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The impact of technology on the development of expertise and teacher beliefs

Diane Robinson Penland
Walden University

Walden University

COLLEGE OF EDUCATION

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Diane Robinson Penland

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Dr. Paul Beisenherz, Committee Member, Education Faculty
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Dr. Paula Dawidowicz, University Reviewer, Education Faculty

Chief Academic Officer

David Clinefelter, Ph.D.

Walden University
2011

Abstract

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Development of Expertise and Teacher Beliefs

by

Diane Robinson Penland

M.A., Northern Arizona University, 1984

B.A., Arizona State University, 1981

Dissertation Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Although successful integration of technology into classrooms has proven beneficial to the learning process, little is yet known about how teachers respond to the introduction of technology and why some choose to use it while others do not. Using Sandoltz' stages of teacher technology adoption as a framework, this multiple case study utilized historical data that captured the experiences of teachers in 2001-2002 to determine the process of teachers' adoption of innovations into existing classroom practices. Participants included a purposive sample of eight 5^{th-} and 6^{th}-grade teachers from 3 schools. Data sources included teacher interviews, classroom observations, and video recordings of classroom practices for each teacher. Analysis included deconstruction by research question to identify patterns and emerging themes. The findings in this study showed that the voluntary nature of participation in technology integration activities contributed to students' success. It also indicated that teachers who received on-going grant support had greater success integrating technology into instructional practices. This study contributes to positive change by providing a tool that can be used by policy makers and staff developers to better improve the adoption of current and future technological innovations where resistance may occur.

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Dedication

This work is dedicated to all who struggle to succeed. Never give up your dreams.

Everyone has the right to be successful.

Acknowledgments

My thanks to the many, who supported this effort. For some this has been a longer commitment than others. My committee, Leslie VanGelder, MaryFriend Shepard, Paul Beisneherz, and Paula Dawidowicz, have offered invaluable feedback and helped me focus my thinking in order to create this document. Susan Barrat, Linda Demos, and Barbara Sirotin have my deep gratitude, not only as friends, but for their efforts in helping open up their schools so I could work with teachers who are truly amazing as they blazed the technology trail in their classrooms. Patricia Thurmond and Jean Hess for giving me the workspace and feedback to get this darn thing completed. And, finally, my family and friends for understanding when I disappeared for periods of time, or was less than my normal happy self. Jack, my husband and partner in life and beyond, my other half, thank you for your tireless editing of yet another revision, never letting me give up, and gently nagging me to continue on this path. My parents, Arthur and Joan Robinson, thank you for supporting me even when you don't always understand me. My center of friends, DaLee Caryl, Irene Grubbs, Barbara Kilian, Kay Klein, Marylou D'Antonio, Sue Burke, and Beth Boland. You are my cheering section, and I really do appreciate each and every one of you as you listened to my thoughts, my frustrations, my hopes, and always knew I'd succeed.

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Chapter 1: Introduction to the Study

Technology innovations in 2011 can be informed by studying the ways teachers adopted innovations during the period (2001-2002) when computer technology hit critical mass in U.S. public schools (Education Week, 2005, p. 8). According to Ware (as cited in Few, 2007, p. 2), "It is not enough to focus on what's happening today. We must see what's happening in the context of history to understand it fully." Going back and reanalyzing data captured in the past gives insights into the present by allowing it to be better understood within that framework. The value of this study came from capturing a specific time period for data gathered when technology began to be more readily available in U. S. public school classrooms (U. S. Census Bureau, 2003), making it possible to study the process of technology adoption and integration as it occurred in 2002 specifically concerned with how that could inform the present. The uniqueness of this time period is that it was the only period in history that this type of mass increase of computers occurred in schools across the United States (Kleiner & Lewis, 2003).

During 1994 through 2002, schools went from 35% Internet access in 1994 to 99% by 2002 (Kleiner & Lewis, 2003) with a ratio of four students per computer by 2003 (U. S. Census Bureau, 2003; Woessmann & Fuchs, 2004). Due to the volume of computers that entered classrooms during this time, a series of decisions were made by educators that cannot be replicated as they, in themselves changed the course of education. Perspective of this time period is important as similar, albeit smaller, decisions are continually being made as new technologies drive innovations that are increasingly being introduced to schools. The emerging patterns of teacher perception, use of technology in classroom practice, ongoing professional development, and subsequent instructional improvement practices from this period of time informs present practice by exploring the process teachers undergo while adopting innovations. By gleaning an understanding of how teachers' perceptions and behaviors change during the increase of innovations, a structured guide tool for professional development was created to assist teachers through adopting innovations successfully in the future.

Examining teachers' use and perception of technology as an influence on their classroom practice in 2002 was the focus of this study. In addition, I examined the growth and pedagogy of these teachers as these key factors related to their perceptions, and the classification of teachers' perceptions of classroom practice over time to the stages of teacher technology adoption (Sandholtz, Ringstaff, & Dwyer, 1997). The responses to these questions informed the field of educational technology because they provided insights into the process teachers experienced when adopting innovations during the era when the ratio of computers to students reached approximately one computer for every four students, a ratio that remains unchanged today (U.S. Census Bureau, 2003, 2008). The findings from this study may lead to an understanding of how to create supportive environments that make adoptions of innovations more successful in the future. In the past 10 years (Wei, Chen, Lin, Li, & Chen, 2008) many teachers have begun to integrate technology in their classes, and the sophistication in the use of technology tools has increased. Hihlfeld, Barron, and Ritzhaupt (2007) found only 4% of students' use of technology involved collaborating on real-world problems with students using computers, while 59% of the time was spent on testing and skill practice. Because teachers must monitor themselves, their perceptions of their abilities impact their performance (Adey, 2006; Adwere-Boamah, 2010; Connelly & Clandinin, 1988, 1999; Lawrence-Lightfoot & Davis, 1997). Researchers have examined why many teachers are not using technology in their classrooms for collaboration in a way that supports student learning (Li, 2007; Zhao & Frank, 2003, p. 807). Insight into the perceptions of teachers at the time from 2001 – 2002 when computers hit critical mass in the classrooms (Education Week, 2005, p. 8) provided insight into the adoption process of teachers today and in the future as they integrate emerging technologies into their classes.

Some teachers are implementing technology into their daily curricula in a manner that anecdotal evidence seems to indicate adds value to student learning (Ajero, 2007/2008; Matzen & Edmunds, 2007; Riel & Becker, 2000). It was important to examine these teachers' professional practices and perceptions in order to determine if their practices could be analyzed and reproduced elsewhere. Evaluating how they have grown professionally from teaching without technology to teaching with technology can provide clues as to how they added value to student learning in 2002, so it can inform practice in 2011.

This became worthy of further study when discussing the integration of technology in the classroom because teachers' perceptions of how effective they may be at using technology for student learning affected the degree to which they used it (Cheung, 2002; Wei et al., 2008; Zhao & Frank, 2003). Numerous reserchers have examined how teachers progress through their career (Berliner, 1988, 2004; Garmston, 2005), their perceptions about their teaching ability (Adey, 2006; Connelly & Clandinin, 1988, 1999; Harwood, Hansen, & Lotter, 2005; Lawrence-Lightfoot & Davis, 1997; Lotter, Harwood, & Bonner, 2007), and how these factors affect student learning. It is possible to take what was learned from this research on teacher perceptions and professional practice as it has to integrating computers into classrooms and reapply it to study professional development and teacher perceptions of classroom practices as they integrate new technologies in their classrooms.

By obtaining the teachers' own perceptions of their classroom practices during 2001-2002 when intense change occurred due to computers hitting critical mass in U.S. schools, the teachers provided insight into how their use of technology was indicative of a particular stage of change. To understand those common experiences, apply them to technology integration as it is influenced by ongoing professional development opportunities, provided insight into why there has been no consistent "impact (of technology) on teaching and learning in most classrooms" (Sandholtz & Reilly, 2004, p. 487). It is possible to effect widespread changes in the ways teachers adopt future innovations.

By exploring the various dimensions of stage changes in teacher professional practice as it has to do with expertise in pedagogy (Berliner, 1988, 2004), teacher leadership (Riel & Becker, 2000, 2008) and teacher adoption of technology innovations (Sandholtz et al., 1998) this study provided insight into teachers' use of technology in their classrooms, the role of ongoing professional development in technology, the teachers' perceptions of technology in classroom practice, and how they subsequently used technology to create changes in their teaching practice. To revisit historical data from the beginning of the 21st century at a point when computer technology was hitting critical mass was useful for trying to determine why teachers have not adopted new technologies more fully in their classrooms. Each of these areas of research was expanded upon in chapter 2.

Problem Statement

Wei et al. (2008) found that many teachers are still at the beginning stages of technology integration with only minimal changes in educational practices occurring in the past 10 years. Many researchers have examined how teachers adapt to educational innovations (Cheung, 2002; Project Tomorrow, 2008; Sandholtz & Reilly, 2004; Sandholtz et al., 1997). Data gathered in 2001-2002 when computers were becoming extensively available in public school classrooms around the United States and sought to understand the process teachers went through during this time of potentially extensive change was the focus of this study. These data are unique in that they captured teacher perceptions and use of technology during this period in time. A gap in the literature was filled by this study in that it captured the thoughts and feelings of teachers as they were going through the process of intense change at a time when computers were hitting critical mass in public schools. No studies were found that considered the evolution of technology in schools during the time period when technology began to be accepted in the mainstream by teachers. The findings from this study might assist policy makers and staff developers in 2011 in better understanding what supports teachers need in order to successfully adopt innovations, and respond to the technological demands society places on schools.

Purpose Statement

An exploration of the various dimensions of (a) stage changes as teachers used technology in their classrooms, (b) the role of ongoing professional development in technology, and (c) teachers' perceptions of technology in classroom practice and how teachers subsequently used technology to create changes in their teaching practice was the focus of this study. I sought to understand those common experiences from the early period of school technology adoption and applied them more broadly to emerging technology integration as it was influenced by ongoing professional development opportunities to better discern why it was not being used by teachers for student learning to the extent possible (Dede, 2007, 2008; Groff & Mouza, 2008; Kleiner & Lewis, 2003; National Center for Educational Statistics as cited in U. S. Department of Education, 2005, para. 3; Levin & Arafeh, 2007; Li, 2007; Sandholtz & Reilly, 2004, p. 487). From an understanding of the common experiences among the participants, both supports that encouraged integration of technology and barriers to success, it was possible to create a structured guide tool for staff development that better supports future teacher adoption of innovations, and responds to the technological demands society places on schools.

Nature of the Study

This qualitative, case study was designed to examine, document, and describe eight teachers' professional practice and knowledge (Connelly & Clandinin, 1988, 1999) of technology use in their classrooms to determine the extent to which teachers' perceptions of their abilities to use technology were consistent with observed performance in a classroom at a time in history when the introduction of computer technology hit critical mass in public schools.

Historical data analyzed in this dissertation were collected from three distinctly different sources: interviews, observations, and videos. Secondary analysis occurred by source, and was triangulated by participant and deconstructed by research question. Once the research questions were organized by case, patterns and emerging themes were compared to recent findings in the literature. The methodology for this study will be discussed in greater detail in chapter 3.

Research Questions

This study focused on the following research questions:

Research Question 1

1. How do data from a study of teachers' use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice?

Research Question 2

2. How does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation?

Research Question 3

3. How can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful

support systems for teachers as new technological innovations in education are introduced?

Data Collection and Analysis

Historical data analyzed in this dissertation were collected from three sources: interviews, observations, and videos. Data were collected through initial interviews with eight teachers, followed by 13 visits to each of their eight classrooms during which an observational diary was kept. Finally, a 15-minute video was collected in each classroom of students using technology in some manner. Content analysis (Marshall & Rossman, 1989; Merriam, 1998; Ryan & Bernard; Silverman, as cited in Denzin & Lincoln, 2000, p. 785) occurred in three phases. In the initial phase, I analyzed teachers' perceptions about classroom use of technology and working with students. I grouped teachers by years of participation in the particular grant in which they were awarded through outside funding sources. I examined the ways in which teachers used technology and whether that matched their perceptions of their teaching using technology for student learning. Drawing on multiple data sources, I looked for patterns both within and across groups. This analysis occurred to detect recurring themes. The stages of teacher technology adoption (Sandholtz et al., 1997) was used to analyze data from the participants to provide a matrix for teacher development.

A secondary analysis of historical data (Glass, 1976) occurred for the purpose of answering new research questions with previously collected data. The perceptions and feelings of the particapants were explored and analyzed against current research that explored reasons why technology has not been more broadly embraced by teachers. The research questions were used to organize the data analysis and detect themes that will help inform practices in 2011. Current research added a layer of understanding to the mostly unanswered question of why teachers are not using technology in the manner it was intended in U.S. public schools.

Participants

Using purposive sampling (Creswell, 1998), this study followed professional growth and development of eight classroom teachers from three states in different regions of the U.S. that participated in a 3-year technology grant. In each location, the administrator was given the option of selecting the participating teachers; those they felt were "competent" teachers who were using technology in some manner. It was left up to the adminstration, as the instructional leader at each location, to determine which teachers to recruit for the study.

Each teacher in the study applied for and was awarded a state or organizational grant from within the school setting in which they were located. This was done outside of this study, although only teachers who had received technology grants were included in the study. The grants were awarded to assist interested teachers in integrating technology into their individual classrooms. The technology grants provided computers at a ratio of one computer to four students, Internet access, and required ongoing professional development for integrating technology into the classroom of each teacher participant. All grants were of at least 3 years duration, with two teachers participating into the fourth year. The teachers participated during the period of time they received their grants. Three teachers from each of three schools were invited to participate in this study. It was determined that one of the participants did not meet the requirement of ongoing professional development and was eliminated from the study. The data used in this study were historical data that were collected in 2001-2002 as part of a previous dissertation study at Teachers College, Columbia University during the window of time when technology adoption was hitting critical mass in U.S. schools, and grants were readily available to teachers and schools through outside sources.

Conceptual Framework

Stages of teacher technology adoption (Sandholtz et al., 1997) were used as the basis of analyzing how teachers move through adoption of innovations into existing classroom practices. Teacher leadership, as described by Riel and Becker (2000) was considered as the stages they identified that correspond to how teachers integrate technology into classrooms. Both of these stage theories were addressed by Zhao and Frank (2003), who observed that the factors most frequently cited as affecting technology use in schools are associated with the teacher (Matzen & Edmunds, 2007; Schwartz, 2008).

Stage Theories

The stages of teacher technology adoption as reported by Sandholtz et al. (1997) was used as the framework for this study as they outline the progression teachers make when adopting technology innovations in schools. This stage theory was chosen because it is widely used and frequently cited in educational research (Hughes, 2008; Riel & Becker, 2008; Sandholtz & Reilly, 2004; Shuldman, 2004). Teacher leadership (Riel & Becker, 2000, 2008) and stages of teacher technology adoption (Sandholtz et al., 1997) were addressed by Zhao and Frank (2003), who observed that the factors most frequently cited as affecting technology use in schools are associated with the teacher (Becker, 2003; Sandholtz et al., 1997). They wrote that "teachers' attitudes toward, and expertise with, technology are often key factors associated with their use of technology" (Zhao & Conway as cited in Zhao & Frank, 2003, p. 809). Teachers' perceptions of their ability to use technology effectively for student learning becomes the impetus for how they integrate innovations in their classroom practices.

The early development of the stages of teacher technology adoption originated in studies from the Apple Classrooms of Tomorrow (ACOT) project and included five stages of teacher adoption of technology (Sandholtz et al., 1997). The findings from the ACOT study concluded that understanding and using technology are intrinsic parts of instruction that take considerable time and effort.

Stages of Professional Practice

Stages of professional practice, as it related to technology integration, are derived from two main sources; the teacher leadership studies initially conducted by Riel and Becker (2000, 2008) and from the ACOT study (Sandholtz et al., 1997). Essentially, these two stage theories gave a similar view into the professional practice of teachers and showed how their actions directly related to the use of technology in the classroom for instructional purposes. A third study (Sandholtz & Reilly, 2004) expanded upon these first two studies by considering how professional development support structures could affect teacher growth.

Teacher Leadership

Riel and Becker (2000, 2008) showed how teachers who use technology have other qualities desired among educators. Riel and Becker focused on three areas of what they called "professional engagement" (p. 1). Riel and Becker stated these areas are

> (1) the frequency that a teacher had *informal* substantive communications with other teachers *at their school*, (2) the frequency and breadth of professional interactions with teachers *at other schools*, and (3) the breadth of involvement in specific peer leadership activities–mentoring, workshop and conference presentations, and teaching courses and writing in publications for educators. (p. 1)

Informal professional engagement at their schools, at other schools, and formal professional meeting activities give emphasis to Riel and Becker's final point that teacher leaders engage in inquiry-based teaching.

