that they were more likely to engage students in higher order thinking skills as a result of framing instruction around essential questions that stimulated interest in a topic. They developed collaborative activities for students, encouraging them to find solutions to authentic tasks. Teachers reported that the lack of the availability of computers for each child led to collaboration on multimedia projects. Teachers supported more independence from students, having a greater understanding of how the students were using the technology.

Impacting Variables

In every learning situation there are external variables over which a teacher has little or no control. When working with instructional technology some of those factors are related

to the equipment, however some of those variables are related to student skills. In this generation of digital natives students do not remember when they learned to use a computer because it has been such an integral part of the landscape of their lives. All students however do not share the same access to technology outside of the classroom. Teachers have to realize that there are differences and accommodate for those in their classrooms.

Both the federal and the state governments recognize the importance of technology in education and have therefore developed comprehensive plans for the access to equipment, teacher training, and student skills. Within the state technology plan in North Carolina, each school district is required to develop a five year plan. Most schools within each district are therefore required to submit a school level technology plan. Instruction in every classroom that involves technology therefore is defined by the school level technology plan and instructional decisions must support both the school and district goals.

Transience of both students and teachers is an impacting variable because collaboration between members of a team depends on the members of the team remaining in a school setting. Students who work in collaborative teams must learn to integrate new students into a team as students transfer into a new school.

Student Prerequisite Skills

One of the factors that contribute to the amount of instructional time devoted to direct computer skill instruction is the level of prerequisite skill that a student has when entering a classroom. In North Carolina the K-12 Computer/Technology Standard Course of Study requires students to be able to demonstrate effective technology use across six topic strands by the time they leave middle school. For high school students, the expectation is that all students are proficient in the use of technology since they are tested on their skill proficiency

at the beginning of the eighth grade; however there is not a 100 percent proficiency rate on the test at the eighth grade. North Carolina has piloted a fifth grade Computer Skills test to determine what skills students still lack prior to entering middle school, however that test has not been widely used. Students enrolled in grades 6-8 have instructional objectives in all six topic strands in the North Carolina Standard Course of Study Computer Skills curriculum, including multimedia presentations skills, telecommunications, and societal and ethical issues. Direct instruction of those skills when integrated into curriculum-based units engages students and teaches them the required skills. Teachers also reported that students who transferred into a middle school from an elementary school where technology was not used are farther behind and do not have the skills necessary to easily complete computer based activities without additional support.

Student Access to Computers Outside of School

Students have different levels of access to technology outside of the classroom, primarily depending on the socio-economic status of the family or the availability of public facilities that provide access to students, such as a public library or community center. The term digital divide is used to describe the perceived gap between those who have access to technology resources and those who have limited or no access. There has been a concern that people could be disadvantaged by their geographic location, age, gender, culture and/or economic status. In the schools used for this study, all of those factors are a consideration to be examined by further research. North Carolina has three distinct geographic regions: coastal, piedmont, and mountain. The geographic diversity represents economic diversity as well, with more well-funded school systems located in the piedmont section of the state where there is a larger tax base and more industry. The teams selected to attend The Wired

Classroom intentionally represent diverse regions of the state, and therefore represent the diverse populations of those regions.

In schools A and B the teachers reported that student access to computers outside of schools was approximately 90% as reported by students and parents, thereby enabling teachers to assign student activities outside of class that required computers. In the schools in the northern and eastern part of the state the results were different. Teachers from Schools C, E, and F reported that approximately 50% of the students in schools had access to computers in their homes. In addition to having fewer personal computers, there was also limited access to central locations, such as a library or civic center, where students could go to complete assignments. In school D, teachers reported that approximately 60% of students had access to computers in their homes however they had access to computer access at both the public library and an active community recreation facility that provided computer access to students.

Access to computers during school can be equitable with careful planning of the classroom environment by the teacher. The digital divide no longer refers to access to technology in the classroom, however the digital divide definitely refers to the inability of all students to have access to technology once they leave the school.

LEA/School Technology Plan

North Carolina requires each Local Education Agency (LEA) to develop a five-year Technology Plan that examines the technology currently available in the school, the ways in which the technology is used, and plans for future technology acquisition and use. The plan includes both equipment and professional development necessary to use the equipment effectively with students. In most North Carolina LEAs individual schools are also required

to complete school level technology plans as well, because every school has unique goals to address individual student needs. The school level technology plan is developed by the school level Technology Planning Team or Technology Planning Committee. As indicated in a previous section, several summer participants served on the Technology Planning Committees in their schools and have made recommendations about the purchase of equipment. School and district technology plans also address the need for professional development to support teacher skills.

Teacher Transience

North Carolina, like other states, faces a shortage of qualified teachers, especially at the secondary level. Teachers leave the teaching profession, move to another location, or get promoted to another position within the same district. Whatever the reason for a teacher's change of location, transience is an issue in all of the schools included in the study. Teachers who attend the summer sessions work collaboratively with colleagues and develop activities that are cross-curricular. Some of the teachers, although not all of them, planned to co-teach instructional units that they developed during the summer. In School C one team member reported that "unfortunately, most of our team has transferred to other schools or districts this year."

Teachers who transferred to other teaching positions reported that they had been unable to use the skills learned during the staff development because they were teaching in a different setting. Teacher E-2 stated that "I loved working on the PowerQuest during the summer, but unfortunately I have not been able to use it because I was assigned a different job and I have different students."

Summary of Impacting Variables

A variety of factors external to the teaching conditions in the school impact the ability of a teacher to effectively integrate technology into instruction. Those factors include student prerequisite skills, student access to technology outside of school, the LEA and school level technology plan, and finally teacher transience. The range of student prerequisite skills is great, even though North Carolina has a Technology/Computer Skills Standard Course of Study to guide student skill development. The technology skills are formally assessed in the 8th grade, so prior to entering middle school, students may not have acquired the necessary skills to be independently successful in middle or high school. The students that Marc Prensky refers to as "digital natives" include the students who are so familiar with the technology that they provide support within the classroom to other students who may have more limited skills. In addition to a wide range of pre-requisite skills, students have varying levels of access to computers outside of school. In schools where students have limited access to computers outside of school, the number of assignments where students must have access to computers is limited.

Core Category: Technology Integration Pedagogy

The final construct to be discussed is the core category. The core category in grounded theory research is at the center of the model and represents the main theme of the research (Strauss & Corbin, 1998). The core category "pull(s) the other categories together to form an explanatory whole" (Strauss & Corbin, 1998, p. 146). In this research project the core category was identified after examining all of the components of the teachers' responses about implementing skills learned during professional development (School Support, Technology Available, Teaching Strategies, and Impacting Variables) and trying to

determine the overall theme that emerged. Analysis resulted in one comprehensive category, entitled 'Technology Integration Pedagogy' which will be discussed in this section.

The term *technology integration pedagogy* is used to identify the core category because it recognizes the diverse factors that contribute to the art and science of teaching with technology. It recognizes the ability of a skilled teacher to make instructional decisions based on a variety of factors and is a more comprehensive understanding of teaching than just identification of instructional strategies. Technology Integration Pedagogy represents a change in practice over time, as well as a change in philosophy about the way that instruction should take place.

The major focus of this study involved the relationship between professional development and teacher practice; however there were a number of factors that were identified by the focus groups that impacted a teacher's ability to change teaching practice. When teachers make decisions about the professional development in which they participate, unless specific professional development is required, they are making a decision about the acquisition of skills that will impact their instruction. A decision to participate in instructional technology professional development reflects a decision to integrate the tools, as well as the strategies that use the tools.

Most of the teachers that participated in the focus groups discussed their willingness to try to implement the instructional strategies that they developed during the professional development, however some of those teachers indicated that they were unable to implement strategies because of lack of adequate hardware, software, or internet access. The teachers who indicated that they were able to modify their instruction without the use of the specific tools provide examples of teachers who are making pedagogical shifts. Instruction that

depends on specific technology tools is ineffective because the technology tools are changing so rapidly and instruction based on a single set of tools will be obsolete as soon as the tools are obsolete.

Examples of teachers who indicate that a pedagogical shift is occurring include the teacher who reported that all of her instructional units now begin with an essential question that drives the instruction and creates an interest in the instructional topic. The students are engaged before the instruction begins and the students' prior knowledge is activated. This process does not require the use of technology; however the teacher reports that it is facilitated by the abundance of internet resources that she acquired during the professional development.

Teachers who discussed their decision to develop activities that allowed students to collaborate in the development of multimedia projects or the completion of authentic tasks indicated evidence of pedagogical shifts in their philosophy. The development and use of webquests that are cross-curricular activities also encourage students to establish curriculum relationships across curricular boundaries. The teachers who have returned to their classrooms and continued to develop these types of activities represent teachers who are undergoing pedagogical shifts as a result of the new skills that they acquired which facilitate the integration of technology into their instructional practices.

Overview of the Emergent Theory

This chapter ends with connecting all of the individual pieces of the puzzle explaining how instructional technology professional development impacts teaching practice. As previously discussed, the suggested relationships between the constructs are a result of a review of the focus group responses. The emergent theory is represented in FigureTwo. The

theory proposes that the change in participants' pedagogy after instructional technology professional development is best understood as a relationship between four variables: School Support, Technology Available, Teaching Strategies, and external Impacting Variables. These factors are bound together by the unifying theme of Technology Integration Pedagogy.