Riel and Becker (2000, 2008) measured both the degree of teacher engagement in these three areas and the extent to which these areas entered into the professional lives of the teachers. The authors also showed how, over time, teachers use technology in their classrooms, and how their existing predisposition toward collaboration lends itself to wanting to adopt new inquiry-based teaching methods.

Stages of Teacher Technology Adoption

Sandholtz, et al. (1997) provided the typical stages for adopting technology innovations. The five stages summarized are

- *Entry.* Teachers are introduced to technology in their classrooms and typically do not use it for instructional purposes;
- *Adoption.* Teachers begin to use technology for self-productive purposes and to support traditional teaching practices;
- *Adaptation.* Teachers automate their existing practices and begin to use technology in ways that are connected to the curriculum;
- *Appropriation*. The stage where teachers understand technology well enough to use it as a tool for new methods of instruction thus building into lesson design learning experiences that take advantage of the technological capabilities, and;
- *Invention*. The stage where teachers begin to make systemic changes in their professional practice by leveraging the power of technology.

When technology is first introduced into the professional life of the teacher, he or she typically struggles to learn the basic workings of the computer. Sandholtz et al. (1997) reported that many of the problems teachers experience at this point are similar to those of first-year teachers. As they become more familiar and comfortable with technology, teachers begin to progress through a series of stages that go from using the computers for simple drill and practice activities to more innovative learning practices. Sandholtz et al. included constructing knowledge, developing curricular content around the use of technology, sharing materials with each other, and allowing students to create their own content as well as using information from the Internet. At this point, teachers may be involved in restructuring the curriculum. It is through the lens of this stage theory that Sandholtz et al. have shown how teachers responded when new technology entered their professional practice.

Sandholtz and Reilly (2004) amplified upon the work from the ACOT study (Sandholtz et al., 1997) and researched how different support structures can affect the rate at which teachers progress through the stages. Traditionally, teachers had been expected to learn the technical aspects of using technology in their classrooms. However, Sandholtz and Reilly found that when teachers are supported by technical staff and allowed to use their expertise in curricular design, they were able to integrate technology into their curriculum in a manner that added value to student learning. This change in focus of ongoing professional development around technology integration allowed teachers to gain higher stage advancement within 2 to 3 years, as opposed to the 5 or more it took in the ACOT study (Sandholtz et al.).

Operational Definitions

Operational definitions are provided as a way to ensure that all readers have a common knowledge and an understanding of the terms as they are used in a study. The definitions are, for the most part, those that are readily accepted by the educational community.

Professional development: Professional development refers to formal and informal learning experiences that occur during the career of a teacher from pre-service teacher education to retirement (Fullan, 2001).

Technology integration: Technology integration refers to the different ways that teachers use technology to engage and enhance student learning (Johassen, Peck, &

Wilson, 1999). Learning can be supported using technology in many ways. Some include (a) using technology as a tool to support knowledge construction, (b) technology as an information vehicle for exploring knowledge, (c) technology in support of learning by doing, and (d) technology as a social medium to support collaboration (Johassen et al.).

Constructivist pedagogy: Knowledge occurs in the learning environment by active construction based on available structures (Liu & Matthews, 2005, p. 387), not transmitted. As knowledge is constructed, these representations are constantly open to change and influence the ways in which other knowledge structures are internalized.

Teacher perception: Teacher perception is designed to emphasize the teacher's knowing of a classroom. It captures the idea that past experiences, as they inform present and future perceptions, is flexible and fluid; therefore it takes recognizing that people say and do different thing in different circumstances, thus, making the situation critical (Connelly & Clandinin, 1988).

Apple Computers of Tomorrow (ACOT): ACOT initiated in 1985, was a research and development collaboration among public schools, universities, research agencies, and Apple Computer, Inc. to investigate how the routine use of technology by teachers and students might affect teaching and learning (Sandholtz et al., 1997).

Multimedia: Information in more than one form. It includes the use of text, audio, graphics, animation, and full-motion video. Multimedia programs are typically games, encyclopedias, and training courses on CD-ROM or DVD (Websters Dictionary, 2009).

Portraits: Portraits are a record and interpretation of the perspectives and experiences of people who are studied, documenting their voices and their visions (Lawrence-Lightfoot & Davis, 1997).

Assumptions, Limitations, Scope, and Delimitations

Assumptions

Case study research is significant in that it illuminates in detail larger issues, in this case a view into a captured period of time when large amounts of technology were new to education. It was assumed that from this study came new insights for education as data collected in 2001-2002 were analyzed using questions generated in 2010. Historical data were reanalyzed by using new research questions so that they could be used to inform practices in 2011 and the future (Fielding, 2004). This study included traditional case study research and was an in-depth study of a preselected number of teachers defined in terms of time and place (McMillan, 2000). It was assumed that the teachers in this study fell into Berliner's (1997) competent stage or beyond. It was further assumed that the teachers in the study were willing to use technology for personal and professional use.

Limitations

I sought to understand how the practices of teachers, combined with their self-reported knowledge of computer use, were associated with levels of teacher development in general education classrooms. Limitations of this study include the following:

1. The data were collected in 2001- 2002 under the auspices of Teachers College, Columbia University. The 6-month period of time in which the participants were

observed may not completely accurately portray the complexity of each classroom.

2. The study provided a single interpretation at a particular point in history. As such, it must be viewed as unfinished.
3. Students with access to technology at home or in other settings showed different behavior patterns when using technology in classroom settings.
4. There were unequal hardware and software access, and technical support among the schools being studied.
5. The limits inherent in using this population were that these teachers possibly differed from their nonparticipating colleagues in their motivation to use technology during this time period.

Scope

Time, place, and a limited number of participants bound the scope of the study. The study was limited to a 6-month period during one academic year in 2001-2002. It was limited to three locations around the United States that were selected using purposive sampling (Creswell, 1998) at a time when travel was especially difficult due to increased security measures in the United States. Originally, three teachers from each school were selected to participate in the study. When it was determined that one of the teachers did not meet one of the qualifications, professional development tied to the grant award, she was eliminated as a participant. The collection of data began at the time of Institutional Review Board (IRB) approval from Teachers College and proceeded for 6 months.

Delimitations

Delimitations of the study included narrowing the focus to fifth and sixth grade teachers. Each teacher was involved in an outside grant that awarded them computers at a rate of one computer for every four students and were all connected to the Internet. Additionally, each teacher was required as part of the grant to participate in ongoing professional development opportunities that had to do with the integration of computer technology into the existing curriculum. This professional development occurred outside of the classroom and was spread over the academic school year. It consisted of set periods of time when the teachers went to another location and met with other teachers involved in their state's grant. The limits inherent in using this population were that these teachers differed from their nonparticipating colleagues in their motivation to use technology during this time period. Given the volume of data collection of 13 visits over a 6-month period, only three participants were selected per site. Eventually one participant was eliminated, as she did not meet all of the criteria.

Educational Significance of the Investigation

Implicit in the call for technology integration in education has been the suggestion that constructivist-oriented pedagogy should be infused into technology innovation (Ajero, 2007/2008; Matzen & Edmunds, 2007; Tapscott, 2008). Studying how teachers react to an influx of technology, how they perceive their new situation, and how it is impacted by ongoing professional development made it easier to identify their common experiences. Further, it also made identifying possible best practices for integrating technology into the classroom easier. Presently, most researchers have suggested ideas for integrating technology as opposed to broad studies of how teachers integrated technology for student learning and how it changed teaching and perceptions about their professional practice (Angeli, 2008; Harris, Mishra, & Koehler, 2009; Mishra & Koehler, 2006).

Specifically, this study provided information about the following:

How Teachers' Practice Supports Their Growing Pedagogy

While there was disagreement as to the order of events, researchers seemed to support that teacher experiences, perceptions, and behaviors are intermingled to produce professional growth (Baird, Fehsham, Gunstone, Penna, & White, 1991; Fullan, 1985; Guskey, 1986; Richardson, Anders, Tidwell, & Lloyed, 1991). What was missing was how technology adoption fits into the broader view of teacher experience, perceptions, and behaviors as a vehicle for professoinal growth in pedagogy. Throught the analysis of data collected in 2001-2002, this study added to the body of research by comparing how teacher experiences, perceptions, and behaviors influence their use of technology in classrooms for student learning. The study then extended the literature by providing a structured guide tool of the process teachers go through when innovations are introduced to their classsrooms with the idea that the findings will assist policy makers and staff developers in 2011 in better understanding what supports teachers need in order to successfully adopt innovations, and respond to the technological demands society places on schools.

The components of ongoing professional development support the integration of technology into the curriculum in meaningful ways (Harris et al., 2009; Mishra &

Koehler, 2006; Riel & Becker, 2000, 2008; Weber, 2005). Hargreaves (2003) and Zhao and Frank (2003) postulated that learning communities, or social interactions, support teacher development through collaboration. Reubling (2006) stated that ongoing development is critical for helping diverse student populations succeed. I explored ways in which teachers experience growth in pedagogy through integration of technology and professional development. Inherent in these findings are increased opportunities for students to learn and grow through the use of innovations. By reanalyzing data collected in 2001-2002 it is possible to understand why there has not been widespread adoption of many emerging technologies. With further study, the findings ultimaltely led to a structured guide tool that can be used to effect systemic change in educational practices when future innovations are introduced to teachers.

Extent and Ways Teachers Perceive Their Use of Technology in Classrooms

Researchers have supported that teachers monitor themselves as their perceptions impact performance (Connelly & Clandinin, 1988, 1999; Richardson, 1996). More recently (Wei et al., 2008) professional learning has been tied to instructional innovations and how technology contributes to teachers creating professional knowledge through inquiry. By analyzing data gathered during 2001-2002, the process by which teachers begin to adopt innovations was explored and a structured guide tool for professional development as future innovations emerge was developed. By creating online learning communities around these practices, greater access to global teaching practices will occur encouraging social change.

Summary

Chapter 1 included an introduction to this study. In spite of wide-spread technology availability in schools (U. S. Census, 2009, Table 247), computers are not being used by teachers for student learning to the extent possible (Dede, 2007, 2008; Groff & Mouza, 2008; Kleiner & Lewis, 2003; National Center for Educational Statistics as cited in U. S. Department of Education, 2005, para. 3; Levin & Arafeh, 2007; Li, 2007; Sandholtz & Reilly, 2004, p. 487). After reviewing the past and current literature on teacher perceptions and how that affects teacher professional behaviors, a gap in the literature was identified with how those teacher perceptions and behaviors could be used in the adoption and integration of technology into classrooms (Lim & Chan as cited in Teo, Chai, Hung, & Lee, 2008). Historical data that were collected in 2001-2002 were used because they come from a period of time when computer technology hit critical mass in U.S. making it possible to better understand how teachers' perceptions and behaviors change during the increase of technological innovations.

Chapter 2 includes a review of the literature in four main areas: (a) teacher pedagogy as it related to professional expertise; (b) teacher perceptions, experiences, and collaboration used to construct knowledge; (c) findings on teacher professional development and leadership; and (d) teacher adaptation of educational innovations, with an emphasis on technological classroom applications. The review of literature unearthed a gap in the literature that this study filled, namely, to determine how those perceptions, practical knowledge, and experiences translate into professional behaviors, or growth toward increased levels of expertise (Berliner, 1988, 2004; Darling-Hammond, 2000;

Darling-Hammond, Sato & Wei, 2008; Richardson, 1996; Wei et al., 2008) when innovations are introduced to the classroom. Chapter 2 concluded with a review of different research methodologies and provided an argument for the use of case study research as a way to glean understandings of the process teachers underwent at a time when computers were hitting critical mass in public schools.

Chapter 3 includes the research design, purpose, research questions, participants, sampling, data collection, methodology, thematic analysis, and data analysis. Using data collected in 2000-2001, a secondary analysis occurred that answered new research questions posed in 2010. Chapter 4 comprises the findings from the reanalysis of the data around the new research questions. New themes emerged that more closely match concerns found in the review of literature. Taking those findings and comparing them to the review of literature allowed me, in chapter 5, to report how historical data can inform present practice and create a structured guide tool that might assist policy makers and staff developers in 2011 in better understanding what supports teachers need in order to successfully adopt innovations, and respond to the technological demands society places on schools.

Chapter 2: Literature Review

This chapter includes an examination of the literature regarding the impact of professional development expertise and teacher perceptions on technology development and integration. In examining these two areas of research, common patterns of development emerged. Patterns in the area of professional development expertise were used to predict the growth of teachers as they adopt technology. It was possible to take what was learned from the literature review and reapply it to study professional development and teacher perceptions of classroom practices as they integrate new technologies in their classrooms. Professional development and teacher perceptions as it has to do with integrating new technologies into classrooms was a subject that had not been as thoroughly studied.

The review of literature included four main areas: (a) teacher pedagogy as it has bearing on professional expertise; (b) teacher perceptions, teacher experiences, and collaboration as it is used to construct knowledge; (c) findings on teacher professional development and leadership; and (d) teacher adoption of educational innovations, specifically as it related to technology. The review of literature was organized in this order so that the first three areas were an overview of teacher professional development, while the last area reviewed the literature in the newer area of teachers adopting technology. A comprehensive search of the literature was conducted using ProQuest, EBSCO, and Eric Database, in addition to reading books of past and present theorists. Initially, a series of key words were used such as *technology integration, professional development, teacher perceptions, teacher behaviors, teacher pedagogy, teacher* *experience, teacher growth, teacher knowledge, teacher leadership, and teacher adoption of technology*. Once specific researchers kept emerging as support for research findings, it was determined that the search was complete. Additionally, key words were referenced to original researchers in order to determine new research that existed under each topic area including research from 1988 through 2010.

The first section of the review of literature considered research into professional expertise. The literature on teacher development explained how teachers learn, their focus on pedagogy, and why they participate in life-long learning. The second section, teacher experiences and perceptions, reviewed the literature on career formation. Research on adult learning and collaboration provided a context for further discussing the reasons teachers advance and retreat through various stages of development as they work to construct knowledge. The third section, stages of teacher development and teacher leadership, added to the formal base of knowledge about professionalism or attainment of expertise of teachers through a developmental lens. Several models offered ways of looking at teacher development and teacher leadership. These models helped to explain differences in the way teachers view and interpret the usefulness of technology as a possible learning and teaching tool in the classroom. In addition, teacher behavior, and how adjustments occur in the presence of change was examined. The fourth section, teacher adoption of educational and technological innovations, served as a contrast for comparing professional expertise, teacher experiences and perceptions, and teacher development and teacher leadership. This section included literature on the stages teachers go through in the adoption of technology and examined research on teacher leadership, most especially in focusing on how teachers improved their overall pedagogy through the use of technology. Additionally, this section noted the gaps in the current research in this realm and gave a brief explanation as to why the research described in this study serves as a contribution to the literature of the field. This section made up the basis for the conceptual framework for this study, including a rationale for using historical data collected in 2001-2002. Finally, the last section concluded with a brief review of different research methodologies, ultimately focusing on an argument for using a case study approach, the method used for this investigation. Different methodologies were explored and discarded. A summary for using historical data is explained.

Teacher Pedagogy

Several studies conducted in the last 20 years have focused on teacher development, examining how teachers learn, their focus on pedagogy, and why they participate in extended education. Examining this research provided a foundation for understanding what was already known about how teachers generally learn, grow, and change. Such an understanding was essential before attempting to extend knowledge on teacher development, pedagogy, and professional development into the relatively new areas of teacher growth involving technology. The three models discussed here span work from 1988 to 2007 and each model focused on elements of professional practice that serve to inform ways in which educators ultimately engage their professional learning with new information, such as technology. Berliner (1988, 2004) examined the development of professional expertise; Darling-Hammond (1998, 2000; Darling-Hammond & Bransford, 2005, 2006; Darling-Hammond, Sato, & Wei, 2008) considered the life transitions of teachers in their professional development and collaboration among teachers to promote expertise of practice; and Hargreaves (2003, 2007) discussed professional learning systems as a way of encouraging professional learning in schools.

The Development of Expertise in Teaching

Berliner conducted research into education, including teacher expertise. Berliner (1988, 2004) identified a series of stages that support teaching practices that move students to increasingly higher levels of understanding. Berliner (2004) compared his stages to teachers who were attempting to gain National Board Certification. As a result, this stage theory offered a different perception than the previous competency-based models of teacher development. Berliner (1988) wrote that when compared to the developmental models that attempted to explicate the process of becoming a teacher career expert, the competency-based models appeared to offer little insight into the formative processes of teachers as they master their profession.