The interactions in this model occur in the context of schools where teachers have chosen to attend instructional technology professional development as members of a team which has committed to both implement the strategies that they learn and share the skills with other faculty at their school. The theory proposes that after participating in professional development, there are a number of factors that affect the ability of a teacher to implement new skills. The theory further proposes that if the teacher is able to implement the new skills learned in the staff development, a pedagogical shift occurs related to technology integration.

Support

Implementation of new instructional strategies that integrate technology requires teachers to have support from administration in the school. That support includes, but is not limited to, the appointment of qualified faculty members onto the Technology Planning Committee in the school. The Technology Planning Committee makes decisions about purchasing new equipment and providing professional development in the school. Members of several of the focus groups had been appointed to the Technology Planning Committee as a result of their professional development attendance and were able to influence decisions about the use of technology. One focus group reported that the entire technology committee attended the professional development as a team and while they were at the professional development they planned strategies for sharing new skills with their faculty. Administrators who attended the professional development as a member of the team were able to influence

decisions about scheduling lab time, scheduling planning time, as well as providing support for teachers in a number of other ways. The structure that this level of support provides enables teachers to change their instructional philosophy.

Available Technology

In order to implement the instructional skills that teachers acquired during the professional development experiences, they must also have the technology available. The teams of teachers that attended the professional development sessions returned to schools with a variety of technology configurations. All of the teachers had access to a minimum of a single classroom computer with internet access and all of the schools had a computer lab that was available for instructional use at least part-time. In some of the schools teachers were supported by a full-time technology facilitator who worked with both the teachers and the students in the school. The teachers who reported having technology support personnel in their schools were able to focus on the instructional strategies while the technology facilitator installed software or helped students master pre-requisite skills. Teachers also depended on the technology facilitator to keep the equipment functional so that when the technology was a critical element of the instructional strategy, it was working correctly.

Teaching Strategies

As a result of professional development, there is an expectation that new teaching strategies will be implemented. While the instructional technology professional development included training in specific technology skills, it also included training in a philosophy that supports a shift in instructional practice or pedagogy. When teachers returned to their schools in August with plans to modify their instructional practice some of them reported that they began to frame their instruction with essential questions and that questioning became a

more significant part of their instruction, with the expectation that students would have access to internet resources to search for answers or to frame additional questions. Many of the teachers used the webquest activities and worked with colleagues to develop additional instructional activities of this nature. Teachers also described students working more collaboratively to complete tasks.

Impacting Variables

While the teachers planned to integrate the technology strategies into their instruction in ways that would result in a change in their teaching practice, external variables impacted their ability to do so. Teachers planned to return to school with members of the team with whom they attended the staff development. In a few of the schools teachers indicated that some of the team members transferred out of the school and in a single school the majority of the team transferred to different schools. Teachers who were planning to collaborate and support each other were unable to do that.

Teachers who work in schools in districts that required the development and implementation of a school technology plan were impacted by the plan and the specific goals established for the entire school. In most of the schools with plans, the systematic purchase of equipment was the primary goal, with professional development as a secondary goal.

Teams of teachers who participated in the focus groups represented diverse socio-economic regions of the state. As a result of that, there was a disparity between the access to computers that students had outside of school. In the wealthier districts, teachers reported that virtually every student in the school had access to a computer at home, with internet capability. In more rural schools, teachers reported that fewer than fifty percent of the students had internet access at home, even if the students did have a computer at home. In

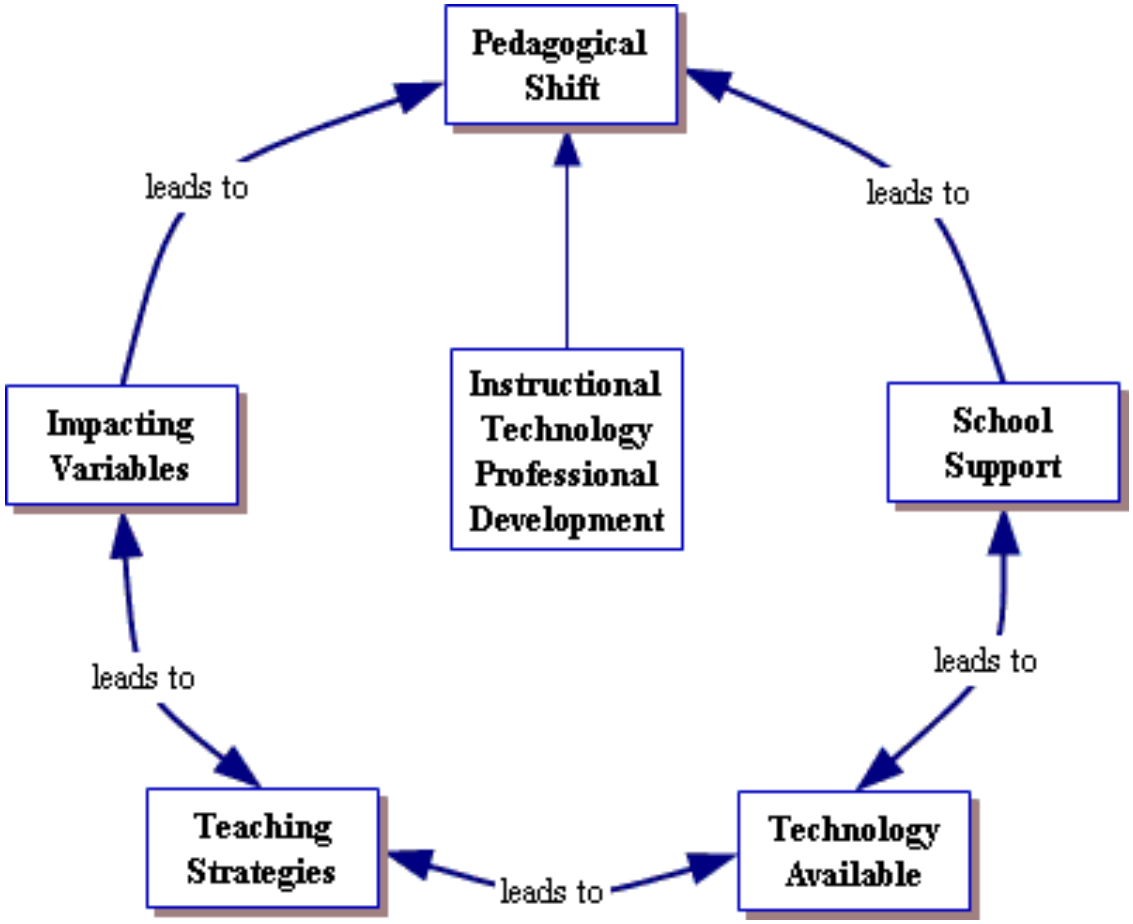
the same schools, students who had greater access to computers outside of school also had better prerequisite skills when they needed them in order to complete instructional tasks. Students who came to class without prerequisite skills required more direct skill instruction prior to the completion of the task that required the skills.

The emergent theory of instructional technology pedagogy involves the exploration of the integration of the factors of support, teaching strategies, available technology and impacting variable within the overarching theme of technology integration. Pedagogical shift requires the support of all of the factors identified by the focus groups in the research. Teachers reported efforts to integrate new skills in the absence of administrative support, available technology, or other impacting variables with less success than they would have experienced if those other factors had been in place. The absence of any of those factors does not make the pedagogical shift impossible, but it creates barriers that make the shift more difficult for teachers.

Figure Two

Theory of the Impact of Instructional Technology Professional Development on

Technology Integration Pedagogy



School Support	Technology Available	Teaching Strategies	Impacting Variables
Administrative Support	Computers, labs, and laptops	Essential question framework	Student prerequisite skills
Collegial Support	Internet access	Multimedia presentation	Student access to computers outside of school
Technology Support	Availability of labs for instructional use	Collaborative assignments	Teacher transience
	School level instructional technology coach		LEA/School Technology Plan
Instructional Technology Pedagogy			

CHAPTER V

DISCUSSION

The goal of this research investigation was to use grounded theory methodology to examine the instructional technology professional development experiences of secondary teachers in North Carolina schools, the ways that it impacted teacher practice and therefore, student performance. Analysis resulted in a model of responding that is centered by teacher pedagogy and addresses the challenges faced with levels of support, technology available, individual teaching strategies, and external variables that impact the use of instructional technology. In this chapter, the individual elements of the model will be discussed in relation to the research questions that guided this research. At the conclusion, the limitations of the study will be addressed, as well as the implications of the findings of this study for an improved model for professional development that has a greater likelihood of impacting student performance.

The chapter begins with a discussion of the findings and how the emergent theory relates to research in the fields of instructional technology and professional development. The discussion is organized by the research questions that guided this study.

The three questions that guided the research were:

1. How has technology professional development of teachers impacted their instructional practice?

2. How have teachers integrated technology into their instructional practice as a result of professional development?
3. How has the use of instructional technology in classrooms where teachers have had professional development impacted student performance?

Research Question #1: How has technology professional development of teachers impacted their instructional practice?

The main question that guided this study explored how the instructional practice of teachers was affected by the instructional technology professional development in which they participated. The information that was shared by members of the participant focus groups provided insight into the ways that teachers were able to modify their instructional practice as a result of the acquisition of new skills. It also provided insight about the factors that prevented teachers from implementing new skills. The instructional practice of teachers that attended the professional development sessions was impacted in a variety of ways and depended on factors including the support that the teachers received when they returned to their schools, the technology available in their schools, and their ability to integrate the new skills into their curriculum. Briefly, teachers who participated in *The Wired Classroom* professional development as a member of a team of teachers from their schools encountered both success and frustration in the implementation of newly acquired skills in their classrooms. Analysis of the cumulative responses of participants revealed a broad goal that captured their experiences. This goal was represented in the core category of the emergent theory, titled Instructional Technology Pedagogy.

Instructional technology professional development that is more likely to lead to a transfer of skills into instructional practice must include several conditions. First, the

professional development should allow adequate time for the teachers to acquire new skills and then incorporate them into instruction (Boe, 1989; Kinnaman, 1990). Individual teacher's prerequisite skills vary and therefore the length of time required for a group of teachers to master a new skill will also vary. Guhlin (1996) found that adequate time is whatever is necessary for each teacher to develop the new skills. In addition to the amount of time for the training, the designation of time is also a factor. In order for training to become integrated into the teacher's instructional practice, the professional development should take place outside of the regular instructional day and setting (Shelton and Jones, 1996). Training should take into account individual interests and content areas, allowing teachers flexibility in their training (Shelton and Jones, 1996). Flexibility should allow for individual differences in learning preferences, as well. Particularly in the area of instructional technology, teachers need continuous support that collaborative planning and problem solving provide (Pearson, 1994; Persky, 1990; Stager, 1995; and Persky, 1990). Browne & Ritchie (1991) further suggest that if expert teachers provide the instruction, then the learners have a benchmark for measuring their own progress. Guhlin (1996) and Persky (1990) found that instructional technology professional development must also have an instructional focus that helps teachers learn how to integrate the technology into the curriculum that they teach. Taken together this body of research describes the organization of *The Wired Classroom* professional development.

As previously stated, teachers attended *The Wired Classroom* as a member of a team of teachers from their school, accompanied by an administrator. The sessions were held for one week on a college campus, where teachers were removed from their normal routine and given an opportunity to focus entirely on their professional development. During the session,

professional development was provided by teacher trainers who both modeled effective use of the strategies and were able to provide practical ways of implementing the strategies into their classrooms. Teachers worked both independently and collaboratively during the week and developed a curriculum-based webquest that they would use when they returned to their schools in the fall.

As a result of the purposeful organization of *The Wired Classroom* following the research supporting effective instructional technology professional development, teachers indicated that the professional development impacted their instructional practice in a variety of ways. Teachers from each of the focus groups reported that they had used the curriculum based webquest that they developed during the summer and some of the teachers indicated that they had further developed additional webquests for use with their students. Teachers also reported that they were using the internet as an instructional tool with their students more effectively after the professional development. Following the findings identified in the previous research, teachers who attended *The Wired Classroom* professional development implemented the strategies when they returned to their classrooms. The research question further implies, however, that there are factors that contribute to more sustained impact on instructional practice.

A common factor that was central to the participants' goal of implementing new skills into instructional practice was Support. First participants acknowledged the importance of administrative support, which included interaction with the administrative team, the technology team, and the school improvement team. Additionally, participants recognized the critical roles of peer support and technology support. As reviewed earlier, the ability to implement strategies acquired in professional development depends on a number of factors,

including support or lack of support to implement the strategies (Guskey, 2002). Spodark (2003) referred to this support as an enabling environment and included a proactive, visible leader with a clear plan for the use of technology.

Administrative Support

As reported earlier, administrators can articulate the vision for the use of technology in the school and then provide a level of expectation that the entire school works toward that vision. When administrators participate in learning sessions and provide the support that teachers need in order to implement the skills, there is a greater likelihood that the skills will be implemented. Ways that administrators can support the implementation of new skills include: establishing flexible schedules so teachers can practice what they learned, encouraging team teaching and peer coaching, allowing teachers to visit each other's classrooms to observe technology integration, and scheduling opportunities for teachers to plan and discuss using technology in instruction (Boe, 1989; Persky, 1990; and Stager, 1995).

Most of the focus group participants acknowledged the importance of having both administrative support and administrative leadership after the professional development in order to implement the instructional strategies in their classrooms. School level administrators attended the professional development sessions as part of the team from each school. The administrators returned to the school with the same skills as the teachers, but instead of practicing the skills in an instructional setting, the role of the administrator was to make recommendations for the purchase of new equipment and software, either develop or approve the school master schedule, including planning time for teachers, and participate in the development of the School Improvement Plan, as well as the School Technology Plan.

The administrator has a high degree of influence on pedagogical shifts by encouraging specific behavior in instructional settings, such as the integration of technology into instructional practice. As a participant member of the professional development team, the administrator is able to recognize new skills when they are implemented in the classroom.

Participants who worked collaboratively with the administrators reported that the Action Plan for implementation of the skill, developed as part of the staff development, was shared with the administrative team at the school. In larger schools, this administrative team may include several members, whereas in smaller schools the administrative team would be smaller. With administrative support for the Action Plan, the likelihood that the plan would be implemented was increased.

A secondary level of administrative support was provided by the Technology Planning Team or Technology Goal Team (names of the team vary from school to school). Teachers indicated that they had a variety of opportunities to interact with the technology committees. In some settings, summer participants were included as technology team members after their professional development and as a result of their experiences. In other situations, teachers reported that the Technology Planning Team members comprised the team of summer participants because of their interest in technology integration and their interest in implementing new strategies into their instruction. In schools where neither of these situations occurred and where teachers indicated success in implementing new instructional strategies, the teachers reported that they had been in contact frequently with the Technology Planning Committee.

The types of decisions that were made by administrative support positions included a variety of factors such as scheduling that allowed collaborative planning time, as well as encouragement to observe other teachers who were successfully implementing the new skills.

Collegial Support

Peer collaboration provides collegial support for teachers to implement new skills, especially in the area of instructional technology, where a teacher may lack confidence in his or her skill level. Technological professional development must provide a safe environment which is aware of the individual teacher's level of experience. (Browne & Ritchie, 1991) During the professional development, collaborative problem solving and project development, along with cooperative learning provide the support that reluctant learners will need to implement the new skills. (Persky, 1990) Peers within the learning community remind individuals to focus on and achieve goals. (Wexley & Baldwin, 1986) Reluctant learners may observe in classes where instructional strategies are being implemented successfully (Broad, 1997; Browne & Ritchie, 1991).

The criteria of attending *The Wired Classroom* with a team of teachers from the same school contributed to the ability of the teachers to implement the strategies that they acquired within their own classrooms. Several teachers indicated that the support from other team members was essential to the success of the group, because if there were a degree of difficulty in implementing a strategy, then the team encouraged a colleague to try to implement the skills or offered suggestions about ways that they had been able to implement the skill in their own classrooms. During the summer session, teachers collaborated with team members to create curricular projects. This collaboration during the summer contributed to continued collaboration during the next school year unless their colleagues

transferred to a different school. It also allowed teachers to develop comprehensive skills when working together that encouraged the teachers to support each other in the implementation of the new strategies.

Technology Support

Instructional technology, unlike some other areas of pedagogical practice, requires support outside of the control of the classroom teacher. In order for there to be technology integration there must be technology, the equipment must be maintained, the network must be maintained, and software must be installed, among other things. All of this support is prioritized, with system-wide priorities taking precedence over the needs of teachers in individual classrooms.

Teachers reported returning to their schools and demonstrating the use of specific skills, which led other teachers to seek software, equipment, or other resources that might be available in their schools, of which they had previously been unaware. Technology facilitators or support technicians were essential in making technology available for teachers.

The lack of technology support in schools where the teachers did not find a high degree of success in implementing the newly learned skills was the greatest area of concern. Teachers reported returning to schools to find that the computers in the school had been re-imaged during the summer and were left in a state of disrepair for several months after school started. Another concern was the inability of teachers to access resources that they located during the professional development session because of firewalls that restricted internet access in their schools. Finally, in schools where the instructional computer labs were used for testing and remediation, teachers reported that even though the school had a number of

computers, they were frequently unavailable for instructional purposes because of testing and remediation that required the use of the instructional labs.

School Level Instructional Technology Coach

A significant body of research (Kinnaman, 1990; Shelton and Jones, 1996; Guhlin, 1996; Stager, 1995; Pearson, 1994) suggests that one of the most effective ways of aligning technology staff development with the instructional goals of the school, district, and state is to invest in someone with experience in both technology and curriculum, such as a technology resource teacher located within the school. The technology resource teacher is an especially important person in the school where there are a large number of novice users or a school with a significant investment in new equipment or software. Pearson (1994) found that the emotional support provided by a technology resource person did not vary greatly whether the person was located at the school or the district level, as long as the person was accessible to teachers.

Teachers in the focus groups indicated that the role of the technology resource person was critical to their success in implementing new skills, particularly ones that relied on specific software or technical requirements. Several of the teams included the technology resource teacher as a member of their team and several other teams included the media coordinator as a member of the team. In schools where there is not a technology resource teacher, the media coordinator fills that role. In the two schools where there was not a technology resource teacher, the teachers reported less success in implementing the skills that they acquired in the professional development.

The primary focus of *The Wired Classroom* professional development was to provide teachers with a framework of engaging students in higher order questioning skills, then using

a variety of technology-rich instructional strategies to conduct the inquiry-based activities. *The Wired Classroom* professional development session provided teachers with a technology-rich environment in which to design and develop instructional projects that they could use when they returned to their classrooms. During the week, teachers located and evaluated digital resources that supported instructional units. The ability to have the time to locate the resources, of which they were previously unaware, enabled the teachers to build collections of resources that they could share with students and use in building additional units.