Berliner (1988) named the five stages in the developmental sequence: novice, advanced beginner, competent, proficient, and expert. (Although he mentioned a sixth, the postulate teacher, the research was not descriptive of the attributes of the postulate stage.)

The following section summarized each of the different stages as described in Berliner's 1988 work.

Novice. Berliner (1988) described novice teachers as those individuals who are consumed by the effort of trying to survive the complexities of the teaching milieu. Typically, beginning teachers manifest the attributes described in this stage.

Advanced beginner. Advanced beginners begin to develop strategic knowledge and starts to blend experience with verbal knowledge (Berliner, 1988). However, when teaching, there is a lack of timing in the execution of lessons. This individual will make instructional errors and is detached from instructional behaviors (Berliner).

The most significant characteristic for the novice and the advanced beginner is they rarely possess the insight to understand that the educational and behavioral student outcomes in their classrooms are a direct result of teacher actions. Berliner (1988) noted that the novice or the advanced beginner teacher tends to blame the low achievement scores of his or her students on the home environment of students or the administrative policies. Consequently, individuals in these two stages are associated with a low ability to predict how their teaching behavior affects student outcomes (Berliner). Somewhat related, Berliner also stated that novices and advanced beginners usually have trouble observing and interpreting the teaching/learning act in complex and sophisticated terms.

Competent. Competent teachers make conscious, deliberate decisions about their teaching (Berliner, 1988(. They have rational goals and meanings. They feel personally responsible and they study the context of the classroom environment. The competent teacher sets priorities and plans, knows what to ignore and what to attend to in the classroom environment, and is becoming predictive. Competent teachers are not yet fast, fluid, or flexible (Berliner).

Proficient. A teacher who is well versed in knowledge and skill engages in effortless teaching (Berliner, 1988). This individual is reflective and holistic in teaching.

The proficient teacher is context specific and analytical. This teacher has refined decision-making skills and exhibits precision in predictions (Berliner).

Expert. A teacher who demonstrates special skills exhibits a form of artistry in teaching (Berliner, 1988). This teacher shows precision in techniques and knowledge in action. The expert is intuitive and fluid. The expert integrates instruction, while being highly contextual and has skillful timing and execution. The expert does not appear reflective. Routines are a basic part of the expert's performance. Expertise is specific to a domain and "is developed over hundreds and thousands of hours" thus necessitating that "it is likely that every expert pedagogue has had extensive classroom experience" (Berliner, 2004, p. 201). Expert teachers rarely enter their classrooms without thoroughly understanding the content they will teach and nearly always plan one or more activities to teach that content. Expert teachers believe "their pedagogical expertise depends, in part, on knowing their students well" (Berliner, p. 202).

Berliner (1988) suggested that the realistic goal of a school district should be to upgrade all personnel to at least the third stage, the competent level. Berliner asserted that it is possible to teach the skills and attitudes necessary for all teachers to reach the competent level. Berliner wrote,

> Although individual differences abound, I would hypothesize that Novices are generally student and beginning first year teachers, Advanced Beginners are often in the second and third year of their careers in teaching, and if they have any talent and motivation whatsoever, along about the third or fourth year, a teacher may become Competent. … Perhaps in the fifth year or so a modest

> number of teachers may move into a further stage of development, that of Proficient. Some of these proficient teachers will reach the highest stage, achieved by very few members of the field, that of the Expert. (1988, p. 2)

Berliner (1988) wrote that just as it is possible to reach the competent stage, it might not be possible for all teachers to reach the subsequent developmental stages: proficient and expert. Later, Berliner (2004) hypothesized that attaining these latter stages may have more to do with intelligence, the ability of the teacher as a performing artist, or the level of adult development of the individual.

The time it takes teachers to move among the stages varies. According to Berliner (2004), anecdotal reports from teachers told that it “takes three to five years until they are no longer surprised by what happens to them in their schools and classrooms” (p. 201). If a teacher works hard to acquire high levels of skills, he or she can reach competency about 2 years prior to reaching expertise, which takes from 5 to 7 years of intense work (Turner, 1995; Lopez as cited in Berliner, 2004).

Berliner (2004) further contended that there are two different types of expertise: crystallized expertise and adaptive or fluid expertise. Crystallized expertise is more environmentally specific and “consists of intact procedures that have been learned through experience and is brought forth and used in relatively familiar tasks” (2004, p. 203). Adaptive or fluid experts appear to “learn throughout their careers, bringing expertise they possess to finding new ways to tie new situations they encounter to the knowledge bases they have” (p. 203). Berliner’s recent study adds clarification to the different ways teachers can achieve expertise in pedagogy.

Berliner (2004) found empirical evidence suggesting that those who are "designated as experts in pedagogy affect student achievement in positive ways" (p. 200). Teachers who passed the National Board for Professional Teaching Standards (NBPTS) assessment (Bond, Smith, Baker, & Hattie, as cited in Berliner, 2004) excelled on every prototypical feature. When Bond et al. (2004) assessed the students taught by these teachers, they found that 74% demonstrated higher understanding through relational and more abstract student work. This indicated that teachers who are considered expert have students whose work samples were of a higher quality than those teachers who do not meet the criteria as expert teachers (Bond et al., 2004). Those characteristics that were used to identify teachers for NBPTS certification were

> Better use of knowledge; extensive pedagogical content knowledge; better problem-solving strategies; better adaptation and modification of goals for diverse learners and better skills for improvisation; better decision making; more challenging objectives; better classroom climate; better perception of classroom events and better ability to read cues from students; greater sensitivity to context; better monitoring of learning and providing feedback to students; more frequent testing of hypotheses; greater respect for students; and display of more passion for teaching. (Berliner, 2004, p. 201)

Teachers have an impact on student learning. Through Berliner's (1988, 2004) work one recognizes both the stages of teacher development in terms of time frames, but also in terms of individual development. While the goal in education is to have expert teachers in every classroom, other key factors impact not only individual classrooms but also schools as a whole (Marzano et al., 2001). Berliner's model for identifying the stages in which teachers progress was helpful in supporting other models that were used to create the conceptual framework for this study. Berliner's stages of expertise in pedagogy had relevance in that teachers continue to show evidence of progressing forward and backward based on influences in their classrooms. Of interest to me was how the inclusion of technology influenced this movement.

Teacher life transitions. Darling-Hammond and Bransford (2005; Darling-Hammond, 2006), explored how teacher ability is changed by other influences, such as the quality of the school where the teacher is employed. Darling-Hammond (2000) wrote that, "teacher quality variables appear to be more strongly related to student achievement than class size, (and) overall spending levels" (p. 37). Darling-Hammond identified teacher expertise as the single most important factor in determining student achievement. More recently, Darling-Hammond (2006) found that teachers who do not have adequate preparation tend to blame the students for their lack of skills. This supported Berliner's (1988) earlier stages of expertise in pedagogy. In addition to advocating for teachers with strong teaching skills, especially in those schools with the largest inequities, Darling-Hammond, with Sato and Wei (2008), assessed the National Board Certification recipients and how that process influenced teachers' classroom practices. In particular, Darling-Hammond et al. focused on assessment practices. In a manner similar to Berliner (2004), Darling-Hammond et al. (2008) found teachers who engaged in the process of developing accomplished teaching as a means of acquiring National Board Certification, used a variety of assessment practices to support student learning, thus moving them toward higher levels of expertise in pedagogy. Additionally, teachers have consistently reported "becoming more conscious of their teaching decisions and changing their practices as a result" (Darling- Hammond et al., p. 671). Darling-Hammond et al. found that this process influenced teacher thinking, learning, and practice through this on-going engagement in classroom professional practice.

Researchers working in teacher education have identified the practices shared by those teachers that are considered effective. Arends (2009) wrote about the influence teachers have on student learning and the importance of practicing both the art of teaching and engaging in research based educational practices. Marzano, Pickering, and Pollack (2001) wrote that "individual teachers can have a profound influence on student learning even in schools that are relatively ineffective" (p. 3). Most of Marzano et al.'s research focused on pedagogical skills and pedagogical content knowledge, the art of teaching. There is support for the part of teaching that is based on the science of teaching. Furthermore, Leithwood, Louis, Anderson, and Wahlstrom (2004) explained that, "evidence suggests that significant amounts of variation in student learning are accounted for by teachers' capacities, including: subject matter, content knowledge, pedagogical skills, and pedagogical content knowledge" (p. 64). They included strategies such as cooperative learning, use of nonlinguistic representations, using cues, questions, and advanced organizers (Marzano et al., 2001), all of which supported a more inquiry-based learning environment.

In education, all students deserve a qualified teacher (Darling-Hammond, 2000) and researchers have supported that the teacher has the most impact on student learning.

Conclusions from Darling Hammond's work suggested that it is important for teachers to have ongoing professional development to sustain and develop those specific skills that benefit student learning. Marzano et al. (2001) found that highly capable teachers make a significant difference even in low-performing schools.

Professional learning systems. The need for ongoing professional development, especially within learning communities, has been highlighted by the work of Hargreaves (2003, 2007). Hargreaves (2003) argued that "teachers can no longer take refuge in the basic premises of the pre-professional age: …that once you have qualified to teach, you know the basics forever" (p. 25). Hargreaves suggested that creating professional learning communities within schools helps teachers focus their learning on those areas of importance for that school community. Hargreaves wrote that because teachers work in large communities, schools need to be "sophisticated professional learning systems that are organized and structured to encourage professional learning for teachers, so it becomes an endemic and spontaneous part of their work" (p. 25). Hargreaves added that teachers must engage in action, inquiry, and problem-solving collaboration in order to improve teaching practices that benefit student learning. More recently, Hargreaves (2007) wrote that "student learning and development do not occur without teacher learning and development" (p. 37). Hargreaves reflected that the older methods of professional development are not valid for teacher learning. Successful professional development assumes that teachers are "intelligent professionals who should be critically engaged in improving teaching" (Hargreaves, p. 38). Ruebling (2006) noted that it is critical to develop people. Teachers must either "develop, or already possess, the capacity to apply instructional, curricular, and assessment practices that have high potential for helping a diverse student population learn successfully" (p. 123). Ruebling's findings provided support for the work of Hargraves (2007), who advocated for professional learning communities as one way in which to move teachers and the school community to greater levels support for student learning.

Darling-Hammond and Bransford (2005) considered similar ideas, writing of the importance of collaboration among teachers to promote expertise of practice. Darling-Hammond and Bransford wrote that, "Teachers must be able to function as members of a community of practitioners who share knowledge and commitments, who work together to create coherent curriculum and systems that support students, and collaborate in ways that advance their combined understanding and skill" (p. 13). Darling-Hammond and Bransford further explained that more recent research on teacher learning suggests, similar to Berliner's stages of development, that, "there is evidence that teachers' learning may … follow a developmental trajectory" (2005, p. 29). Berliner (1988, 2004) outlined the continuum teachers follow as they progress through their careers.

Others have found that giving teachers opportunities to reflect on their learning helps teachers to understand at deeper levels and transfer their learning. Bransford, Derry, Berliner, and Hammerness with Beckett (2005) furthered Berliner's (1988) earlier work by analyzing the ways in which expert teachers organize knowledge. Bransford et al. wrote that, unlike novice teachers, who have lists of disorganized facts about their disciplines, expert teachers connect and organize knowledge around important ideas of their discipline (p. 45). Bransford et al. also expanded that some expert teachers seem to have adaptive expertise; they, “change their core competencies and continually expand the breadth and depth of their expertise’ (p. 49) making their teaching practices more flexible in the long run. Finally, Bransford et al. theorized that this idea of constantly changing core competencies to expand the breadth and depth of expertise point toward the need for life long learning and engaging professional learning communities.

Summary on teacher expertise. Berliner (1988, 2004) identified a series of five development stages of teacher behavior to attain career expertise. Berliner argued that all personnel should be able to reach the middle stage he called the competent level. Berliner noted that all teachers have the capabilities to reach this level with professional development opportunities provided by schools, thus providing a qualified teacher in every classroom.

Darling-Hammond (2000; Darling-Hammond, Sato, & Wei, 2008), Darling-Hammond and Bransford (2005), and Marzano et al. (2001) corroborated Berliner’s (1988, 2004) findings by advocating that it is the teacher who makes the difference in how students learn. Hargreaves (2003, 2007) offered an argument that professional learning communities encourage ongoing discussions that further teacher learning within the context of the school community. These theorists offered the first level of analysis of teacher practice.

The research on teacher expertise began to build a foundation for how teachers’ behaviors change in direct relationship to changes in their lives. If it was accepted that teachers are the most important aspect of the classroom, and that the behaviors of the teacher can significantly affect student learning, then it was possible to begin to observe and analyze under what conditions that movement occurred. For the sake of this study, the process teachers went through when there was an increase of technology in their classrooms was the focus of this observation and analysis. In the next section, the focus built to examine analysis of teacher practice by teachers themselves in an arena called teacher perception.

Teacher Perception

Teachers' practices as observed by researchers addressed only one variable. Other important variables were how teachers perceived themselves, and the experiences teachers gained over the years. Many researchers have considered various aspects of these ideas. Connelly and Clandinin (1988, 1999) along with Lawrence-Lightfoot and Davis (1997) all found that teachers must monitor themselves because their own perceptions of their abilities affect their performance. Clandinin and Connelly (1987) and Richardson (1996) focused their research specifically on teacher perception through the lens of "practical knowledge"; a structure they offer for showing how teacher perceptions and experience contribute to growth. Wei et al. (2008) studied how professional learning and instructional innovation contributes to teachers becoming "progressive-looking" by creating professional knowledge through inquiry. This ultimately leads to teachers who begin to integrate technology. Schön's (1983) early work also contributed to this concept by offering up an explication of an approach called "knowledge-in-action," providing impetus for Wei et al. who wrote about prior knowledge becoming new understandings and new knowledge "through the process of reflection, dialogue, and inquiry" (2008, p. 3328). Adey (2006) described a process he called “cognitive acceleration” (p. 49), which helps students develop thinking skills, or “the acceleration of general intellectual development” (p. 50). Adey found that changes in teacher thinking leads to changes in teaching pedagogy.

With regard to teacher experiences, there are several theories as to how teacher perceptions and teacher experiences interact. Fullan (1985) and Guskey (1986) proposed that teacher perceptions change after there is a change in practice. Richardson, Anders, Tidwell, and Lloyd (1991) disagreed with this proposed order of events, saying that before anyone can make a change, one must first perceive a change must be made. Baird, Fehsham, Gunstone, Penna, and White (1991) suggested that there is no real an order at all, but that teacher experiences, teacher perception, and teacher behavior are intermingled to produce professional growth.

In the third section of this discussion on teacher perception the concept of constructivism was introduced and the work of Liu and Matthews (2005), Bransford, Sherwood, Hasselbring, Kinzer, and Williams (1990), and Delia, O’Keefe, and O’Keefe (1982), explored how constructivist practices were one of the ways teachers’ professional practices evolved towards a more inquiry-based approach. Finally, collaboration through social interactions to construct learning was discussed.

The concept of teacher perception informed this study by providing a basis for analyzing how this perception influenced teacher behaviors. If, in fact, they are linked, then it became important to think about how to change perceptions as well as behaviors. Once a pattern was established and evidence showed one changes before the other, or both are linked in some manner, then it was possible to begin to build a structured guide tool that can be used to assist teachers in their movement through various stages of teaching by providing certain types of professional support.

Perceptions and practical knowledge. Clandinin and Connelly (1987) and Connelly and Clandinin, (1999) presented a perspective on teacher practical knowledge that shows how teacher perceptions and experience contribute to growth. Smith described practical knowledge as having four components in that it (a) refers to the ways in which a teacher knows or understands a classroom situation, (b) is gained through experience, (c) is often tacit, and (d) is contextual (Richardson, 1996; Smith as cited in Rudestam & Schoenholtz -Read, 2002). When teaching experience was assessed against these four components, one can see the actual structure of a teacher's growth.

Greene (1988) a philosopher of education, built on the first component, the idea of teacher perception, when she wrote that one's perceptions are individual and that each teacher will have a particular sense of what that means, given the context of his or her setting, those around them and other variables that can impact the teaching environment. Greene wrote, "A free act, after all, is a particularized one. It is undertaken from the standpoint of a particular…; and the nature of the project cannot but be affected by shared meanings and interpretations of existing social realities" (p. 70). According to Greene, each experience contributed to the teacher's perceptions of their teaching and their own teaching environment. Later, Harwood et al. (2005), Lotter, Harwood, and Bonner (2007), and Arends (2009) supported the notion that teachers' beliefs influence how they teach. Lotter et al. (2007) went on to report that this translates into how they respond to professional development.