Teachers indicated that because of the environment in which the professional development was provided, in a summer residential setting away from the pressures of school, they were able to spend time developing both instructional strategies that they could use in their classrooms, as well as a strong collegial network with other members of their team that continued back in their schools. Teachers that were successful in implementing all or some of the skills into their instruction acknowledged the importance of the collaborative planning that took place during the week. As further support of the research, the collaboration with peers provided a significant impetus for success in expanding the skills when they returned to their schools.

Browne and Ritchie (1991) further validated the importance of modeling effective instructional practices in a professional development session in order to help teachers see how the instruction should be implemented. They found that teachers who learn with trainers who model good use of technology are more confident about using the strategies in their classrooms. Again, participants provided additional support for this research, indicating the

when they were less confident about trying a new strategy in their classrooms, they were able to observe other teachers who were successfully implementing the skills.

Research about the effective planning and delivery of professional development in order to help teachers implement the skills that they acquire was supported by the findings of the current study. Teachers that were successful in implementing strategies, such as the development of essential questions or multimedia based WebQuests, into their instruction as a result of the professional development, valued the model of professional development that removed them from their school setting, provided time and support to learn new skills, and modeled the effective use of the technology available. The support provided by administrators was critical to the ability of the teachers to implement the skills, as well as the support of colleagues. When the skills were technology-specific, all of the teachers recognized the necessity of strong technology support at the school level.

Barriers to Implementation

In schools where teachers were unable to implement some or all of the new skills that they acquired during the summer, factors that were identified again validate the research about implementation of new skills. One of the most frequently mentioned reasons was the lack of time to implement the strategies or the inability to acquire the needed technology because of scheduling conflicts with instructional labs. Teachers in the schools where the skills were not implemented at a high level also indicated that lack of peer support was a factor. The lack of peer support occurred because team members transferred to other schools prior to the beginning of the school year and therefore were unable to provide support for colleagues. Instead of regarding these factors as barriers, they could be shared as factors to carefully consider prior to the decision to engage in the professional development. If the

factors are identified prior to the session, teachers may develop strategies for overcoming these issues before they become barriers.

Research Question # 2: How have teachers integrated technology into their instructional practice as a result of professional development?

In the digital age of the 21st century, teachers need a variety of skills in order to work effectively with the digital natives that inhabit their classrooms. Many researchers (Prensky, 2005; Warlick, 2002; & Weglinsky, 1998) cite the level of comfort that students have with technology, using laptops, instant messaging, social networking, chat rooms, and cell phones outside of the classroom, however in the classrooms where students attend school they do not routinely use these resources. They agree that it is ineffective for teachers to learn to use specific skills or equipment in the absence of curriculum goals because the tools will quickly become obsolete. Teachers do however need to have a level of confidence with technology that allows them to interact with the tools that will lead to more effective use of the technology that is available for them. Wenglinsky (2006) suggests that secondary teachers should avoid planning lessons around the computer, but should plan lessons with strong curricular goals with the expectation that students will use technology-based tools to complete some of the tasks of the learning if those tools are appropriate.

As a result of the professional development in which the teachers participated, they reported a variety of ways in which they were able to integrate technology into their instruction. The skills that they learned during the professional development included, but were not limited to, identification, evaluation, and archiving appropriate internet resources for instructional units; using graphic organizing software to develop and organize instructional units; and acquiring the multimedia skills necessary to create a non-linear

multimedia presentation to organize a WebQuest. Teachers reported a variety of levels of success in integrating technology into their instruction as a result of the professional development that also supported student learning.

Internet Resources

According to March (2005) the internet has empowered students to complete "pointless, rote research assignments through copy and paste masterpieces" (p. 17) if teachers do not learn to effectively harness the learning power which has been opened up through the World Wide Web. Access to such a broad range of information has shifted the learning power to the students themselves, according to March. The wealth of information provides that opportunity for students to engage with the information and make meaning.

Teachers identified a range of accessibility to internet capable computers outside of school for their students. Students in the central piedmont section of the state were highly likely to have internet access at home and very likely to use it to complete assignments, as reported by the teachers. Students from schools in more rural areas were less likely to have internet access at home and were not likely to use the internet to complete assignments, according to their teachers. According to Marc Prensky (2005), as a result of this growing independent access, students must be taught skills to evaluate information in order to select the most appropriate resources for any activity in order to become responsible users of the resources. Prensky also suggests that the access to this information creates an environment that enables teachers to easily personalize learning, instead of involuntarily assigning all students the same activities regardless of their interests. To extend that concept, the internet enables teachers to create learning partnerships and collaborative groups with other students anywhere else in the world.

Teachers reported that they valued the time and the ability to locate, evaluate, and bookmark internet resources for instructional units, using a social bookmarking program to which they were introduced. As previously reported, research by Boe (1989) supported the need for adequate time in a professional development session in order to allow teachers to acquire skills and use those in ways that will transfer back to the classroom. Teachers also indicated that effective search strategies were skills that they learned and could transfer directly to their students. In several of the schools, teachers indicated that the bookmarked files were the first of the skills that they implemented in their schools. They reported being able to locate and evaluate other resources effectively and were able to manipulate those resources using the social bookmarking files. The improved ability to access effective internet resources encouraged teachers to independently find additional ways to incorporate them into their instruction and to develop student activities that incorporated the use of those resources.

Multimedia Presentations

According to Bernie Dodge (1995), creator of the WebQuest authentic learning framework, a webquest is an inquiry-oriented activity in which some or all of the information that learners interact with comes from resources on the internet. The webquests involve a specific sequence of steps: introduction, task, process, resources, product, and conclusion. Webquests are generally collaborative projects with motivational elements that encourage students to engage in higher order thinking skills. One of the barriers that teachers who developed this type of activity for their students frequently faced was the inability to publish their project to a school website because of barriers to publication. *The Wired Classroom*

introduced teachers to a PowerPoint template which allowed them to develop webquests much more easily.

Alternative uses of multimedia presentation software, such as Microsoft PowerPoint, which was universally available in the schools of the focus group participants, expanded their ability to develop instructional activities for their students. In each of the focus groups there were teachers who reported using the WebQuest activity that they developed in the summer session. Three of the teachers indicated that they had developed additional WebQuest activities for use in their classrooms and that they would continue to develop those types of activities. In addition, teachers indicated that students were developing more multimedia presentations for other teachers' classes as well and would continue to support those efforts with their own students. The schools where teachers reported that students were more independent users of multimedia tools were schools where students had greater access to technology both within the school and outside of the school as well.

Technology Available

According to research (Burns, 2005) many schools have not made the commitment to provide the necessary funding to fully support technology in the classroom. By failing to provide such components as long-term professional development, access to sufficient equipment and software, and adequate time to develop and deliver inquiry-based, technology-rich activities, along with school-based technology support, schools have limited the extent to which technology can impact instruction. The teachers who indicated that they had successfully integrated technology as a result of the professional development were the teachers in schools where there were adequate technology resources for instructional use.

Teachers who were appointed to Technology Planning Teams in their schools participated in the school-based decisions about the procurement of new equipment for the school, as well as for the professional development to support the new equipment. For the teachers who were not directly included on the Technology Planning Team, several teachers reported that they were able to provide advice about the purchase of equipment.

Computers, Labs, and Laptops

As indicated earlier, every teacher that participated in the professional development was in a school where there was a minimum of a single computer with internet access in each classroom. Several of the schools had more than one computer in each class in addition to teacher access to instructional computer labs. One school purchased a cart of laptop computers with wireless access to create even more flexible access to computers for the teachers and students. Teachers indicated that they had become aware of new technology tools that would impact their instruction as a result of the professional development and worked with leadership teams to acquire the equipment to expand the capacity that they had to use their current technology. Teachers who were able to integrate technology successfully into their instruction first indicated that it was important to have access to computers that were working and had appropriate software. Teachers who were unable to integrate technology successfully cited first that they did not have the adequate technology to do so.

As stated earlier, a significant body of research has found that teacher knowledge, including knowledge about how to use technology, is situated and local (Ball & Cohen, 1999; Borko & Putnam, 1996; Lampert & Ball, 1999; Putnam & Borko, 2000). The knowledge is not only about what technology can do, but also what technology can do for them in their own school or instructional setting. The process of learning to use technology is a process

whereby teachers understand the meaning and implications of a specific technology and translate it into a solution for a local problem within their school or classroom. Teachers indicated that because the professional development session involved the creation of content-specific activities that they could use with their students, it was much easier to implement the skills when they returned to their schools.

Barriers to Implementation

Unlike the category of barriers to implementation that teachers had to overcome in order to implement the new skills into their instruction, the barriers to implementation for integrating technology into their classrooms usually involved the technology, over which the teacher frequently has no control. Teachers reported that it was difficult to get computers repaired in some schools because of the lack of technical support. Teachers also suggested that instructional technology resources were unavailable for large blocks of time as a result of testing and remediation that took place in the school computer labs. Teachers indicated that if resources were not readily available when they were needed, alternative instructional strategies were used in order to teacher the content in a timely manner. Delays caused by broken equipment, lack of lab availability, poor internet access reliability led teachers in some schools to avoid technology integration because of the frustration for the teacher.

Research Question # 3: How has the use of instructional technology in classrooms where teachers have had professional development impacted student performance?

In an interview for the Journal of Staff Development in 1998, Linda Roberts, Director of the Office of Educational Technology for the US Department of Education, explained that increases in student achievement as a result of the use of instructional technology in the classroom are not necessarily reflected in increases in test scores, but "in terms of knowledge

and skills that students acquire and have for the rest of their lives."(Votjek (1998), p.15) Howard Lee, Chairman of the North Carolina State Board of Education, stated in the introduction to the North Carolina Standard Course of Study that "while students must attain enabling skills such as reading, writing, and computing, they must also attain the new basics which include creative thinking and problem solving, interpersonal skills, negotiation and teamwork." (NC Standard Course of Study, 2002) Those are skills that are not necessarily measured by standardized test scores, as indicated by Linda Roberts, but are certainly observable in classrooms where those skills are evident.

Traditional education has been described as the "passive transmission of content from the mouth of the teacher to the brain of the learner and the subsequent recitation of content by the student at the cue of the instructor" (Fryer, 2005). In the 21st century, students must have the opportunity to develop group problem-solving skills, more independence, and responsibility for their learning according to Jamie McKenzie (1999). David Warlick (2002) further suggests that accessing and using information available online is just the starting point for digital literacy in the 21st century. Students must be engaged in the creation of authentic knowledge products, collaborating with students in a modern classroom that prepares them for the future. Fryer (2005) reinforces this and further suggests that "students in the 21st century need to be actively engaged in the collaborative creation of authentic knowledge products using technology tools, rather than sitting in front of drill and practice software helping them answer multiple-choice questions for an end-of-year standardized test" (p. 27).

In collaboration with the North Central Regional Educational Laboratory (NCREL), Cheryl Lemke and Ed Coughlin (2006) developed a framework that describes the skills that

students should master in order to be literate in the twenty first century found in Appendix F. The framework includes a variety of skills such as basic literacy, numeracy, and basic technology skills, but also effective communication, social awareness, and the ability to manage information. The skills identified in this framework can be acquired and developed through the use of instructional strategies that help students become collaborators in their own learning by exploring and engaging with a variety of resources, collaborate with their peers to solve authentic tasks, and communicate their results.

As a result of the professional development that teachers received during their sessions of *The Wired Classroom* and the subsequent implementation of the skills in their schools and classrooms participants indicated that there were a number of changes that were observed in student performance both in their classrooms and in the classrooms of other teachers in their schools. When students learn strategies and skills that can be transferred to other classes, then the instructional strategies of the teachers who attended the professional development sessions are transferred to the classes of other teachers in the school. Focus group participants indicated that a number of strategies that they learned during the summer sessions were implemented in their classrooms and that they witnessed changes in student performance as a result of the changes.

WebQuests

The emphasis of *The Wired Classroom* professional development is placed on the curriculum and instructional goals of the teacher rather than the instructional technology tools that are used during the professional development. As a result of that philosophy, skill instruction was provided for teachers as part of the process of developing instructional activities that were curriculum based. The development of curriculum based WebQuests

was a primary instructional outcome of the professional development. As stated earlier WebQuests are an authentic learning model designed by Bernie Dodge from San Diego State University that provide students with a problem that must be solved collaboratively using a variety of resources which include internet resources selected by the teacher. During the process students transform the information that they locate in a manner that leads to the solution of the identified task or problem.

Most of the focus group members reported that they returned to their schools and used the WebQuests that they developed during the summer session with success in helping students learn to collaborate to solve authentic problems or tasks. A secondary goal of the WebQuest is to gather information from a variety of resources, then transform that information in ways necessary to solve the problem. Teachers reported that students became more efficient in gathering necessary information, evaluating the information for its appropriateness, then using the information to solve the problems. Students who learn these skills in this instructional setting will transfer the skills to other settings.

At the conclusion of most webquests students are required to communicate the results of the solution to their problem or task. For many of the webquests created during the professional development, students were instructed to create PowerPoint presentations to share the results. This requirement led to the enhancement of multimedia presentation skills among the students. Teachers reported that students were more confident with communicating results in this manner and were working independently to develop presentations for other classes as well. The enhanced multimedia skills that students demonstrated included better organization of non-linear multimedia, integration of images and graphs into their presentations, as well as other advanced skills which were assessed

using rubrics. The ability to gather and evaluate digital information, collaborate with other students to find the solution to problems, and effectively communicate the results of a learning task are identified as 21st century literacy skills (Lemke and Coughlin, 2006)

Student Collaboration

When students work in classrooms where technology is a part of the instructional landscape students change the way in which they interact with each other. Students collaborate to solve more complex problems, using collaboration as a learning strategy. Part of this is related to the shortage of technology or the inability to schedule classes for an extended period of time in a school computer lab. It is not unusual for students who are using computers to complete a research task to share the examples that they find with their peers. Students work together to complete assignments, including WebQuests and multimedia presentations.

Teachers observed that since they are now more willing to allow students to collaborate on projects, students are more effective in their ability to collaborate. They reported that they observed students planning, organizing for the use of limited resources, and communicating with each other. When students work collaboratively they develop improved skills in the areas of organization, planning, and communication, all skills essential for success in the twenty-first century. Students consequently learn to take more responsibility for their work. Teachers from several schools also indicated that throughout their schools, students were working collaboratively on more digital projects in all content areas and for all teachers. Teachers observed where there were multiple computers available for student use, students gathered during lunch and after school to collaborate on projects and tasks.

The skills that students are developing in the classes where teachers have participated in *The Wired Classroom* professional development are the skills that educators suggest are necessary for 21st century literacy. The skills that teachers observed include the ability to locate and evaluate resources, use those resources to solve authentic problems, collaborate with their peers to complete projects, and communicate their results effectively. These skills are not measured through responses to multiple choice tests, but can be documented through teacher observation and alternative assessment tools. In classrooms where teachers develop curriculum-based activities that engage students in a learning environment that takes advantage of the appropriate technology, students become more responsible for their own learning, contributing to ongoing learning skills which continue after the student moves on to other classes. As indicated earlier, these skills are not measured by standard end of course tests.

Limitations of the Study

The primary limitation of this study is that it focuses only on secondary teachers who have attended *The Wired Classroom* instructional technology professional development with the North Carolina Teacher Academy. While many effective professional development opportunities are available to teachers, and while the teachers in this study may have participated in additional professional development, only Teacher Academy participants were interviewed about the implementation of the skills that they acquired in this specific professional development session.

A second limitation of the study is that there was no independent measurement of student classroom performance. Teachers reported on changes in student outcomes that they

observed in their own classrooms however, those changes were not verified by an independent observer.

A third limitation of the study is that there was not a way to account for the amount of funding that an individual school had received for technology. The study involves participants from schools that do not have a consistent level of technology available to them because the level of funding for technology varies between schools and school districts. While teachers all received the same professional development, their ability to implement the skills when they returned to their districts was impacted by the available technology in their schools, as well as the level of technology support available in the school.

A fourth limitation of the study is that there was not a standardized assessment that was available to determine changes in student achievement. The teachers that participated in this study represented teachers in grades 6-12 in a variety of content areas, as well as administrators, media specialists and technology facilitators. End of grade or end of course test scores for the classes of each of the teachers were not used to inform opinions about changing student performance for several reasons. An end of course standardized test was not administered for each of the classes that the participants taught, nor was there a comprehensive assessment that measured the student performance across all of the grade levels and content areas. Teacher observation was used as an indicator of changed student performance, based on student performance in previous classrooms. Teachers were not asked to keep comprehensive notes on observed student behavior, but were asked to indicate changes in patterns of behavior that they observed in the students in their own classrooms.

A final limitation of the study is that the number of teachers that constituted a team varied in each school. In schools where there were more teachers, there was a greater degree

of collegial support than in the schools where there were not as many members on a team. The team remained complete in only two of the schools that participated in the professional development. In four of the schools team members transferred to other instructional positions or to other positions outside of the school.

Implications for Curriculum and Instruction

Millions of dollars are spent for professional development for teachers each year in an effort to improve student achievement. The suggested percentage of instructional technology budgets that should support professional development is 25%-30% of the total technology funding. In an era when there is less funding available and greater demands for those limited funds, school districts need to be able to determine the factors that must be in place in order for the teachers to implement the strategies that they have learned during their professional development in ways that effect student performance. Beyond the implementation of the strategies that teachers learn, an additional outcome of this study will be the identification of the type of professional development that provides the greatest likelihood of changing student performance.

Professional Development Factors that Lead to Implementation

The results of this research support the findings of earlier research that there are specific circumstances that lead to professional development which has a greater likelihood of impacting student achievement. Teachers must understand the relationship of their pedagogical practice on the learning needs of their students and select the professional development that helps them meet the learning needs of their students. In the National Staff Development Council professional development model of "beginning with the end in mind" (Killion, 2002) teachers identify student learning goals prior to selecting appropriate

professional development. Teachers who attended *The Wired Classroom* applied to attend the professional development as a result of a review of the School Improvement Plan and Professional Development Plan in each of their schools. Their application represented a commitment to share the skills with their colleagues and to implement the skills in their classrooms.

In order to impact student performance, professional development must be delivered in a professional, non-threatening environment that values the individual skills of the learner. *The Wired Classroom* professional development was provided in a summer residential session that allowed teachers to focus on the skills in a collegial environment that removed them from the distractions of their classrooms. The instructors were classroom teachers who were able to provide examples of the ways that strategies were implemented in their own classrooms. The teams also included an administrator or administrative designee to provide support for the instructional goals of the professional development. During the professional development teachers also created instructional materials that they could use in their own classrooms and in their own schools.