Calderhead (1996), whose theories are still widely used to describe teacher perceptions and practical knowledge (Ellis, 2007; Wei et al., 2008), added to the discussion of perception by considering teacher beliefs and knowledge in order to understand teaching and learning in the classroom. In previous work, Calderhead (1988) wrote, “The nature of teachers’ practical knowledge – the knowledge that is directly related to action-is qualitatively different from academic, subject matter or formal theoretical knowledge” (p. 54). Osborne and Gilbert (as cited in Claderhead, 1988) suggested that “all teachers have views of learning, which are implicit in their practices, but are rarely articulated, even to themselves” (p. 194). Johnston (1988) added that when teachers are confronted with implementing new teaching approaches, which may require them to restructure their underlying perceptions about teaching and learning, “such challenges to their beliefs may be quite problematic” (p. 194). Adey (2006) wrote, “there are no short-cuts or quick fixes” (p. 51). Adey found that it takes a substantial amount of time and money to change teaching practices.

Freire (1994) examined this idea of self perception by writing how critical thinking, and the teaching of those skills, can help lead to freedom as groups of people begin to engage in conversations that open doors previously closed to those who are oppressed. While this paper was not considering the aspects of freedom and oppression, his consideration of critical thinking as an opener of doors was important (Gordon, 2009). Through active interaction and dialogue posed as problems, teachers and students cocreate learning. In fact, Greene (1988) hypothesized that obstacles create opportunities to overcome by using problem solving abilities, thus encouraging educators to allow students to learn these skills. Greene wrote, “The very existence of obstacles depends of the desire to reach toward wider spaces for fulfillment, to expand options, to know alternatives” (p. 5). This fed into the idea that teachers’ perceptions and experiences create challenges that could be met and overcome or, contrarily, be ignored and used as a reason to become stagnated in professional practice.

Schön (1983) contributed to this idea of teacher practical knowledge with his concept of knowledge-in-action. He wrote that teacher knowledge is inferred from action that arises in the course of experience as a teacher. Contrary to earlier researchers who felt beliefs drove actions, Schön recognized that thinking and acting are interdependent. Schön suggested that educational systems move from an emphasis on *knowing-in-action* to *reflection-in-action.* Schön wrote, by moving toward *reflection-in-action*, teachers develop an “epistemology of practice which places technical problem solving within a broader context of reflective inquiry” (p. 69). By that Schön meant that reflecting on professional practice allows teachers to move toward depth of thought while maintaining high levels of academic rigor. Additionally, reflection takes place “in the midst of action, without interrupting it” (Schön, p. 26). Ellis (2007) offered a model that takes a situated view of subject knowledge, or “subject knowledge in practice” (p. 447). This supported the work of Schön by placing teacher practical knowledge in the schools.

Richardson (1996) summarized the work of Clandinin and Connelly (1987), Calderhead (1996), and Schön (1983) by writing that although beliefs might initially drive actions, experiences and reflection on actions may lead to changes in beliefs and/or additions to beliefs. More recently (Wei et al., 2008), teacher perceptions, as evidenced by surveys of actual practice, showed that the impediments described by Greene (1988) were, in fact, holding back creative use of technology in a constructivist and freedom-enabling manner. The research has moved teacher practical knowledge into the realm of how student teachers access this knowledge in their host teachers (Meijer, Zanting, & Verloop, 2002) and how teachers used that knowledge to integrate technology (Wei et al., 2008). In a survey of Florida schools (Hihlfeld et al., 2007, p. 16), only 4% of the student use of technology involved collaborating on real-world problems. Fifty-nine percent of the use was testing and practicing for skill mastery and 34% for research (Hihlfeld et al.). Wei et al. wrote that “information technology integration into instruction is still at the beginning for the time being” (2008, p. 3330), supporting that while the promises of technology were quite real, also real was the current minimal use of technology in a manner to develop higher-level thinking skills.

Perceptions and practical knowledge were presented by Clandinin and Connelly (1987; Connelly & Clandinin, 1999) as a basis that, when coupled with experiences, contributed to growth. As explored earlier, Berliner (1988, 2004) advocated that teacher growth is linked to increased levels of pedagogy making it important to ask teachers how their perceptions and practical knowledge help inform their professional practice (Calderhead, 1996). I explored how those perceptions, practical knowledge, and experiences translate into professional behaviors, or growth toward increased levels of expertise (Berliner, 1988, 2004; Darling-Hammond, 2000; Darling-Hammond, Sato, & Wei, 2008; Richardson, 1996; Wei et al., 2008) when innovations were introduced to the classroom by analyzing data collected at a time when computers were hitting critical mass in public schools (Education Week, 2005).

Teacher experience. Just as teacher perceptions are different, teacher experiences are different. Because the number and kinds of experiences are so varied, researchers have primarily focused on the process of how experience informs practice. Fullan (1985) and Guskey (1986) offered the idea that teachers change their perceptions after they see the effect their practices have on student learning. Both contended that changes in practice gives teachers the opportunity to see positive effects on students and learning, thus leading to teachers to modify their perceptions accordingly. However, Richardson, Anders, Tidwell, and Lloyd (1991) argued that teachers change their practice after they change their perceptions.

A third concept is offered by Baird, Fensham, Gunstone, Penna, and White (1991), who wrote that it might not be important to determine the order of change between perception and practices. Instead, Baird et al. contended the important issue is that changes in perceptions, ways of thinking, and classroom action all affect the process of teacher change. As Clandinin and Connelly (1988) wrote, “a person’s personal practical knowledge depends in important measure on the situation” (p. 26). In that way, it depends on the experience and it is specific to that experience. English (2007) embraced the idea of “messy situations” or interruptions that occur in teaching that leads to teacher reflection on teaching and practice. English concluded that teachers, like any professional, “need to recognize themselves as embedded in learning processes, and begin to “listen” to the perplexing and difficult experiences in their practice” (p. 141).

This use of personal experience to construct knowledge from learning and reflection has been defined in large part by research in the last 20 years into constructivist thought.

Teacher experiences seem to be linked to teacher perceptions, or the value added experience to teacher professional practice and student learning (Fullan, 1985; Guskey, 1986). While Baird et al. (1991) did not feel the order of change was important; the ways of thinking about educational practice become more critical, especially as that translates into teaching and student learning. I sought to determine the process teachers experienced when computers were hitting critical mass in public school classrooms by analyzing how teacher experiences using technology lead to changes in teacher perceptions, and possibly translate into changes in teacher practice. Through this analysis, it was possible to glean insights into those strategies that led to success in order to create a structured guide tool for professional development that can assist teachers in adopting innovations successfully in the future.

Constructivist theory. Constructivism and postmodern learning theories have taken a deeper look at how curriculum is being taught. The work derived from constructivist and post-modern learning theories can and are applied to the students in the classroom and the professional growth of the teacher. Constructivism suggests that it is important to have learning take place in the context of meaningful activities that can be transferred back to what is happening in the real world (Liu & Matthews, 2005; Sandholtz & Scribner, 2006), and that the learning task is not isolated, but rather is part of a larger context (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990). Every learner brings into the learning environment his or her own understandings and point of origin. All humans come with prior experiences and learning stems from that perception. According to constructivist theory, it is at that point that educators must provide a frame of reference that will make sense (Loucks-Horsley, Hewson, Love, & Stiles, 1998; Smylie, 1995) and provide students with opportunities to construct meaning from contextual clues and find validity through multiple perspectives (Wilson, 1995). Piaget (as cited in Elkind, 2005) discovered early in his research how “a child progressively constructs the idea of permanent objects that continue to exist outside of his or her experience” (p. 328) by combining the properties of the object with his or her mental activities. Thus, humans must reconstruct knowledge in order to make sense of the object. Humans are, in essence, reconstructing the real world event or object.

Constructivist theorists Delia et al. (1982), described how communication is intentional, goal-driven, and that shared meaning (or interpretation) occurs through negotiation. Delia et al. wrote that the construction of meaning occurs through choices people make as they interact with others and their environment. Inherent in this idea is how people make communication choices, and how that supports or hinders their ability to make meaning, or achieve their interpersonal communication goals.

Bruner (1990) called the process of learning from phenomena in which humans interpret their experiences based on prior knowledge, reason about them, and reflect on the experience and reasoning *meaning making*. When educators engage in constructivist practice they are making meaning of their own experience. In terms of their potential to engage in technology adoption or other new practices, constructivist thought suggests that they must have enough experiences from which to draw to be able to engage in meaning making and invest in change.

Constructivist learning practices suggest that learning takes place in the context of meaningful activities grounded in real life experiences (Liu & Matthews, 2005; Sandholtz & Scribner, 2006). In chapter 1 of this study, it was established that only 4% of students use technology in real-life contexts (Hihlfeld, Barron, & Rizhaupt, 2007) and that many teachers, even when using technology, continue to use teaching practices that are outdated (Halverson & Smith, 2009/2010). If, as suggested, it is important to engage students in meaningful activities, then it becomes important to study data collected when computers hit critical mass in U.S. public schools (Education Week, 2005, p. 8). By studying the process as computers affected teachers' perceptions and behaviors, it offered insights into how to encourage teachers to engage in more inquiry-based behaviors in their classrooms as future innovations are introduced to schools. I sought to determine if teachers begin to change toward more constructivist teaching practices as they begin to adopt innovations.

Collaboration. With the exception of the handful of remaining rural one-room schoolhouses, teaching is not done in isolation from other professionals, so naturally there is the aspect of human interaction to be considered when addressing teacher perception. Zhao and Frank (2003) wrote that teachers depend on social interactions as one way to construct learning. Collaboration among colleagues is one way to provide those opportunities. A substantial body of research exists regarding collaboration among teachers; the most relevant to this study is discussed below (Darling-Hammond &

Bransford, 2005; Fullan, 2001; Katzenmeyer & Moller, 2001; Riel & Becker, 2000, 2008).

Riel and Becker (2000, 2008) observed that teachers who exhibited teaching practices that were considered most successful were also the teachers who work with their peers in a collaborative manner, are committed to the education of themselves and others, and use technology in constructivist ways. Riel and Becker wrote,

> The more extensively involved teachers were in professional activities, the more likely they were to (1) have teaching philosophies compatible with constructivist learning theory, (2) teach in ways consistent with a constructivist philosophy, and (3) use computers more and in exemplary ways. (p. 2)

Riel and Becker's findings substantiated those of Berliner (1988, 2004) who also found that teachers who were in the upper continuum of expertise in pedagogy were those who taught in more inquiry-based manners.

Fullan (2001) discussed the importance of collaboration. Fullan expanded the discussion by asserting that learning in the setting where one works, or, in his words, "learning in context" (p. 126), is the learning that will give the teacher the greatest gains because it can be customized to the context of the situation and because it involves the group. More recently, Fullan (2007) concluded that in order to get 95% or more of students to be proficient in literacy and mathematics, it takes "a mission driven at its core by moral purpose" (p. 36). Fullan went on to write that the means of getting there requires "personalization, precision, and professional learning by teachers" (p. 36). Adey (2006) wrote that if change in the school is the desired outcome, then it is imperative that professional developers “get into schools” (p. 51). Katzenmeyer and Moller (2001) agreed that advocates of learning communities believe that expertise does not come from experts who are external to the school; rather it comes from within those working with the problem.

Riel and Becker (2000, 2008) found that those teachers who exhibited successful teaching practices were also highly collaborative with their colleagues, both within the school setting and outside. Darling-Hammond (2000; Darling-Hammond, Sato, & Wei, 2008) and Marzano et al. (2001) contended that the teacher is the most important element in the classroom. Taking these two aspects into consideration and adding perceptions (Baird et al., 1991) and practical knowledge (Clandinin & Connelly, 1987; Connelly & Clandinin, 1999) coupled with experiences (English, 2007) that influence behaviors and contribute to growth (Berliner, 1988, 2004; Darling-Hammond, 2000; Darling-Hammond, Sato, & Wei, 2008; Richardson, 1996; Wei et al., 2008), it became important for this study to explore the process teachers use (Fullan, 2001; Katzenmeyer & Moller, 2001) as they begin to adopt innovations in their classrooms as a way to support student learning. One way to do that is by reexamining historical data collected during an historical period when computers were hitting critical mass in public school classrooms.

Summary of research on teacher perception. Connelly and Claninin (1988, 1999) along with Lawrence-Lightfoot and Davis (1977) all found that teachers own perceptions of their abilities impact their performance. Clandinin and Connelly (1987) and Richardson (1996) further described this as “practical knowledge” which offers structure to teacher perceptions and growth. Several conflicting theories exist as to whether teacher perceptions change before, after or are intertwined with changes in practice. The common thread set forth in the research is that thinking and acting are interdependent and interactive.

This investigation was based on the assumption that not only changes in perceptions influence the use of technology, but also the act of integrating technology in the classroom might in turn influence perceptions. In a manner similar to the theory set forth by Baird et al. (1991) that there may not be a set order for how this occurs, this study sought to explore how teacher perceptions and teacher behaviors as innovations were being introduced created an environment for changes in teacher pedagogy. The review of literature answered the question that teacher perceptions and experiences lead to teacher growth and changes in pedagogy. What was not answered was how technology fits into this picture.

Teacher Professional Development and Leadership

Throughout the research, references to teacher professional development often get made, whether these are driven by external forces in a school district or by the desire for learning communities within groups of teachers. In the following section, several models of teacher development were discussed and offered information on the differences in how teachers view and interpret the usefulness of technology as a learning and teaching tool in the classroom. In addition, these models examined teacher behavior, and how changes occurred in the presence of certain factors.

Professional development. Historically, the professional development of teachers has taken on many forms. One form is one-time group seminars to professional learning communities that are similar to college lectures and mentoring style development, most commonly called "inservice" training (Murphy, 2002, p. 16). This most common form of professional development is one of the least effective (Sandholtz & Scribner, 2006). Another form is ongoing supportive professional development such as localized coaching, one-to-one mentoring, or learning in self-directed or small group led teacher communities. More recently, educators are recognizing that this second method is more successful than the first (Adey, 2006; Desimone, Porter, Garet, Yoon, & Birman, 2002; Van Driel, Bulte, & Verloop, 2008).

Professional development by teachers can have an impact on student achievement (Adey, 2006). Hargreaves (2003, 2007) provided an argument that teachers need to continue to learn and grow within the teaching profession. Darling-Hammond (1999; Darling-Hammond & Bransford, 2005) reported that there is evidence that teachers, who take advantage of sustained and curriculum-based professional development opportunities, can influence student performance. Cohen and Hill wrote that these opportunities create, "changes in practice, that in turn, were associated with significantly higher student achievement scores on state assessments" (as cited in Darling-Hammond & Bransford, 2005, p. 1). Specifically, the type of professional development reported by these researchers involved teachers working with each other and experts in the academic area "over a sustained period of time" (Darling-Hammond & Bransford, p. 1). According to Darling-Hammond, "Key features of this successful professional development appear elsewhere in the literature on effective approaches: ongoing work with colleagues, and a focus on curriculum and teaching issues teachers encounter in their classrooms" (p. 1).

Sandholtz and Scribner (2006) concurred in their synthesis of the literature over the past 15 years. Sandholtz and Scribner found an "almost unprecedented consensus" (p. 1105) had been reached on the vision of professional development. It included teachers reach consensus through school-based professional development that is driven to decrease the gap between student learning and performance by identifying learning needs. These opportunities are ongoing and organized around collaborative problem solving with the intent of being part of a "comprehensive change process" (Sandholz & Scribner, p. 1105). Van Driel et al. (2008) concluded that the consensus in the literature reported that reform of actual practices should be in the hands of the professionals, thus giving teachers and schools ownership over educational change, which in turn, will increase the likelihood of "successful and enduring innovation" (p. 108). Penuel, Riel, Krause, and Frank (2009) expanded this thinking by concluding that professional interactions that can lead to school change occur not only in formal ways but, whenever teachers meet in what they called "a network perspective" (p. 126). In this way, the social structure of the school provides a framework for ongoing professional development when there are shared goals.

Other research supports the concept that ongoing professional development includes shared goals. The Report on Monitoring School Quality 2000 (U.S. Department of Education, 2000) advocated that professional development include opportunities "to learn about new theories of teaching and learning, changes in student population, and how to use new technologies (such as computer and the Internet) in their classrooms" (p. 15). Fullan (2006) supported learning within the context of the school environment from those who work in that environment. Mouza (2002/03) concurred and stated that ongoing, curricular-based, hands-on professional development that has follow-up support in the classroom is needed in order for there to be change in student achievement and teaching practices.