Teachers, in whose classrooms a change in student behavior occurred, were in schools where there was a commitment to provide the necessary instructional technology and technology support throughout the school. As the student population changed there was a continuous effort to acquire new equipment to meet the instructional needs of the students and teachers. In schools where the student population exceeded the available space in the school, the technology team recommended the purchase of laptop carts, for example. In addition to the equipment, schools where the skills were the most effectively integrated and

changes in student behaviors were observed, were the schools where teachers were supported by technology facilitators or technology support located in the school.

Technology Funding

The level of funding for technology in individual schools is inconsistent because North Carolina does not currently have a budget line item for technology expenditures. Until there is a minimum expected level of funding for hardware, software, network service, and technology support, schools will be unable to provide classrooms with a consistent level of both funding and support. Teachers reported that a significant barrier to implementation was the lack of equipment in working condition.

The Wired Classroom professional development sessions in which the teachers participated were purposely designed in order to insure a level of implementation of the skills that the teachers learned by including the development of an instructional activity that could be incorporated in the teacher's classroom. The greater impact of effective professional development however, must include implementation of skills beyond the use of a specific instructional activity that was developed during the session. The greater impact of the professional development must provide the teachers with the skills to modify their pedagogy, rather than just implementation of isolated skills.

Technology Professional Development

Technology professional development can no longer involve instruction in specific software or hardware in isolation from curriculum, because the software and hardware change so quickly that they become obsolete before teachers actually have the opportunity to use them in their classrooms. Professional development must focus on the skills that students will master, and then offer teachers a variety of ways to help students master those skills,

including technology tools. The skills that students need to master in order to be considered literate in the twenty first century require fully integrating technology into instruction, but do not require an emphasis on the tools. The emphasis of twenty first century literacy is on the skills that students will need to solve complex problems using whatever tools may emerge in the next six months, six years, or six decades.

Strengthening the Possibility for Impact

A variety of learning opportunities for teachers are defined as professional development, including instruction about how to use student information management systems, school or school system policy training sessions, or human resources information sessions. If teachers are required to earn a specific number of professional development hours in order to renew licensure, the professional development hours must be less broadly defined and must focus specifically on professional development that improves pedagogy and impacts student performance.

When the definition of professional development is limited to only those learning opportunities that improve pedagogy and impact student performance, then all professional development must be designed for those purposes and should clearly articulate that a change in teaching practice should exhibit a change in students. The individuals who have the most direct impact on student performance are the teachers in the classrooms; therefore they should be instrumental in determining the professional development that they need in order for change to occur.

While schools, districts, states, and the nation share common goals for student performance, individual teachers have a variety of unique skills that do not represent a common skill set. Professional development must allow for the unique skills that individuals

possess. In the words of Hayes Mizell , Senior Fellow with the National Staff Development Council, without consideration of individual teacher needs, professional development treats teachers as if they were "empty vessels waiting to be filled rather than knowledgeable educators who bring different levels of instructional experience, expertise, and effectiveness to their learning"(2007, p. 21) . A one size fits all approach to professional development erodes teacher responsibility for identifying their own needs and reduces the likelihood that the professional development will impact pedagogical change, if implemented at all.

The impact of small groups of teachers working together to bring about change in student performance is documented in the current research related to professional learning communities (Sparks & Hirsh, 1997) and has direct implications for professional development application. Rather than working in isolation in their own classrooms, teachers collaborate with grade level, content area, or cross curricular teams, to do action research, analyze student work, observe professional practice in other classrooms, and form study groups to review the literature related to learning goals. When combined with common professional development, the teachers begin this collaboration with a common set of skills and a common focus for their discussion. That organization does not reduce the necessity of the consideration for individual teacher needs, but supports the need for a common focus. A feature to assess the impact on student performance must be included in all professional development that is designed for that purpose in order to measure the effect of the professional development. The absence of accountability creates a perception that the professional development does not matter and that there is no expectation that it will have an impact on student performance. Assessment does not imply the use of standardized tests unless the change in student performance is a change that can be adequately measured in that

way. Informal assessments that measure changes in student performance, including observation checklists, evaluation of authentic tasks, or other measures of change in student performance should be specific to the goals identified.

Planning for Implementation

In an effort to help teachers learn to recognize the relationship between professional development and student performance, a planning tool has been developed that will guide teachers through the process of planning for professional development, implementing instructional strategies, assessing student performance, and evaluating the impact of the professional development. An ongoing implementation log should be completed which records the progress of the teachers and holds them accountable for the implementation of the skills. The log may be completed by the team of teachers who have participated in the training when they meet to review progress and should be included in the Professional Development Plan of the school, as well as the Individual Growth Plan of each teacher in the group.

Professional development programs, such as *The Wired Classroom* and other programs for which teachers apply to attend, as well as graduate courses, online professional development, and the variety of professional development that is available for teachers, must encourage teachers to evaluate their expected outcomes as a result of the professional development. Individual schools, as well as the professional development providers, can require teachers to complete a planning tool prior to engaging in the professional development in order to receive continuing education credit for licensure. Currently many school districts require prior approval forms that seek permission to participate in professional development, as well as the correlation of the professional development to

school, district, or state goals; however they may not require follow-up verification of the implementation of the strategies or evidence of student performance. Simple documentation that is not excessively time-consuming helps the teacher to focus attention on the goals and the expected outcomes.

The purpose of the documentation is not only to show evidence of student change, but to show evidence of thoughtful consideration of the skills needed and the implementation of those skills after the completion of the professional development.

Professional Development Planning Tool

1. What student learning will be impacted by this professional development?
2. What student goals are associated with these learning outcomes?
    a. Knowledge
    b. Skills
3. If technology skills are associated with the goals, are the technology tools available?
4. How will this professional development help you be able to create a classroom where students can achieve these goals?
5. What support will your colleagues be able to provide for you?
6. How will you be able to support your colleagues?
7. How will you measure the impact on student performance?

Prior planning should focus the attention of the teacher on the expected student outcomes related to the professional development and will make the teacher accountable for trying to implement the new skills in a ways that the teacher has identified to impact student learning. The administrator must provide protected time in the instructional schedule to

enable the focused planning to take place. That does not mean that collaborative planning time must be scheduled each day; however, it means that there is protected time during the school year for teachers to review their student performance, define instructional goals, and identify needed professional development. School districts schedule teacher workdays at the beginning of the year, which are appropriate for this planning. Sustained assessment and reflection must occur continuously, however and should be scheduled throughout the year, including time for both individual and team collaboration. The final determination about the impact of the professional development will be made by the teacher(s) who participated in the professional development, based on collected evidence of teaching practice and documented evidence of student performance. All professional development will not lead to expected changes in student performance, but teachers will seek additional skills to bring about the changes.

Framework for Implementation

A professional development program that prepares teachers to meet the needs of students in the digital generation should have a framework flexible enough to meet the needs of a wide range of teacher learners, but be specific enough to ensure that the skills will transfer into instructional practice. The framework of the professional development, like the twenty-first century literacy skills themselves, must focus on instructional practice, rather than specific technology skills, which are transient. Long-term instructional planning involves a combination of the learning goals, the skills needed to implement the goals, and the facilities necessary to insure the goals can be met. Training in the void of planning or facilities will be minimally implemented, just as technology facilities in the void of planning or training will be minimally used.

The Professional Development Implementation Checklist (Figure Three) that has been developed is an open-ended framework allowing teachers to "begin with the end in mind" by examining current student performance and then establishing goals for student growth. Student goals should represent a combination of knowledge and skills, rather than reviewing those as isolated sets of goals. In this planning model, technology skills will be imbedded into the combined instructional goals. When technology skills are integrated into the instructional goals, teachers must determine if the technology is either present in the school, or accessible to the school, in order to meet the goals. If technology goals include skills for which it is impossible to obtain the tools, then the goals will have to be revised. Teacher self-assessment helps the individual teacher determine what skills each person needs in order to meet the learning goals.

Figure Three

Professional Development Implementation Checklist

Skill	**Evidence of Completion**
1. Analysis of student performance	
2. Establishment of class, grade, or school level goals	
3. Teacher skill self-assessment	
4. Commitment to acquire and implement skills	
5. Training in new skills	
6. Support by colleagues	
7. Assessment of student progress	
8. Sharing successes and challenges	

Formal staff development may not be necessary for acquisition of some new skills when teachers work collaboratively. Teachers learn new skills by observing colleagues, discussing skills, and reading related research. Common professional development would be necessary for a team of teachers who do not possess a skill set nor know how to integrate those skills in ways that will change their teaching and impact student performance. For example, a group of teachers may determine that they have an adequate level of expertise in multimedia presentation software, such as Powerpoint, but do not have the skills to integrate it in ways that will change student performance.

With the establishment of student goals and the acquisition of teacher skills, then the teachers will decide the most appropriate ways to determine if the professional development is impacting student performance. Teachers will need to maintain a measure of the impact in order to provide evidence of continuous growth and to provide the necessary data to determine when instructional changes should occur. Finally, teachers should report the results of their work in ways that highlight their careful planning, learning, implementation, and assessment in an environment that provides the time necessary for this to occur.

The Professional Development Implementation Checklist will be introduced to teachers who are making decisions about future professional development. The checklist will be reviewed and updated periodically as teachers implement the skills into their instruction. Utilizing a framework such as this will allow teachers to make a more effective determination about their own professional development needs in order to achieve established goals for student performance in ways that will support the needs of themselves and their colleagues. Implementation of the professional development that teachers receive will not be happen unless the teachers understand the link between the professional

development and the learning goals for the students. Teachers must make a commitment to implement the strategies before engaging in the professional development in order to learn the skills necessary for the implementation to occur.