Fullan (2001) and Katzenmeyer and Moller (2001) argued that collaboration leads to increased levels of expertise in pedagogy. Berliner (2004) and Darling-Hamond (1999, 2008; Darling-Hammond & Bransford, 2005) agreed that collaboration among educators causes teachers to perform at higher levels. Professional development has taken many forms, but researchers have found the most successful experiences contain certain elements (Adey, 2006; Desimone et al., 2002; Van Driel et al., 2008), including but not limited to, localized coaching, one-to-one mentoring, or learning in self-directed or small group led teacher communities. I sought to determine how professional development was used during the time period when computers were hitting critical mass in public education. By studying the process of professional development opportunities of the teachers involved in individual grants to determine how that contributed to teacher growth, it was possible to create a structured guide tool for improving teacher adoption of innovations in the future.

Collaboration. As noted earlier, collaboration is a part of modern-day teaching, but how it is conducted can have a noteworthy effect upon teacher professional development. Related to this, it is also important to the advancement of the teacher leadership. In recent years, educational researchers have examined these factors' influence upon teacher professional development.

Finger et al. (2006) found through collaboration individual learning increased through personal coconstruction and reflection. The process of design and development required that collaborators build and retain knowledge through discussions, sharing artifacts, and creating documents making the learning cocreated in a participatory environment. Teacher leaders provided an important structure for collaboration within the educational setting.

One of the most common definitions for teacher leaders comes from Katzenmeyer and Moller. Katzenmeyer and Moller (2001) defined teacher leaders as, “Teachers who are leaders lead within and beyond the classroom, identify with and contribute to a community of teacher learners and leaders, and influence others toward improved educational practice” (p. 5). While working alone should not be construed as an unhealthy way of working (Hargreaves as cited in Katzenmeyer & Moller, 2001), Bedone and Addie (1999) wrote that teachers working in collegial work environments are more effective.

Online learning communities. While the use of technology will be discussed later, it is important here to note the use by teachers of technology for their own professional development. Innovations included unprecedented immediate access to information, and innovative tools that can improve instruction. One other added benefit for teachers, especially those who are isolated by a variety of factors was the development of online learning communities. Researchers are seeing some parallels between online learning communities and more traditional face-based learning communities.

Charalambos, Michalinos, and Chamberlain (2004) defined “online learning communities” as those that made connections between the learning and the creation of relationships among the participants. Rudestam and Schoenholtz-Read (2002) reported the impact of learning communities when they wrote that participants in online learning communities have the ability to contribute to ongoing discussions in more thoughtful ways (p. 167). Adults learn not only as individuals but also through conversations (discussions) with others (Dobrovolny, 2006; Revill, Terrell, Powell, & Tindal, 2005). Dobrovolny (2006) stated they “construct knowledge by conversing with others, analyzing problems together, identifying solutions together, and meeting goals together” (p. 156). It is through this shared experience that teachers can grow in the area of pedagogy expertise (Berliner, 2004; Darling-Hammond, 2001, 2008).

Finger et al. (2006) added support to this concept when they found that collaborative learning increases individual learning through personal coconstruction and reflection. Finger et al. explained that the process of design and development required that collaborators build and retain knowledge through discussions, sharing artifacts, and creating documents. Kang, Lee, Lee, and Choi (2007) explored the voluntary behaviors of an online learning community. Kang et al. wrote that the causal effects that were identified support the member during communication, perceived value, recognition for contributions, freedom of expression, and interactive communication, which led to commitment to the community by the member, loyalty, and social participation. Kang et al. added that interest promotes a stronger desire to interact with others leading to a sense of belonging, and commitment to the community. In many ways, this fits with the thinking of Fullan (as cited in Adey, 2006), Guskey (1986), Richardson et al. (1991), and Baird, Gunstone, Penna, and White (1991), who wrote about teacher change as it has to do with teacher perceptions, ways of thinking, and professional practice in the classroom. Thus, online learning environments become an important aspect of collaboration, teacher perception through co-creation of content, and teacher change.

Summary on professional development and leadership. Darling-Hammond (1999, 2008) and Bransford (2005) showed there is support in the literature for sustained and curriculum-based professional development as a way to influence student performance. Darling-Hammond (2000) explained, "teacher quality variables appear to be more strongly related to student achievement than class size, (and) overall spending levels" (p. 37). This has been supported by others (Leithwood et al., 2004; Louis, Anderson, & Wahlstrom, 2004; Marzano et al., 2001). Additionally, collaboration with teachers and other experts in the field in specific academic areas contribute to teachers taking on leadership roles in their schools, which ultimately affect student performance (Finger et al., 2006; Katzenmeyer & Moller, 2001). Online learning communities, which give participants the opportunity to cocreate content and reflect asynchronously with others with similar interests, are explored as a way for teachers to collaborate. Fullan (2001) and Zhoa and Frank (2003) suggested that in order for teachers to adopt innovations, they must clearly understand the nature and goals, and the value for student learning.

Collaboration and online learning communities create opportunities for educators to have access to a wide-range of others who wish to share similar experiences.

Engagement becomes more thoughtful as reported by Rudestam and Schoenholtz-Read (2002) and increases individual learning (Finger et al., 2006). By exploring ways in which teachers engage in professional learning experiences and how that may influence their perceptions and professional practice, it was possible to suggest creating online learning communities giving educators greater access to those with shared experiences leading to greater growth in perceptions and professional practices.

Teacher Adoption of Educational Innovations

In the 35 years since the personal computer was introduced as a way to bring computing to the public, all professions, teaching included, have been challenged to routinely incorporate new options and opportunities with regard to information acquisition and transmission. Like other areas of the teaching profession, researchers have tried to understand and identify best practices regarding how teachers adopt and adapt it to their teaching practice. This section includes the examined of teacher adoption of educational and technological innovations.

In spite of the increase in technology availability in classrooms over the past 20 years (National Center for Educational Statistics, 2005, 2007; Woessmann & Fuchs, 2004), only, "20% of teachers report feeling well prepared to integrate technology into their teaching" (Sandholtz & Reilly, 2004, p. 487). Poftak, Smith, and Jones (2005) showed that while 67% of teachers "believe computers are essential teaching tools" (p. 5), only 54% integrate them into their daily curriculum. Eighty six percent of respondents felt they were well trained for using computers for administrative purposes, however, "27% have little or no training on integrating computers into instruction"

(Poftak et al., p. 5). *Teachers and Technology: Making the Connection* (1995), described the opportunities and obstacles of using technology in schools in the United States. While technology offers "richer, more varied, and more engaging learning opportunities for students, simply increasing the number of computers available for instructional use is not likely to lead to significant changes in instructional methods" (Sandholtz & Reilly, p. 487). However, Cuban, Kilpatrick, and Peck (2001) found that most teachers who do use technology in their instruction tend to use it mainly to support existing instructional practices. This becomes of concern when confronted with the recent study by Darling-Hammond (2007) that reported students are dropping out of school at alarming rates while at the same time the United State's ability to prepare students for future global jobs is falling further and further behind international education (p. 318-319).

Reviewing the literature on the stages of adopting technology and research on teacher leadership illuminated how teachers show improvement in their pedagogy through the use of technology. This was the basis for the conceptual framework for this study.

Technology and value. Zhao and Frank (2003) researched technology and its perceived value to teachers. Zhao and Frank found that if teachers perceive the value of technology, they will use it in ways that add value to student learning, writing that, "teachers' attitudes toward, and expertise with, technology are often key factors associated with their use of technology" (Becker, 2003; Hadley & Sheingold, 1993; Sandholtz et al., 1997; Smerdon et al., 2000; Zhao & Conway as cited in Zhao & Frank, p. 809). ChanLin (2007) found that teachers felt perceptions about the use and manageability of technology were significant. ChanLin explained that there were many areas in which teachers felt they had control and could manage the technology, but that they also wanted to have a sense of community, control over curricular decisions, and support for its use by someone who would maintain working order of the technology. ChanLin further concluded in her research that in order to have teachers who use and advance the use of technology in the classroom, there needs to be long-term professional development and nurturing of technology literacy in addition to keeping hardware and software current. Taking into consideration the above-mentioned study by Hihlfeld et al. (2007), ChanLin has grounds to assert that long-term professional development on how to integrate technology into curriculum is a valid concern.

Teacher behaviors. While many of the concepts outlined so far related to external influences on the teacher, there was also the question of how the teacher's own behavior, on its own, can influence teacher professional development.

Cuban (1988) identified certain patterns that occur as teachers begin to change behaviors. Cuban made a distinction between what he called first-order changes and second-order changes. Cuban wrote that first-order changes are those that improve the efficiency of what is currently done without fundamentally changing school organizational features or the roles of teachers and students. Second-order changes, however, seek to alter the fundamental ways in which organizations operate, including new goals, structures, and roles. Most changes in education since the start of the 20th century have been first-order changes.

Cuban (2001) conducted a study to look at teachers' use of technology. From that work, Cuban provided findings that he described as unexpected. Contrary to previous explanations, Cuban found teachers and students were not fearful of technology or resistant to using informational technology. Cuban also found that although teachers used technology for preparation and communication purposes, less than 10% weekly used technology for instructional purposes. In fact, Cuban concluded that less than 5% of teachers integrated computer technology into curriculum and instruction.

In addition, Cuban found no clear evidence that technology supported an increase in student achievement. Cuban further reported that, for most teachers, despite the access to technology, it was business as usual because they "employed the technology to sustain existing patterns of teaching, rather than to innovate" (Cuban, 2001, p. 134). Cuban's finding added to the research that showed teachers were not making significant changes in their teaching practices to support student learning using technology.

Becker (2001) established that technology integration follows the same patterns as those identified by Cuban (1988). Becker's work established the primary applications of computers employed in secondary schools are word processing followed by drill and practice software. This has since been reaffirmed by studies by Bebell, Russell, and O'Dwyer (2004) and Poftak, Smith, and Jones (2005), with the change from Becker and Cuban that teachers are using technology more as an administrative tool. This is in line with the first-order changes identified by Cuban. Becker went on to write that in spite of changing the manner in which a task is accomplished, these applications do not have a significant impact on the way teaching and learning is conducted.

However, it was business as usual for the teachers, recent studies of students show that they were the ones who were using technology to assist in learning. Hinson (2005) concluded in a focused study that when all students have access to the same technology and the Internet both at school and at home, 73% of students felt the combination was helping them become better students. At the same time, two-thirds of the teachers reported that students were "becoming more independent and detail-oriented learners" (Hinson, p. 25). An interesting result was that for those students who already had access to technology and the Internet, most lost interest in the school provided materials "because they had little reason to use it" (Hinson, p. 26). The real significance was in the changes in teacher behaviors. Almost half of the teachers reported incorporating Web-based resources into lessons. These teachers were assigned to schools that drew their population from lower income homes. The author reported that "those who were more interested and supported were more willing to integrate Web resources than those who were not as comfortable or interested" (Hinson, p. 26). Once the teachers found that the Web resources added value to student learning, they were more willing to incorporate it into their teaching. Additionally, support for the use of Web resources allowed teachers to feel more comfortable using it.

Penuel (2006) examined 30 articles that focused on one-to-one laptop computer initiatives and wireless Internet access. Penuel reported that these initiatives in the United States and abroad have cited successful progress toward meeting the goal for preparing students for the 21st –century by focusing on computer literacy, and showing positive effects on student writing. Apple (2005) reported similar findings across many studies.

Significant in these studies was the discovery of a problem with the acquisition and implementation of new technology. Donovan, Hartley and Strudler (2007) found that unfortunately, “teachers who are going through the change process are rarely consulted on the usefulness of the innovation, yet they are expected to adopt it with open arms” (p. 265). Fullan (2001) argued that teachers must find value for student learning before they will implement innovations or make other changes in their teaching practices.

There are other certain factors that influence teachers’ use of technology (OTA, 1995; Sandholtz & Reilly, 2004). These factors included the availability of resources, time, and the teachers’ perceptions toward change and technology. Teachers need access to technology into order to use it and that they also need time to learn how to use technology, and plan for its integration in their curriculum. Sandholtz and Reilly focused on time and the importance of giving teachers common times in which to plan and learn together. Sandholtz and Reilly also argued that teachers vary in their level of eagerness and energy to experiment with new ideas. Their arguments were consistent with the findings from Hindson (2005).

Those teachers who are highly motivated seem to have many of those factors presented by OTA (1995) in their professional lives (Becker & Ravitz, 2001). Specifically, when teachers have adequate technical expertise, sufficient access to technology in their classrooms, and an environment that supports meaningful learning around group work, they are more likely to adopt and integrate technology into their curriculum (Becker & Ravitz). In addition, those teachers who undertake leadership roles among their colleagues and are professionally active are the most active computer users (Riel & Becker, 2008).

Fullan (2001) hypothesized that change is multidimensional and it can vary within the same person as well as within groups. Fullan outlined three critical dimensions of implementing any teaching innovations: (a) the possible use of new or revised materials (e.g. new technologies or a new curriculum), (b) the possible use of new instructional approaches (e.g. new teaching strategies), and (c) the possible alteration of perceptions (e.g. pedagogical assumptions underlying the innovation). Fullan argued that as all three aspects of change are deemed necessary, difficulties could arise.

Fullan (2001) suggested that teachers might only superficially adopt innovations if they do not clearly understand the nature and goals, and if teachers do not see the value for student learning, they will not adopt the innovation. For example, a teacher might use the technology without changing his classroom practices. Or, a teacher could use the technology and alter some of his classroom practices without subscribing to the beliefs underlying the effective introduction of technology in schools. Fullan wrote that in order for real change to occur, new practices must involve changes in perceptions and classroom behaviors. Donovan et al. (2007) found similar findings when the teachers in their study reported they "were uncomfortable as they attempted to blend their traditional pedagogies with the requirements for teaching in the one-to-one environment" (p. 277). Understanding the importance perceptions of teachers play in changing their behaviors as innovations are introduced to their classrooms can shed light on what supports are needed in the future.

The late 1990s and early 2000s was a time of great influx of technology into schools in the United States, and a time when computer technology hit critical mass in U.S. schools. I analyzed data that were collected during this time period. Taking data gathered during the 2001-2002 school year, when technology hit critical mass, offers a unique slice of history that is not possible to replicate today. By analyzing data collected in this time, one can examine a clear process of technology adoption. I examined the process in which teacher perceptions, experiences, and professional practice interacted together as teachers struggled to integrate radically new technology into their classrooms in a manner that encouraged student learning. By evaluating teachers' own perceptions of their classroom practices during this period of intense change, it was possible to gain insight into how their use of technology was indicative of a particular stage change. I sought to understand those common experiences from the early period of school technology adoption and apply them more broadly to emerging technology integration as it is influenced by ongoing professional development opportunities to better discern why there has been no consistent "impact (of technology) on teaching and learning in most classrooms" (Sandholtz & Reilly, 2004, p. 487). Understanding the experiences of teachers as they are first introduced to innovations and how professional development supports their successes can provide insights into how teachers interact with those innovations.

Technology and constructivism. According to Jonassen, Peck, and Wilson (1999), the concept of constructivism was relatively new to the field of educational technology in the 1990s. Jonassen et al. wrote that educational technology follows the lines of traditional teaching: That originally the students' role was to learn the knowledge as it was presented by the technology, but gradually technology has moved from sources of knowledge to tools for learning. Karagiorgi and Symeou's (2005) more recent study agreed, suggesting that rather than analyzing the conditions such as content, the learner, and the setting, as was the practice for more behaviorist learning environments, instructional designers developed procedures for situations in which the instructional context plays a dominant part. In that way, students are empowered to make choices from the context of authentic tasks. Jonassen et al. suggested that technology can be used for more than extending "the capabilities of humans; they can amplify them" (p. 14). Technology can be used as cognitive tools that "engage learners in thinking while constructing knowledge of which they would otherwise not have been capable" (Jonassen et al., p. 14). Jonassen et al. argued that technologies can support meaning making for students, and, in fact, students can learn with technology.

The implication of using educational technology in constructivist ways assumes that the educational process is one of constant change (Jonassen et al., 1999). According to Jonassen et al., "Technologies will not cause the social change that is required for a renaissance in learning, but they can catalyze that change and support it if it comes" (p. 219). Jonassen et al. suggested that if teachers were using technology in ways that are more inquiry- based and allow the students to make meaning of the learning, the educational process would be reformed.