A framework that supports full implementation of professional development must begin with a plan that identifies the needs of teachers based on stated learning goals. Planning requires teachers to assess both the instructional goals, the tools needed to carry out the instruction, and their own skills deficits in order to help them determine what skills they need to learn in order to support the goals. After the learning goals and the recommended tools have been identified, teachers should complete a skill self-assessment in order to determine the skills for which they need training.

Teachers need to make a commitment to acquire the needed skills and to implement them into their instruction with the support of their colleagues. Support from their colleagues, including the administrators, must include collegial planning, coaching, and ongoing reinforcement of the skills, as well as review of instructional practice as a result of the professional development. Informal assessment of student progress in reaching goals should be measured in a variety of ways in order to inform changes necessary in implementation of skills. Finally, teachers must meet to share their successes and challenges on a regular basis in order to revise goals and review the impact on students. In that framework, the professional development is an integral component but not an isolated series of unrelated activities.

Instructional technology professional development that is framed in a holistic manner, which supports changes in student performance, more fully integrates technology into curriculum-based instructional goals. The technology will be viewed as a tool to help

students to achieve learning goals, rather than a finite skill set isolated from other instruction. Students who have grown up with technology and speak with the accent of a digital native do not need teachers to show them how to use the tools, they need teachers to create learning environments that require them to use the tools to solve instructional problems and develop the skills necessary to be literate in the twenty first century. In order to do this, teachers must make effective use of the professional development opportunities that they have by matching their learning with the instructional goals, implementing the skills that they learn, and assess the impact on student learning.

Appendix A:

Informed Consent Form

Title: Impact of Instructional Technology Professional Development on Student Performance
Principal Investigator: Ren Bryan
Faculty Advisor: Dr. Barbara Day
University of North Carolina-Chapel Hill

Dear Secondary Teacher:

I am asking you to participate in a research study about the impact of instructional technology professional development on student achievement. The study is being conducted by Ren Bryan, a graduate student in the School of Education's EdD program. To join the study is voluntary and you may refuse to join if you choose.

Research studies are designed to obtain new knowledge. The new information gained from this research may help design more effective professional development in the future.

The purpose of this study is to learn about the impact of instructional technology professional development on student achievement. You are being asked to participate in this study because you are a member of a team of teachers who attended an Instructional Technology session of the North Carolina Teacher Academy.

If you decide to be in this study, you will be one of approximately fifty people in this research study. You will be asked to participate in a focus group at your school that will last for approximately one hour. During the focus group questions will be posed about the nature of the instructional technology professional development that you have participated in and the impact that it has had on student achievement. You may be phoned after participating in the focus group in order to clarify information that you provided.

Possible benefits of this study will be the redesign of instructional technology professional development in a way that will provide teachers with specific skills that will impact student achievement.

Participants will not be identified in any report or publication about this study. Data gathered from this research may be reviewed by representatives of the University of North Carolina for purposes of quality control.

I have read the information in this consent form and

_____I **agree** to be in the study _____I **do not agree** to be in the study.

_____ _____

Signature of the Participant Date

Appendix B:

Demographic Information

Year attended NC Teacher Academy *Integrating Technology into Instruction*_____

Available Technology

1. Internet access in the school? (Y) ____ (N) ____
2. Computer in the classroom? (Y) ____ (N) ____
3. Internet access in the classroom? (Y) ____ (N) ____
4. Available computer lab for classroom use? (Y) ____ (N) ____
5. Internet access in the computer lab? (Y) ____ (N) ____

Teaching Experience

1. Number of years of teaching experience in this school _____
2. Number of years of teaching in North Carolina _____
3. Number of total years teaching _____
4. Subject (s) currently teaching
    a.
    b.
    c.
    d.

Planning Time

1. Daily Planning Period (Y) ____ (N) ____
2. Subject level common planning period (Y) ____ (N) ____

Professional Development (use back of page if additional space is needed)

List additional Technology Professional Development that you have participated in:

Appendix C:

North Carolina Teacher Academy *The Wired Classroom*

Organization and Philosophy

The Wired Classroom is the name of a five day summer residential professional development session offered to teams of teachers (four – eight members, including an administrator) from North Carolina schools, held on college campuses. The focus of the training is the development of strategies that teachers will use in their own classrooms to integrate technology seamlessly into their instruction.

The training is provided by master classroom teachers who have received extensive training in the components that are included in the summer session. The training that the individual trainers have received includes Apple *Classrooms of Tomorrow,* Intel *Teach to the Future,* and WebQuest development based on the research of Bernie Dodge from San Diego State University, as well as Polaris grant writing training. The trainers annually attend and present at state and national conferences related to instructional technology and implement the skills into their own instruction. As technology changes, the summer program has been updated to incorporate the most recent skills that teachers need.

The Wired Classroom is organized around the development of a curricular unit of study that the teachers can implement when they return to their classrooms. The unit of study is anchored by the development of an essential question, followed by the identification of online resources that can support students in seeking the answers to support the essential question. Social bookmarking files are created that allow teachers to archive bookmarks that they can use in their future instruction.

Teachers learn about the process of developing authentic tasks for students and then create curricular webquests using a powerpoint template with imbedded hyperlinks. The project that is created includes elements of collaborative learning that is necessary when student work to solve a common problem. At the conclusion of the five day session, teachers share resources that they have developed for use by other teachers who have attended the session.

Week at a Glance

Sunday

- Introduction
    - Vision, Norms, Expectations, and Objectives
    - Research supporting use of instructional technology
    - Use of portable keyboards to record findings
    - Survey of resources available in each school

Monday

- Framing the Essential Question
    - Organizing thoughts around the Essential Question
    - Inspired organization, using graphic organizer software to develop ideas
- Finding and evaluating the resources to answer the Essential Question

Tuesday

- Developing a hook to engage students using multimedia tools
- Creating multimedia presentations with students

Wednesday

- Use of peripheral equipment to answer the Essential Question
- Action planning "Where do we go from here?"

Thursday

- Grantwriting skills to enhance school goals
- Rubric development
- Communicating with parents

Appendix D:

International Society for Technology in Education NETS Standards for Teachers

The six standards areas with performance indicators listed below are designed to be general enough to be customized to fit state, university, or district guidelines and yet specific enough to define the scope of the topic. Performance indicators for each standard provide specific outcomes to be measured when developing a set of assessment tools. The standards and the performance indicators also provide guidelines for teachers currently in the classroom.

TECHNOLOGY OPERATIONS AND CONCEPTS
Teachers demonstrate a sound understanding of technology operations and concepts. Teachers:

A. demonstrate introductory knowledge, skills, and understanding of concepts related to technology (as described in the ISTE National Education Technology Standards for Students)
B. demonstrate continual growth in technology knowledge and skills to stay abreast of current and emerging technologies.

PLANNING AND DESIGNING LEARNING ENVIRONMENTS AND EXPERIENCES
Teachers plan and design effective learning environments and experiences supported by technology. Teachers:

A. design developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of learners.
B. apply current research on teaching and learning with technology when planning learning environments and experiences.
C. identify and locate technology resources and evaluate them for accuracy and suitability.
D. plan for the management of technology resources within the context of learning activities.
E. plan strategies to manage student learning in a technology-enhanced environment.

TEACHING, LEARNING, AND THE CURRICULUM
Teachers implement curriculum plans, that include methods and strategies for applying technology to maximize student learning. Teachers:

A. facilitate technology-enhanced experiences that address content standards and student technology standards.
B. use technology to support learner-centered strategies that address the diverse needs of students.
C. apply technology to develop students' higher order skills and creativity.

D. manage student learning activities in a technology-enhanced environment.

ASSESSMENT AND EVALUATION

Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies. Teachers:

A. apply technology in assessing student learning of subject matter using a variety of assessment techniques.
B. use technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize student learning.
C. apply multiple methods of evaluation to determine students' appropriate use of technology resources for learning, communication, and productivity.

PRODUCTIVITY AND PROFESSIONAL PRACTICE

Teachers use technology to enhance their productivity and professional practice. Teachers:

A. use technology resources to engage in ongoing professional development and lifelong learning.
B. continually evaluate and reflect on professional practice to make informed decisions regarding the use of technology in support of student learning.
C. apply technology to increase productivity.
D. use technology to communicate and collaborate with peers, parents, and the larger community in order to nurture student learning.