The creative tension of education, one that is always present and impacts the students and their relationship with the teacher has been augmented by a new creative tension, where the teacher is both learning the technology and adapting prior teaching practices to the new opportunities she discovers through this learning process. This additional creative tension continues to exist until the technology is assimilated. How that assimilation occurs is a key factor into how completely the teacher acquires an understanding of the technology, and ultimately how creative the teacher is in using this new technology to its fullest advantage (Zhao, Pugh, Sheldon, & Byers, 2002). By examining historical data collected while teachers were experiencing the process of learning the technology and adapting prior teaching practices to the new opportunities, it was possible to give researchers and policy makers insights into how best to work with teachers when future innovations occur.

Jonassen et al. (1999) stated that for this change to occur, teachers must give up the traditional model of teaching, including acting as content experts, disseminating knowledge that was taken in by the students, and the students in turn interpreting the world through the eyes of the teacher. Teachers should not act as experts; they should help students learn with technology. Tapscott (2008) stated that students must assume both management and intellectual authority and go from comprehending the world through the eyes of the teacher, to making meaning for him or herself about the world. The role of the teacher shifts to helping students “construct more viable conceptions of the world" (Tapscott, p. 220). Teachers must also relinquish some control of the learning activities in the classroom in order for students to become self-regulated learners. In keeping with Piaget (1954), Liu and Matthews (2005), and Sandholtz and Scribner (2006) the learning should be authentic and, therefore, complex.

Constructivist practices suggest that learning takes place in the context of meaningful activities grounded in real life experiences (Liu & Matthews, 2005; Sandholtz & Scribner, 2006). Earlier, it was established that only 4% of students use technology in real-life contexts (Hihlfeld et al., 2007) and that many teachers, even when using technology, continue to use teaching practices that are outdated and teacher-centered (Halverson & Smith, 2009/2010; Jonassen et al., 1999). The outcomes of this study sought to determine if as teachers adopted technology into their classroom they began to change their teaching behaviors toward more constructivist, student-centered teaching practices.

Teacher leadership and technology. Reviewing the literature on the stages of adoption of technology while looking at teacher leadership research explains how using technology as a scaffold encourages teachers to achieve higher levels of expertise in pedagogy.

Teacher leadership research was a basis for explaining teacher experiences and perceptions of their career formation. Riel and Becker (2000, 2008) analyzed the responses of 4,000 United States k - 12 teachers. Riel and Becker showed that they could form four groups of teachers based on the reported levels of professional engagement: private practice teachers, interactive teachers, teacher professionals, and teacher leaders.

Private practice teachers had little professional interaction beyond those mandated by the school system and tended to use more traditional teaching methods, such as direct instruction (Riel & Becker). Interactive teachers had some engagement, but significantly less than did either the teacher leaders or the teacher professionals. Teacher professionals engaged beyond the classroom, but reported fewer leadership activities. Teacher leaders, the highest on the spectrum, placed a high value on professional collaboration and sharing knowledge with their colleagues. Riel and Becker (2008) concluded that teacher leaders are "(a) more constructivist than other teachers of the same subject and level, and (b) use computers substantially more than other teachers do" (p. 398) in keeping with their earlier research.

Riel and Becker (2000) found that teacher leaders and teacher professionals were most likely to continue to invest in their own education, engage in constructivist type teaching styles after promoting knowledge construction, use technology for teaching and learning, and integrate technology into their classrooms in a manner that supports constructive problem-based learning. In 2008, Riel and Becker applied their model to teacher technology leaders and found parallels to their previous research. Teacher technology leaders "foster exemplary practice among other teachers" by making their professional practice more public. More recently, Penuel et al. (2009) studied ways that "teachers' interactions help to constitute a form of leadership within a school" (p. 128). This form of leadership includes the interactions among teachers, school leaders, and teachers acting as mentors for their colleagues. In looking at school communities, they studied subgroups, as well as individual leaders. Penual et al. argued that how these subgroups are composed and linked to the community as a whole provides important "sources of influence on teachers' attitudes and behaviors" (p. 130). Analyzing individuals gave important information as to who the people are in the school who "play critical roles in transferring expertise that exists in one subgroup to another" (Penuel et al., p. 131), thus moving change efforts forward.

Leithwood et al. (2004) contended that recent research using professional learning communities has shown powerful associations with teacher practice. The term professional learning community signifies an interest in "establishing a school-wide culture that makes collaboration expected, inclusive, genuine, ongoing, and focused on critically examining practice to improve student outcomes" (Leithwood et al., p. 66). While many variables can be applied to professional learning communities, Kruse, Louis, and Bryk (as cited in Leithwood et al., 2004) designated five interconnected variables: shared norms and values, a focus on student learning, deprivatized practice, reflective dialogue, and collaboration.

Zhao and Frank (2003) discussed the importance of collaboration suggesting that by giving teachers opportunities to help one another, overall technology use at schools could be increased. ChanLin (2007) provided some ideas as to how to encourage teachers to use technology collaboratively as they take control of the learning environment, in addition to personal, social, and curricular decisions in their classrooms. Included are teacher perceptions, the physical properties of technology, the sense of support within the educational community, and having control of the curriculum (ChanLin).

According to Tapscott (2008), those in the age range of 11 to 31 are highly collaborative. As those in this age group begin entering as new teachers, they are already collaborating with others online in order to cocreate content and have been doing so for quite a number of years (Tapscott). It may be an easy step to encourage them to teach in a manner that supports collaboration among students (Tapscott).

Traditionally, professional development opportunities have focused on computer literacy, particularly basic computer operation and application use (Gilmore, as cited in Sandholtz & Reilly, 2004). Sandholtz and Reilly reported,

> Some of the first guidelines for teacher education programs, sponsored by the Association for Computing Machinery in 1983, proposed that all teacher education students should be required to complete an existing course in computer science that included specific topics, such as ‘‘What Computers Are and How They Work’’ and ‘‘An Introduction to Programming’’ (Willis & Mehlinger, 1996). Though more recent standards include more instructional applications of technology, the assumption that teachers need a foundation in computer operations is evident. The International Society for Technology in Education (ISTE) educational technology standards for teachers includes, as its first category of standards, basic computer/technology operations and concepts. (p. 488)

The assumption was that until teachers can use the basic programs, they cannot be expected to use the technology as a teaching tool for student learning. This assumption was supported by the technology standards developed by states and organizations.

Forty-eight states have technology standards (U. S. Department of Education, September, 2004). Many of the technology standards among the states are similar in makeup. The standards from the three states used in this study are briefly discussed.

The Washington Department of Education (2005) used the ISTE standards for both students and teachers, which, as discussed previously, "for teachers includes, as its first category of standards, basic computer/technology operations and concepts" (Sandholtz & Reilly, 2004, p. 488). Washington wanted to ensure that all teachers have some minimal technological competencies.

The Technology Standards issued by the Arizona Department of Education (ADE, 2000) included fundamental operations and concepts along with technology productivity tools as two of the six standards required for all students. The first standard, fundamental operations and concepts, requires basic skills such as turning on and off various technological components, and to demonstrate correct ergonomic use of technology (ADE). It also included some basic trouble shooting strategies in the event the technology is not working properly (ADE). The third standard, Technology Productivity Tools, sought to ensure all students have mastery of several basic application software programs (ADE).

The Rhode Island Department of Education (2000) also used the ISTE standards for teachers and students. In addition, they relied on the Core Technology Skills by the Milken Exchange (1999), which had a heavy basis on mastering the use of the technology and application software. The Rhode Island Foundation, the funding arm of the Rhode Island Department of Education, stated, "placing teachers at the center of school reform activity is crucial to the improvement of education for students nationwide" (p. 4). In spite of this philosophy, emphasis was still placed on learning technical skills and application software.

In their research from the ACOT project, Sandholtz et al. (1997) found that some teachers become stuck in the beginning stages of technology adoption because they remain focused on technical expectations and their lack of technical skills. Sandholtz et al. wrote this causes teachers to go for years using technology only in limited instructional ways as they spend more time addressing hardware, maintenance, and management issues. Teachers remain mired in the perception they must be technical experts keeping them from exploring technology as an educationally innovative tool.

Riel and Becker (2000, 2008) reported four groups of teachers based on levels of professional engagement. Penuel et al. (2009) observed school communities and found that certain teacher interactions lead to teacher leadership as described by Leithwood et al. (2004). Additionally, collaboration was identified as one of the key components (Penuel et al., 2009; Riel & Backer, 2000, 2008) of teacher leadership, and identified as a way for teachers to grow in expertise in pedagogy (Berliner, 1988, 2004; Darling-Hammond, 2000, 2008). Tapscott (2008) explained how students who fall in the age range of 11 to 31 are highly collaborative. I explored teacher levels of collaboration as it translated into teacher leadership, teacher perceptions of using technology, and teacher changes in professional practices to support student learning at a time when computers were hitting critical mass in U.S. public schools. All of these components worked together to help identify the stages under which teachers fall.

Stages of technology adoption. Sandholtz et al. (1997) conducted studies on teacher change with regard to technology. Their ACOT project demonstrated that teachers experienced significant changes in their classroom practices and use of technology in the classroom. However, these changes did not occur until they had confronted deeply held perceptions about instructional practices. As the teachers in this project attempted new methods of teaching, they began to reexamine their perceptions about teaching and learning.

Sandholtz et al. (1997) described five stages of teacher adoption of technology. These stages emphasize the idea that understanding and using technology are intrinsic parts of instruction that take considerable time and effort. These stages provided the conceptual framework for this study. This stage theory was chosen because it is widely used and frequently cited in educational research (Hughes, 2008; Riel & Becker, 2008; Sandholtz & Reilly, 2004; Shuldman, 2004). The five stages (Sandholtz et al., 1997) are described below.

Entry. This is the stage at which teachers are introduced to technology. They are not comfortable with computers and mostly do not use them (Sandholtz et al., 1997). Teachers tend to have more traditional methods of teaching, and when technology is used, teachers face problems that are more closely associated with first-year teachers or, as Berliner (1988) would call them, “Novice level teachers,” such as discipline, resource management, and personal frustration. Technical issues dominate the experience for the teacher. Teachers showed little inclination to change instruction (Sandholtz et al.).

Adoption. Although teachers continue to confront technical issues, this is the stage at which they use technology to enhance self-productivity and to support traditional instruction, often through drill and practice (Sandholtz et al., 1997).

Adaptation. Teachers automate their existing practices and begin to use technology in ways that are connected to the curriculum (Sandholtz et al., 1997). While lecture, recitation, and seatwork continue to dominate instructional tasks, students begin to use basic programs that enhance productivity for approximately 30– to 40% of the day (Sandholtz et al.). Furthermore, teachers begin modifying some instructional methods so they are more responsive to student needs.

Appropriation. At this stage, teachers understand technology well enough to use it as a tool for developing new methods of instruction (Sandholtz et al., 1997). As a result, teachers design learning experiences and environments that take advantage of the capabilities of technology. The use of technology in the classroom is "effortless" as teachers use it as a tool to accomplish instructional and management goals (Sandholtz et al.).

Invention. Sandholtz et al. (1997) described the invention stage as when teachers are ready to implement systemic changes in teaching and learning by designing learning environments that leverage the power of technology. It is important to note that not all teachers will achieve this stage. The five stages of technology adoption described above suggest that teachers need different types of support at different stages. Therefore, it is important to tailor professional development to the distinct needs of the teacher.

An example of one such study was conducted in a school district in southern California. In a follow-up study, Sandholtz and Reilly (2004) studied a school district that had a "technology program involves all full-time teachers, the district began implementing a technology plan before receiving outside funding, and the program design allowed for collection of longitudinal data" (p. 490-491). The district program supported shifting the focus for professional development and ongoing support from technical issues to those areas in which teachers have the greatest expertise and interest: curriculum and instruction.

Requiring teachers to concentrate on instruction rather than "technical" professional development led to four outcomes. First, all teachers used the technology. Because every full-time teacher in the district participated in the program, each one, depending on where he or she fell on the rotation schedule, received classroom equipment. In contrast to the low rates of classroom use in spite of the increased availability that Cuban et al. (2001) found it was not a question of whether teachers used the technology, but how they used it.

Second, teachers integrated the technology more quickly. Sandholtz and Reilly (2004) found the teachers moved through the stages that were identified in the ACOT study (Sandholtz et al., 1997) at a faster pace, getting to those stages where technology is used for integrating teaching and learning more quickly. This was accomplished by using a system where access to the technology was coupled with professional development focusing "on instructional rather than technical issues" (Sandholtz & Reilly, p. 7). Unlike previous studies (Sheingold & Hadley as cited in Byrom, 1998), this faster rate of movement through the stages allowed teachers to use technology in ways that support student learning.

Sheingold and Hadley (as cited in Byrom, 1998) agreed with Sandholtz et al. (1997), and provided support for Sandholtz and Reilly's findings (2004) when they determined that "because it takes an average of 4 or 5 years for teachers to reach the point where they can seamlessly mix technology-based instructional strategies with traditional instruction, teachers require extensive professional development and technical support" (p. 6). Due to the supports in place, the teachers in Sandholtz and Reilly's (2004) study made gains at a quicker rate.

Successful programs share four characteristics (Hughes, 2008; U.S. Department of Education, 2005). First, districts committed 30% of the budget to professional development training in technology (U.S. Department of Education). Second, the technology training and support was continual and tailored to meet the teachers' needs (Hughes). Third, the staff development was held on-site (Hughes; U.S. Department of Education). Finally, the training was just-in-time, and each teacher was given a computer for home use so he or she could experiment with the software and develop lesson plans that incorporated technology (Hughes; U.S. Department of Education). As many of these factors were in place, Sandholtz and Reilly (2004) found that the teachers in their study progressed to these stages in 1 to 3 years, much more quickly than determined by Sheingold and Hadley (as cited in Byrom, 1998).

Sandholtz and Reilly (2004) found the teachers steadily expanded their use of the technology. Teachers went from initially using a variety of relatively simple software for drill and practice. Teachers next expanded their repertoire by developing presentations for the class. Ultimately, they focused on “working with a smaller set of software applications” (Sandholtz & Reilly, p. 8) that specifically met their curricular needs and appeared to impact student learning. Students progressed from initially using software aimed at raising scores on state standardized tests to later creating their own content as well as using source materials from the Internet. According to Sandholtz and Reilly, “Students’ use of technology expanded as teacher launched class Web sites and incorporated Web-based resources into classroom instruction” (p. 8). As teachers focused on content rather than application, they were able to share materials with each other, which increased their progress of technology integration. Rather than mastering applications, they worked in the familiar realm of curriculum and instruction.

Finally, teachers’ main uses of technology were closely related to curriculum. Teachers begun creating content for instruction. By using software applications such as word processors, presentation programs, and Web page editors, teachers were able to more quickly expand the curriculum and share their work with their colleagues. This has been substantiated through the U. S. Department of Education’s (2005) National Education Technology Plan.

Although Sandholtz and Reilly (2004) did not focus on the connections between pedagogical approaches and technology use, the authors confirmed previous research suggesting, “technology is most helpful and powerful in supporting constructivist-oriented teaching” (p. 10). Still unknown is if technology entices those of constructivist nature to engage in the use of technology or if the technology encourages teachers to become more constructivist in nature.

The ACOT project demonstrated that teachers experienced significant changes in their classroom practices and use of technology in the classroom. However, these changes did not occur until they had confronted deeply held perceptions about instructional practices. These stages provided the conceptual framework for this study. By analyzing teacher perceptions on using technology in classrooms to support student learning and professional behaviors, this study filled the gap in the literature and began to show how collaboration and professional development can be used to grow teachers' expertise in pedagogy.

Summary on teacher adoption of educational innovations. Many components contribute to teachers' success when adopting educational innovations. Some of those explored have to do with teacher leadership as described by Riel and Becker (2000). Those teachers who scored at the highest level, teacher leader, were collaborative and taught by integrating technology through inquiry-based pedagogy. Penuel et al. (2009) investigated social networks that exist within schools and found, with a positive learning culture, learning and collaboration can take place in a variety of ways. Leithwood et al. (2004) contended that recent research using professional learning communities has shown powerful associations with teacher practice. In spite of broad access to technology in schools, Cuban et al. (2001) found that most teachers who do use technology in their instruction tend to use it mainly to support existing instructional practices. Poftak et al. (2005) showed that "27% have little or no training on integrating computers into instruction" (p. 5). Without professional development that encourages integration of technology into classroom practices, teachers will not change their teaching practices. Sandholtz and Reilly (2004), in a follow-up study to the ACOT study of 1997 (Sandholtz et al.), explored teachers as curricular experts instead of teachers as technology experts. Sandholtz and Reilly found that teachers who, through collaboration with their colleagues, thought about infusing technology into their curriculum advanced through the stages of teacher adoption of educational innovations as outlined in the ACOT study by Sandholtz et al. Each of these components has as an underlying theme of collaboration. I sought to explore how teacher perceptions and behaviors translated to professional practice when computers were introduced into the classroom at a time when they were reaching critical mass with ongoing collaborative professional development that required integration of the technology. By studying this process, it was possible to determine ways to support teachers through adopting innovations successfully in the future.

Methodology Rationale

Case study research (Merriam, 1998; Yin, 1994, 2008) was selected for this qualitative dissertation project as it followed the professional growth and development of eight classroom teachers following an event in the teachers' career that caused an increase of computers in the classroom to a ratio of one computer to each four students, along with the addition of sustained professional development matched to the use of technology in the classroom instruction. Case study research (Yin, 2008) was the preferred strategy, "when 'how' or 'why' questions were being posed, when the investigator had little control over events, and when the focus was on a contemporary phenomenon within some real-life context" (p. 1). Yin went on to elaborate, "Case study is preferred in examining contemporary events, but when the relevant behaviors cannot be manipulated" (p. 8). In this case study scenario, I had little control over the events as my role was as observer, and the focus was on contemporary phenomenon, the integration of technology into the classroom, and how the perceptions and behaviors of the teachers translated into professional practice when coupled with ongoing professional development. These met the criteria for a case study.

When assessing other research methods, it was determined that ethnography (LeCompte & Preissle, 1993), which requires total immersion in the setting for long periods of time, and phenomenological (Moustakas, 1990, 1994) research, which requires the participants instead of the researcher to make connections and requires researcher participation in the environment, would not be effective for this study. Historical data from 2001-2002 when computers were hitting critical mass in U.S. public schools was used for this study since the teachers were no longer available in the schools, and a historical period of time was being analyzed. I visited each classroom 13 times over a 6-month period for a week at a time, and that would not serve as a form of immersion, as is required by ethnography. I was a visitor and had no control over the curriculum or how the integration of technology occurred as I made observations of the teachers and their students. The value came instead from the connections I made through a series of observations, a review of the interview, and watching a 15-minute video of each class. Thus, neither the conditions for phenomenology nor ethnography were met by this study.

The power of this study came from the rich body of data collected through a series of 13 classroom visits and observations over a 6-month period when computers were hitting critical mass in public schools. While in the classrooms, I could watch entire lessons while taking notes and speak with the teachers when they had breaks. From that data, reoccurring themes were extracted that were common among the teacher participants, thus adding to the literature and providing a beginning view into an area that had been a consistent gap; how teacher perceptions and behaviors translated to professional practice when technology was introduced into the classroom with ongoing professional development that required integration of the technology.

The review of literature described how teacher perception and behaviors might be inextricably linked. I sought to understand the process of how they work together when teachers integrate technology into classroom practices. Additionally, I sought to determine supports needed for teacher professional practice while going through the stages of teacher adoption of innovations that can lead to systemic change that may evolve into global social change. Specifically, it created a structured guide tool for professional development that can be used by policy makers and staff developers to assist teachers through adopting innovations successfully in the future.

Summary

Berliner (1988) proposed a series of stages that teachers move among as they become increasingly more expert in educational pedagogy. Those stages span the careers of teachers from the teacher candidate, who as a novice is still in school, to those who have taught for a number of years and are considered experts. Berliner hypothesized that only a small percentage of teachers will ever reach the level of expert.

Likewise, Sandholtz et al. (1997) introduced their stages of teacher technology adoption. From their findings from the ACOT project, Sandholtx et al. created five stages teachers travel as they adopt technology into their classrooms. Teachers begin at the entry level and move toward the invention level. In a manner similar to that described by Berliner (1988), teachers focus on themselves and their knowledge first, then begin to think about how it can impact student learning when used in the classroom, finally changing their teaching practice as they advance to the highest levels. Furthermore, Sandholtz et al. concluded that understanding and using technology takes considerable time and effort when they become intrinsic parts of instruction.

Riel and Becker's (2000) study outlined how teachers who use technology have other desirable qualities as educators. Riel and Becker focused on three areas of what they called "professional engagement" (p. 79). They measured both the degree of teacher engagement in these three areas and the extent to which these areas entered into the professional lives of the teachers (Riel & Becker, 2008). The authors also showed how, over time, teachers use technology in their classrooms, and how their existing predisposition toward collaboration lends itself to wanting to adopt new inquiry-based teaching methods.

When faced with an increase in levels of technology in a classroom, teachers exhibit certain traits as described by Riel and Becker (2000), and Sandholtz et al. (1997). Both groups of researchers found that behaviors tend to revert to those found in beginning teachers, with an emphasis on behavior management, specifically, but not limited to, the use of technology. In most cases, teachers exhibit decreased levels of freedom for students and for themselves when they are in these initial stages (Riel & Becker). Additionally, Berliner (1988) corroborated that when teachers experience sudden changes in their lives, or professional practice (like the increase in technology through a grant), their behaviors revert in a manner similar to those described by Riel and Becker and Sandholtz et al.

Each of these stage theories have similarities and differences, with one underlying theme: the further a teacher is on the continuum, the more fluid, collaborative, knowledgeable he is in the craft of teaching with a tendency toward using inquiry methodology, and, conversely, the teacher at the beginning stages tend to be rigid, focused on student behavior, and unlikely to use curriculum in ways that are inquiry-based and lead to greater understanding as the knowledge moves from tacit to explicit, as described by Freire (1973), Greene (1988), and Smith (as cited in Rudestam & Schoenholt-Read, 2002) . Additionally, each stage theorist cautioned that teachers move among the stages, especially as their lives are impacted by phenomena outside their realm of influence. It is important to note that the use of technology in the classroom can trigger this type of change.

Teacher perceptions of their practice and beliefs about teaching influenced their professional practice in the classroom (Connelly & Clandinin, 1988, 1999; Fullan, 2001; Lawrence-Lightfoot & Davis, 1997). Certain kinds of professional development can assist teachers in making changes in both perceptions and classroom behaviors (Fullan, 1985; Guskey, 1986; Richardson, 1996; Zhao & Frank, 2003). This review of literature has shown that collaboration was a key to successful professional development with an eye toward changing teacher beliefs and professional practice in the classroom. The results of this study, by using historical data collected during 2001-2002 when technology was relatively new and hitting critical mass in public schools, indicated the process of how teachers integrated technology into classroom practices. I explored the various dimensions of stage changes as teachers used technology in their classrooms, the role of ongoing professional development in technology, the teachers' perceptions of technology in classroom practice, and how they subsequently used technology to create changes in their teaching practice.

Chapter 3: Research Method

The purpose of this investigation was to capture an historical view of technology integration in 2002 in order to explore the process teachers underwent while adopting technological innovations. This was the time period when computers were hitting critical mass in U.S. public schools (Education Week, 2005) making it an ideal moment in time to study the process teachers underwent when a sudden influx of technology was introduced to their classrooms. An understanding of how teachers' perceptions and behaviors change during the increase of computer technology innovations was gleaned allowing a structured guide tool for professional development to be created to assist teachers through adopting innovations successfully in the future. A careful study of this period of time was important especially studying data that was gathered as this unique expansion happened. More specifically, the outcomes of this study allowed for a deeper understanding of key aspects of teachers' perceptions and their instructional technology practices, and the replicability of these practices across classrooms and schools, which are desired outcomes of qualitative studies (Fetterman, 1989; Yin, 1994, 2008).

By obtaining the teachers' own perceptions of their classroom practices during 2000 - 2001 when computer technology hit critical mass in U.S. schools, the teachers provided insight into how their use of technology was indicative of a particular stage of change. To understand those common experiences, and apply them to technology integration as it is influenced by ongoing professional development opportunities, insight into why there has been no consistent "impact (of technology) on teaching and learning in most classrooms" (Sandholtz & Reilly, 2004, p. 487) occurred. Case study research allowed for ongoing analysis into the thoughts and feelings of teachers as they were experiencing changes in their classroom environment as technology was introduced. By extracting these experiences at the time they were occurring, it was possible to document perceived successes and failures as the participants engaged in technology integration. It is possible to assist contemporary policy makers and staff developers to better understand what supports teachers need in order to successfully adopt innovations, and respond to the technological demands society places on schools.

Qualitative Tradition

This study was a series of three case studies in the tradition of qualitative research methods and content analysis (Tesch, 1990; Yin, 2008). Case study research is the preferred strategy "when 'how' or 'why' questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context" (Yin, 2008, p. 1). Yin elaborated, "Case study is preferred in examining contemporary events, but when the relevant behaviors cannot be manipulated" (p. 8). When assessing other research methods, two other qualitative traditions were considered: ethnography and phenomenology. It was determined that ethnography (LeCompte & Preissle, 1993), which requires total immersion in the setting for long periods of time, was not appropriate because this study was only of 6 months duration and for only 1 week per month at each site. I wanted to analyze the phenomenon of computer integration in three different locations. This was done, in part, to determine if the culture of the school made a difference in how teachers integrated technology. I was not immersed in any of the three school systems. Phenomenology

(Moustakas, 1994) requires the "voice of the participants" instead of the researcher to make connections and requires researcher participation in the environment. It was determined that phenomenology would not be effective for this study because I made the connections through analysis of the data and extracted the common themes. Additionally, I was a visitor and had no control over the curriculum or how the integration of technology occurred as I made observations of the teachers and their students in the three settings.

The value came instead from the connections I made through a series of 13 observations, an interview, and analyzing a 15-minute video of each class. Because the study consisted of intermittent observations over a 6-month period of time, this was too short a time for ethnography. Because my observations were the main form of data collection, phenomenology was not appropriate.

In case study research, three common assumptions guide such inquiry. First, the phenomena of interest should be studied in their natural context (Lane, 2000). Then, the object of interest should be examined without preconceived notions or a priori expectations (Lane). Finally, the researcher, while trying to see the situation from the point of view of those who are being studied, cannot escape from providing a personal interpretation of the situation (Lane).

Three research tools were used to collect data in this study. First, teachers were interviewed to understand their thinking about technology use in the classroom. Second, 13 researcher observations were conducted for each teacher over a 6-month period, and diaries were kept by me to determine the application of technology during classroom instruction. Finally, a 15-minute video segment of classroom instruction was recorded toward the end of the study while the students were engaged in some form of technology driven learning experience. The teacher participant determined the date and time for the videotaping.

Case study research demonstrates the importance of looking at influences of teacher disposition and observed classroom performance, which forces educators and policy makers to analyze the nature of the classroom environment to better understand the relationship that exists among teacher disposition, classroom performance, and student outcomes. While this study did not address student outcomes, a better understanding of the relationship between teacher thinking and disposition, and actual classroom performance were pursued. Looking more deeply and intrusively at relationships between what teachers think and what they do created an opportunity to examine student performances. Connelly and Clandinin (1999) explained that

> These matters are connected to the discrepancies each experience between [the teacher's] identity and the formal curricular expectations of her role. (p. 85) …Each person responds in her own way to that institutional setting with dramatically different consequences for the place each occupies on the landscape and for how she views the relationship of the out-of-classroom place to the in-classroom place. (p. 93)

The differences among the cases gave emphasis to how teachers individually responded and related to experiences in their professional practice making teacher perceptions extremely important when looking at how that can affect student learning.

The recursive process of data collection coupled with the flexibility offered through the 6 months collection period gave me opportunities to reconsider my research design. McMillan (2000) described a key characteristic of qualitative research as the "research design evolves and changes as the study takes place" (p. 252). In effect, the process of rediscovering each classroom created a recursive process of refining the questions as the data unfolded. Additionally, the reanalysis of historical data allowed me to reexamine my data through the lens of 2011. Merriam (1998) explained further, "Essentially, the process is one of continual refinement of hypotheses as the researcher finds instances that do not match the original hypothesis. Eventually a hypothesis evolves that explains all known cases of the phenomenon" (p. 160). By analyzing the data in a recursive process, connections between stated dispositions and observed classroom performance emerged.

This research paralleled the process professionals in education go through to establish relationships between thinking and disposition and practice. Research matched the recursive nature of how teachers grow and develop. I was emerged not only in a process of looking at findings that arose from data analysis, but evolved a way of looking at relationships between thinking dispositions and practice as it emerged within context. My case study research focused more directly on the context of learning environments, and teacher thinking and disposition. This collection of three in-depth qualitative studies was in the tradition of case study research (Yin, 1994; 2008) and content analysis (Tesch, 1990).

Taking historical data that were collected during a period of influx of technology into classrooms in 2002, I reanalyzed the data in order to determine their relevance to 2011. They provided additional layers of understanding about the relationship of teachers' thinking and practices to their use of technology in classrooms, and the extent to which teachers' perceptions of their ability to use technology in the classroom is consistent with actual performance or practice. Given the data that support teacher-student interactions in classrooms, researchers should begin to acknowledge the influences among teacher thinking, practices, and their use of technology. The case study was the best methodology to achieve these goals.

The Role of the Researcher

I engaged as a participant-as-observer (LeCompte & Preissle, 1993) who was the primary instrument for data collection and analysis (Merriam, 1998). I had an undeterminable effect on the teachers and students being observed. Barab and Kirshner (2001) discussed an "agent-in-setting as a unit of analysis, and ... that cognition occurs and is given meaning through the dynamic relations among the knower, the known, and the evolving context through which knowing occurs" (p. 9). More specifically, as I became a familiar presence in the classroom, it was increasingly difficult for me to stay uninvolved, especially when either the teacher or the students requested my assistance.

For this research study, I contacted three school districts. Using purposive sampling (Creswell, 1998), I selected three school systems where I had a contact. Initially, I used a combination of phone calls and email for this contact, followed by a more formal letter sent by U. S. Postal Service. Once I obtained permission to conduct my study through Teachers College's IRB and the school district, I scheduled a visit to each site and met with the administrators. I asked each principal to identify three teachers who they felt were "competent" teachers. I left that definition up to them, but they each understood I was looking for teachers who were using technology in their classrooms. Entirely by accident, principals selected teachers who were participating in some kind of grant that gave them one computer for every four students and Internet connectivity into the classroom.

Once teachers were identified, I scheduled a meeting with each so I could explain my study and enlist individual agreement to participate. Only one teacher declined and I went to the next teacher on the list provided by the administrator. Three teachers in each site were invited to participate in the study. After the teachers agreed to participate in the study and signed the consent forms, I began to schedule future visits and asked for a time to conduct the interview and a separate first observation later in the week. I transcribed those interviews and, over the 6-month period, visited all nine classrooms for a total of 13 1-hour visits. Toward the end of the data collection, it was determined that one of the teachers was not participating in any professional development, so that person was eliminated as a participant as she was not required to integrate technology into her classroom. Every month I spent approximately 1 week at each site. Due to scheduling conflicts that occurred throughout the 6-month period, both at the classroom level and at the school level, typically I was able to observe each class approximately three to four times per week long visit. I had an established location in each classroom so when I went in for the observation I was not disrupting the class. For the video-tape at the end of the study, I used a tripod and situated that video camera at a distance that would not disturb the learning in the classroom, but would allow the camera to film both teacher instruction and comments made by the students as they engaged in learning through the use of technology.

Research Questions

The lens for the reanalysis of the data was focused by the following research questions:

Research Question 1

1. How do data from a study of teachers' use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice?

Research Question 2

2. How does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation?

Research Question 3

3. How can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced?

Contextual Background of Design

This study was based on historical data collected in 2001-2002 as part of doctoral graduate research at Teachers College, Columbia University. The original study was conducted after the researcher received IRB approval from Teachers College.

The study included the professional growth and development of eight classroom teachers following an event in the teachers' career that caused an increase of computers in the classroom to a ratio of one computer to each four students, and the addition of sustained professional development matched to the use of technology in the classroom instruction. Taking data gathered from 2001-2002 when computer technology was hitting critical mass in U.S. schools and analyzing it from the perspective of teacher perceptions and classroom behaviors shed light on how these processes take place.

I used purposive sampling (Creswell, 1998), and sought three schools from around the United States on the basis of schools with inclusive practices and where I was familiar with the actual school, school district, or an administrator within the district. I explained to my administrative contact I wanted to observe several teachers at each school for the purpose of examining teacher integration of technology. Two districts delayed approval until they were satisfied with Teachers College IRB information. One of these two districts required a separate district level IRB prior to beginning the study. The third district gave permission for me to conduct my research without going through a mandated review process. Data collection began when I was informed that my IRB through Teachers College was approved.