SOCIAL, ETHICAL, LEGAL, AND HUMAN ISSUES

Teachers understand the social, ethical, legal, and human issues surrounding the use of technology in PK-12 schools and apply those principles in practice. Teachers:

A. model and teach legal and ethical practice related to technology use.
B. apply technology resources to enable and empower learners with diverse backgrounds, characteristics, and abilities.
C. identify and use technology resources that affirm diversity
D. promote safe and healthy use of technology resources.
E. facilitate equitable access to technology resources for all students.

http://cnets.iste.org/currstands/cstands-netst.html

Appendix E:

Constructs, Main Categories, Categories, and Concepts

Constructs	Main Categories	Categories	Concepts
Support	Administrative Support	Principal and administrative team	• Principal member of team • Team reported to admin team • Scheduled team planning time • Admin supported school-level staff development • Admin provided support during faculty meetings
Support	Administrative Support	Technology Team	• Teacher appointed to Technology Team • Technology team planned for spending technology funds • Tech team members made recommendations about use of funds for equipment based on summer staff development
Support	Collegial Support	Collaboration	• Planned with team • Shared summer skills with other teachers • Members of team transferred to other school • Teacher encouraged each other in creating and completing projects
Support	Collegial Support	Co-teaching	• Planned unit with team and used it in school • Multi-disciplinary units were not practical for every teacher to use • Teachers have planned together since returning

Support	Technology Support	Technology Facilitator	• Technology facilitator loaded software • Technology facilitator provided instruction to students • Technology facilitator was member of some of the teams
Support	Technology Support	Equipment maintenance	• Technology facilitator kept equipment running • Where no tech facilitator was available, equipment maintenance was slow • New software was installed over the summer and computers were unavailable until two months after school started
Technology Available	Computers, labs, and laptops	Equipment installation and maintenance	• New equipment in school was not installed until November • Broken equipment was not repaired quickly
Technology Available	Internet access	Internet wiring	• System responsible for wiring • Teachers did not have knowledge about wiring in school • Firewalls limited access to some of the resources that teachers located during the summer
Technology Available	Internet access	Network maintenance	• System responsible for maintenance • Technology facilitator managed network maintenance
Technology Available	Internet access	Bandwidth	• Unable to download video because of bandwidth

Technology Available	Availability of labs for instructional use	Self-scheduled labs	• Labs were available for student use • Labs were available to teachers based on teacher request • If teachers did not plan effectively labs were unavailable when they were needed
Technology Available	Availability of labs for instructional use	Use of labs for testing	• Labs were used for EOG and EOC testing and unavailable much of the time
Technology Available	School level instructional technology coach	School-level staff development for teachers	• Technology coach provided skill-based staff development for teachers
Technology Available	School level instructional technology coach	Classroom instruction for students	• Technology coach provided skill-based instruction for students • Technology coaches provided instruction at the middle schools
Teaching strategies	Essential question framework	Organization of instructional units	• Realized the importance of asking the right question • Questions force students to compare, contrast, draw conclusions
Teaching Strategies	Multimedia presentation	Teacher-created multimedia activities	• PowerPoint used to create PowerQuests • Unable to use product developed in the summer, but have developed other projects
Teaching Strategies	Multimedia presentation	Student created products	• Students are required to generate multimedia products in every class • Students use available computers to independently complete activities for other classes
Teaching Strategies	Collaborative	Students	• Students collaborate more

	assignments	collaborating as assigned	effectively • Students learn to work together
Teaching Strategies	Collaborative assignments	Students collaborating independently	• Students learn to work together without supervision • Students work in different ways as a result of the training
Impacting variables	Student prerequisite skills	Students have skills that meet the NC SCOS objectives	• Technology instruction is guided by the NC Standard Course of Study • Teachers plan assignments that include internet research to solve authentic tasks • Students create multimedia products
Impacting Variables	Student prerequisite skills	Student skills are above the required SCOS objectives	• Students work independently because they need little instruction
Impacting Variables	Student prerequisite skills	Student skills are below the required SCOS objectives	• Students that don't have pre-requisite skills require more direct instruction
Impacting Variables	Student access to computers outside of school	Students have access outside of school	• Most students have access to computers outside of school
Impacting Variables	Student access to computers outside of school	Students have limited access outside of school	• fewer than half of the students have access to computers outside of school
Impacting Variables	Teacher transience	Teacher population is stable	• all of teachers on team have attended Teacher Academy for several years
Impacting Variables	Teacher transience	Teacher transience is high	• No members of team are still teaching at same school
Impacting Variables	LEA/School Technology Plan	School System Technology Plan	• All schools have district Technology Plan • District technology plans support state Technology Plan
Impacting Variables	LEA/School Technology Plan	School Level Technology Plan	• All schools have school technology

			plan • Technology plan developed by technology team • Technology team members attended staff development sessions
Technology Integration Pedagogy	Support	Teachers collaborate	• Teacher planned instructional units together • Teachers spent time planning how to use instructional units • Teachers encourage each other to implement Strategies • Technology facilitator supports instruction by installing software
Technology Integration Pedagogy	Collaboration	Teachers plan effectively	• Teachers plan instruction around essential questions • Plan instruction then integrate technology
Technology Integration Pedagogy	Teaching Strategies	Teachers plan effectively	• Teachers plan instruction around essential questions
Technology Integration Pedagogy	Teaching Strategies	Teachers locate and evaluate resources	• Teachers build resource files and refer to them • Teachers acquired skills to help students learn to evaluate resources
Technology Integration Pedagogy	Technology available	Teachers organize instruction	• Teachers plan instruction around essential questions • Teacher plan instructional units with authentic tasks
Technology Integration Pedagogy	Technology available	Teachers use technology tools effectively	• Teachers follow NC Standard Course of Study for Computer Technology skills • Teachers are able to use computers effectively when they are maintained by technology

			support • Teachers would use labs more if they were available to teachers • Laptop carts increase access to computers

Appendix F:

Twenty First Century Literacy Skills

Digital-Age Literacies
As society changes, the skills needed to deal with the complexities of life also change. Major new studies now define literacy as the ability to use "digital technology, communications tools, and/or networks to access, manage, integrate, evaluate, and create information in order to function in a knowledge society" (ICT Literacy Panel, 2002).

_ *Basic Literacy:* Can students demonstrate language proficiency (in English) and numeracy at levels necessary for success on the job and in a digital-age society?
_ *Scientific Literacy:* Do students have the knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity?
_ *Economic Literacy:* Can students identify economic issues; analyze incentives; examine the consequences of changes in economic conditions and public policies; collect and organize economic evidence; and weigh costs against benefits?
_ *Technological Literacy:* Do students know what technology is, how it works, what purposes it can serve, and how it can be used efficiently and effectively to achieve specific goals?
_ *Visual Literacy:* Can students interpret, use, appreciate, and create images and video using both conventional and 21st century media in ways that advance thinking, decision-making, communication, and learning?
_ *Information Literacy:* Are students able to evaluate information across a range of media; recognize when information is needed; locate, synthesize, and use it effectively; and accomplish this using technology, communication networks, and electronic resources?
_ *Multicultural Literacy:* Can students understand and appreciate similarities and differences between the customs, values, and beliefs of their own culture and the cultures of others?
_ *Global Awareness:* Do students recognize and understand relationships among international organizations, nation-states, public and private economic entities, socio-cultural groups, and individuals across the globe?

Inventive Thinking
Experts agree: As technology becomes more prevalent in our everyday lives, cognitive skills become increasingly critical. "In effect, because technology makes the simple tasks easier, it places a greater burden on higher-level skills" (ICT Literacy Panel, 2002).

_ *Adaptability/Managing Complexity:* Can students modify their thinking, attitudes, or behaviors to be better suited to current or future environments? Can they handle multiple

goals, tasks, and inputs while understanding and adhering to organizational or technological constraints of time, resources, and systems?
_ *Self-Direction:* Are students able to set goals related to learning, plan for the achievement of those goals, independently manage time and effort, and independently assess the quality of learning and any products that result from the learning experience?
_ *Curiosity:* Do students have a desire to know or a spark of interest that leads to inquiry?
_ *Creativity:* Are students able to bring something into existence that is genuinely new and original, whether personally (original only to the individual) or culturally (where the work adds significantly to a domain of culture as recognized by experts)?
_ *Risk-taking:* Are students willing to make mistakes, advocate unconventional or unpopular positions, or tackle challenging problems without obvious solutions, such that their personal growth, integrity, or accomplishments are enhanced?
_ *Higher-Order Thinking and Sound Reasoning:* Are students adept at cognitive processes of analysis, comparison, inference/interpretation, evaluation, and synthesis, as applied to a range of academic domains and problem-solving contexts?

Effective Communication
According to the 21st Century Literacy Summit, "information and communications technologies are raising the bar on the competencies needed to succeed in the 21st century" (2002). Both researchers and the business community agree: effective communication skills are essential for success in today's knowledge based society.
_ *Teaming and Collaboration:* Can students cooperatively interact with one or more individuals, working with others to solve problems, create novel products, or learn and master content?
_ *Interpersonal Skills:* Are students able to read and manage their own and others' emotions, motivations, and behaviors during social interactions or in social-interactive contexts?
_ *Personal Responsibility:* Do students demonstrate a depth and currency of knowledge about legal and ethical issues related to technology, combined with an ability to apply this knowledge to achieve balance, integrity, and quality of life as citizens, family and community members, learners, and workers?
_ *Social and Civic Responsibility:* Can students manage technology and govern its use in ways that promote the public good and protect society, the environment, and democratic ideals?
_ *Interactive Communication:* Do students generate meaning through exchanges using a range of contemporary tools, transmissions, and processes?

High Productivity
"We are living in a new economy," says the U.S. Department of Labor. In the Digital Age, success is "powered by technology, fueled by information, and driven by knowledge." Though not yet a high-stakes focus of schools, these skills often determine whether a person succeeds or fails in today's workforce.
_ *Prioritizing, Planning, and Managing for Results:* Do students organize to efficiently achieve the goals of specific projects or problems?
_ *Effective Use of Real-World Tools:* Can students use real-world tools (i.e. the hardware, software, networking, and peripheral devices used by Information Technology (IT) workers

to accomplish 21st century work) to communicate, collaborate, solve problems, and accomplish tasks?

_ *Ability to Produce Relevant, High-Quality Products:* Are students adept at developing intellectual, informational, or material products that serve authentic purposes and occur as a result of their using real-world tools to solve or communicate about real-world problems? These products include persuasive communications in any media (print, video, the Web, verbal presentation), synthesis of resources into more useable forms (databases, graphics, simulations), or refinement of questions that build upon what is known to advance one's own and others' understanding.

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