Once I had received a commitment on the part of the three school systems, I contacted the administrator for each school by both phone and letter and outlined my research and the requirements for conducting it at that school. To identify candidates in the schools who were considered “competent” teachers, I asked the principal at each location to nominate several teachers whom he considered to be highly competent, were using technology in their classrooms, and likely to volunteer for this study. In this manner, I was able to increase quality assurance by using criterion sampling (Miles & Huberman, 1994). Two of the administrators recruited the teacher participants, but one provided me with a list of what were described to me as "good" teachers and requested that I contact them directly. Each principal selected teachers who were participating in some kind of grant that awarded one computer to every four students and allowed for Internet connectivity within the classroom for each computer.

After receiving IRB approval, I contacted by mail the teachers who had been recruited for me and introduced myself. I explained the purpose of the investigation, and set up an initial meeting. For the school with the sample of names, I personally contacted the teachers during my first visit to the school in the order provided by the school principal. I accepted for the study the first three teachers from that school who agreed to participate, resulting in a variety of content area teachers and comfort levels using technology in the classroom. The school administrators selected three teachers at the remaining two schools. Of the nine teachers who volunteered, eight participated in some kind of technology grant, on a continuum of anywhere from just beginning to a fourth year participant. Due to the lack of participation in a grant that required professional development, the ninth teacher was dropped from the study. Each teacher had a ratio of at least one computer to four students in the classrooms as provided by a recent grant from either the state or a private organization to the school or district.

The following table shows the number of years each participant had been teaching at the time of data collection and how long they had been involved in their particular grant. This served as evidence that the administrators from each school had named teachers that could be at higher levels of expertise as described by Berliner (1988, 2004). Additionally, it shows how the distribution of time in the grant was fairly evenly distributed across the 4-year period.

Table 1

Teacher Number of Years Teaching and Years in the Grant by School

School	Years Teaching/ Years in Grant	Years Teaching/ Years in Grant	Years Teaching/ Years in Grant
Acorn	Anne = 22/4	Amy = 14/2	Andy = 17/1
Bright	Betty = 9/1	Brenda = 8/3	Bianca = 3/0 (discrepant case)
Crossroads	Cindy = 23/2+2	Carol = 21/2	Cassie = 19/2

Ethical Protection

Maintaining confidentiality was an important consideration. To maintain the confidentiality of the teachers, students, and schools in which I worked, I used pseudonyms throughout the documents and collected data. No one viewed the videotapes of students with written permission granted to me by the parents other than the participants and me. Furthermore, no specific descriptors that would lead readers to identify the particular school being studied were included. Finally, all documentation has been secured in a locked location for the past 9 years. I will continue this practice for securing my data for a minimum of 5 years following completion of this dissertation study. Due to the interactive nature of classrooms, I informed all of the parents and students within the classes selected for the study about the project and asked them to contact me with any questions.

These materials were collected with the written understanding that I would not disclose their contents nor disclose the names of the participants. Specifically, I followed the procedures as set forth by Teachers College, Columbia University's IRB, as specified in the approval for this collected historical data. Upon receiving approval to conduct the research, I contacted the school systems. One of the school districts required a separate IRB process, which was adhered to and permission was granted. The other two districts granted permission to conduct the study based on Teacher College IRB approval. As I conducted secondary analysis of this historical data, I followed the IRB (approval number 06-16-10-0293045) procedures required through Walden University.

Participants and Sampling

The schools involved in this study represented diverse locations, communities, and economic statuses. The following is a description of (a) the school, its mission, demographics and socioeconomic information related to the student population, and (b) the characteristics of the eight teachers who participated in the study. The eight teachers who participated in the 6-month study all were awarded technology grants from outside sources. The grants were awarded to assist interested teachers in integrating technology into their individual classrooms. The technology grants provided computers at a ratio of one computer to four students, Internet access, and required ongoing professional development for integrating technology into the classroom for each teacher who participated in this study. Each teacher was actively involved in the grant at the time of the study. The grants lasted up to 4 years with some of 3 year duration with an option to continue voluntarily into a fourth year. Participants were sampled along a continuum of where they fell within the 4-years of the grants. Nine teachers were chosen because Morse (1994) suggested studying at least six participants "where one is trying to understand the essence of experience" (Ryan & Bernard as cited in Denzin & Lincoln, 2000, p. 780). Even with the loss of one participant, this study was still within the suggested guidelines as described by Morse.

Data related to the characteristics of the schools were obtained from the 2001-2002 Annual School Report Card, prepared by the Office of the Superintendent of Public Instruction's Elementary and Secondary Education Act (ESEA) Department of a state located in the Pacific Northwest; by the Department of Education Information Works! in a state located in the northeastern Atlantic; and by the Department of Education of a southwestern state. Specifically, the report card provided information relating to ethnographic and gender diversity among the student population, number of students eligible for free or reduced lunch, number of teachers, teacher experience, and special programs available during or after school. Additional information relating to the context of the schools was obtained through informal conversations with school administrators. Data relating to the individual teachers were obtained through in-depth interviews and field observations, and by collecting documents and artifacts.

The Schools

The three schools were chosen using purposive sampling (Creswell, 1998). One school was located in a rural bedroom community outside a major urban population center. The other two schools were suburban. The schools were located in the Pacific Northwest, the Southwest, and in the northeastern Atlantic states. Two of the school districts were comprised of fewer than 10 schools; the other had 20 schools. Two districts provided services to pre-kindergarten through 12th grade; the third provided services to pre-kindergarten through eighth grade.

Each of the three school districts encouraged teachers to apply for and obtain grant funding to increase technology used in the schools. While each of these grants was unique to the state involved, they did have some major components in common: (a) teacher application for voluntary participation, (b) one computer for each four students in the classroom at the time of acceptance to the grant, (c) a 3-year commitment to participate in the grant, and (d) mandatory participation in additional off-campus professional development experiences that include integration of technology in the classroom for instructional improvement purposes. Technology-focused instructional improvement intervention was the event used in this study.

When asked to provide a list of potential participants, all three principals recommended teachers who were participating in these grants. Thus, all eight teachers who participated in this study were participating in their state's technology grant.

Participant Portraits

A portrait is a record and interpretation of the perspectives and experiences of people who were studied, documenting their voices and their visions (Lawrence-Lightfoot & Davis, 1997). Portraits are designed to capture the richness, complexity, and dimensionality of human experience in social and cultural context, conveying the perspective of the people who are negotiating those experiences.

The Teachers

The participants in this study consisted of eight teachers who taught fifth or sixth grade in general education classes. Three teachers were selected from each school. Of the nine teachers who volunteered, eight participated in some kind of technology grant, on a continuum of anywhere from just beginning to a fourth year participant. Due to the lack of participation in a grant that required professional development the ninth teacher was dropped from the study. Each teacher had a ratio of at least one computer to four students in the classrooms as provided by a recent grant from either the state or a private organization to the school or district. Additional information about the teachers in the form of portraits is available in Appendix C.

Data Collection Procedures

Data were collected using teacher interviews; field observations, which included videotaping and keeping a diary. A nonstandardized interview (a conversation that begins with a few general topics to help uncover the participants' views and respects how the responses are framed [Marshall & Rossman, 1999]) was used to gather the perceptions of the teacher volunteers. The interview was semistructured and situated in the realm of portraiture, as described by Lawrence-Lightfoot and Davis (1997). This provided necessary context for each participant, and enhanced my ability to create a portrait of each participant. Interviews were recorded and transcribed for analysis by the researcher.

Methods of Data Collection

Three types of data were collected for this study. First, each teacher was interviewed using a semistructured questionnaire developed by the researcher and approved by Teachers College IRB and my doctoral committee. Second, I observed the teachers to ascertain the extent to which teacher perceptions of their abilities to use technology were consistent with observed performance in the classroom environment. Finally, I videotaped each classroom once in a 15-minute interval while the student participants were using the computer toward the end of the study.

Interviews. Initially, I conducted an interview with each teacher participant during November and December 2001, and January 2002. Each interview occurred during teacher breaks and lasted approximately one hour. The questions were planned in advance, but I allowed the flow of the answers to determine the questions in a manner similar to a general interview guide (Moustakas, 1990, 1994). I had an outline of set topics to explore so that I had common information from all of the participants. These semistructured questions can be found in Appendix D.

As referenced in Table 2, data collection began with initial interviews with the teachers (t) to determine their thinking about computer use and instructional methods. For the purposes of this study, the initial teacher interview probed for teacher use of technology in the classroom, understanding of learning specifically as it related to students LLD, and self-identify comfort level of use of computers and other academic technology. All interviews were audiotaped and transcribed using pseudonyms for participant names.

Table 2

Data Collection Timeline

	School 1	School 2	School 3
Initial Interview (Month 1)	t	t	t
Observation 1(Month 2)	t/s	t/s	t/s
Observation 2	t/s	t/s	t/s
Observation 3	t/s	t/s	t/s
Observation 4 (Month 3)	t/s	t/s	t/s
Observation 5	t/s	t/s	t/s
Observation 6	t/s	t/s	t/s
Observation 7 (Month 4)	t/s	t/s	t/s
Observation 8	t/s	t/s	t/s
Observation 9	t/s	t/s	t/s
Observation 10 (Month 5)	t/s	t/s	t/s
Observation 11	t/s	t/s	t/s
Observation 12	t/s	t/s	t/s
Video Tape 1 (Month 6)	s	s	s
Observation 13	t/s	t/s	t/s

Note: t = teacher and s = student

Observations. Observations were a critical component of data collection in this study. This method of study was useful because field observation is eminently suitable to many of the problems that education researchers face (Cohen, 1994). The advantage of field observation is that it allows researchers to discern ongoing behavior as it occurs and make appropriate notes about its salient features. At the same time, observations provide researchers with the opportunity to establish casual relationships with the subjects in a more natural environment, thereby facilitating a cooperative working relationship. As indicated in Table 2, all participants were observed for a minimum of 13 occasions lasting approximately one hour per observation over a 6-month period. Each participant was observed at least once a day for two to three days each week during monthly visits to the school for a total of 13 observations. The teacher participants determined this schedule. I observed the teachers to ascertain the extent to which teacher perceptions of their abilities to use technology were consistent with observed performance in the classroom environment. All observations were recorded in an observation diary.

Each subsequent visit for the next six months included observations of both teachers (t) and any students (s) in attendance during the observations.

Specifically, observations took place in the following settings:

1. I compiled observation notes from a diary describing my participation with my reflections.
2. I observed and documented the teacher practices that occurred pertaining to technology in the classroom. Observations focused on the following issues:
    a. Practices that occurred around the six knowledge areas (Berliner, 1988, 2004).
    b. Technology-based learning activities introduced by the teacher during instruction (Sandholtz et al., 1997).
    c. Topics of discussion during instruction.
    d. Assignments given to the student.
    e. Levels of teacher involvement outside of the classroom (Riel & Becker, 2000, 2008).

During my first classroom observation I wanted to identify placement, age, and working order of the technology, as outlined by the teacher in the initial interview. I also wanted to confirm the teacher's description of how the technology was being used in the classroom. After I completed the inventory, I began the observation of the practices exhibited by the teacher as they related to technology and the levels of teacher development. I kept a diary of the practices and audiotaped the language interactions. The diary played an important role in documenting my on-going reflections. As Peshkin (2001) stated, "An important reason for reflecting on the development of an interpretation is to show the way a researcher's self, or identity in a situation, intertwines with his or her understanding of the object of the investigation" (p. 5). As noted by Moustakas (1990, 1994), because I am not indifferent to this subject, the interpretation was influenced by my previous experiences.

Videotaping. Videotaping occurred once in a 15-minute interval during one of the last visits while the students were using the computer (see Table 2). As Cole and Engestrom (1993) stated,

> Audio- and videotape recording, films, and computers have all, in their own way, enabled us to interact with the phenomena of mind in a more sophisticated way. We can now not only talk about the mutual constitution of human activities, but display it in scientifically produced artifacts. (p. 43)

I placed the camera in a discrete location, but close to the computers. One key student was identified for each classroom and permission was obtained from the parent and student to videotape that student prior to the taping session. The purpose of videotaping students was to provide additional opportunities for a more detailed study of the students' interaction with the teacher and the technology. The videotapes were used to provide another view into how the teachers were using the technology in their classrooms and to substantiate my findings.

Data Analysis

Data analysis occurred in steps or levels as suggested by Moustakas (1990, 1994), Janesick (2000), and Ryan and Bernard (as cited in Denzin & Lincoln, 2000). Data were analyzed through the lens of adoption of technology innovations as described by Sandholtz et al. (1997). Content analysis (Marshall & Rossman, 1989; Merriam, 1998; Ryan & Bernard; Silverman as cited in Denzin & Lincoln, 2000, p. 785) occurred in phases. First, individually, then grouped by years in the grant, and finally, analysis for themes occurred. A 4 x 8 matrix for the purpose of thematic analysis and study of the themes and relationships to each teacher was created. The process was a crystallization from multiple perspectives, which allowed the researcher to look at the data from multiple perspectives, thus giving the researcher a better lens through which to view qualitative research designs and their components (Janesick, 2000; Richardson, 1994). This synthesis brought together a story.

Each description of teachers and their classroom practices drew upon interview and observation data collected over the 6-month period of this study (see Appendix C). The descriptions portrayed each teacher's use of technology strategies and perceptions in their practice. Also included, as available in the data, were professional development opportunities and how those experiences influenced teachers’ perceptions and provided change in levels of expertise, if any, over time.

Content analysis. Content analysis occurred in three phases. In the initial phase, I analyzed teachers' perceptions about classroom use of technology and working with students. I grouped teachers by years of participation in the grant and organized the data accordingly. I examined the ways in which teachers used technology and whether that matched their perceptions. Drawing on multiple data sources, I looked for patterns both within and across groups. This analysis occurred in order to detect recurring themes (Ryan & Bernard as cited in Denzin & Lincoln, 2000, p. 780- 781). Each interview was color-coded to assure confidentiality by removing any identifiable information. Additionally, the color-coding of each participant served as a reminder that data from each individual would be represented on a uniform basis in the analysis of the research.

By constructing visual displays, emerging patterns from both within and among the participants became increasingly evident. Matrices of the number of occurrences allowed me to analyze the data in order to identify the categories (Ryan & Bernard as cited in Denzin & Lincoln, 2000). Data categories specific to the research questions defined this study gave clues as to how teacher thinking and practices influenced levels of development using technology.

A secondary analysis of historical data (Glass, 1976) occurred for the purpose of answering new research questions with the old data. The perceptions and feelings of the particapants were explored and analyzed against current research that explored reasons why technology has not been more broadly embraced by teachers. Current research added a layer of understanding to the mostly unanswered question of why teachers are not using technology in the manner it was intended in U.S. public schools.

Following Marshall and Rossman's (1989) suggestion to keep a separate file to record research procedures, I set up a separate file on the computer to record exact research procedures which, according to their research, served as a way of establishing internal truthfulness of the study for the researcher and advisors to the research.

Data derived from the de-contextualizing process were kept on a computer spreadsheet. In the computerized database, the data was copied and dated each time there was a modification to emergent categories. Coded data was stored in the order of the research questions.

The use of multiple types and sources of data provided the basis for triangulation. Throughout these analyses, I continually looked across data sources for disconfirming and corroborating evidence in the process of identifying patterns, themes, and explanations. Discrepant cases were analyzed and described with the reason for why they were discrepant and how the findings derived from analysis were considered outside the scope of the study.

In summary, the first method of data management was conducted by color-coding the written text to keep participants identified and proportionately represented in the study. The text was de-contextualized and a content analysis was performed on the data. The second method of data management was documented by recording a dated, computerized file of the research procedures that was reviewed by the researcher in order to enhance "truthfulness" to the study. Finally, a computerized database was kept on emergent categories. Each time the database changes, the file was copied, modified, and dated.

Thematic analysis. Data were collected depicting the instructional practices, teacher thinking, and voice of the teacher participants. The focus of data collection was on the teacher's perspective and his or her professional practice knowledge. The research questions were used to organize the data analysis. The data sources important to the interpretative portion of the data are described below.

Interviews. Interviews were conducted with all teachers in person during the first visit to each school and then transcribed. All teachers were assured of confidentiality of their responses. Written consent to use their responses as data for this investigation was secured from the teacher participants. Each teacher was assigned both a color code and an alphabetical code. Each phrase was assigned a numerical code. This allowed the possibility of applying each response individually to the theory of stages of teacher adoption of technology (Sandholtz et al, 1997) that were used as the lens for analyzing the teachers' perceptions against their professional practice. It also allowed for identification of prominent themes that emerged among the participants.

Observation diaries. As a participant-observer, I took observation notes during each classroom visit throughout the duration of the study. Included in the observation diaries were my thoughts and reflections about my observations during the study. Observation notes were later read, analyzed, and pondered, and additional reflections and analytic memos were written. Observations were noted by date, time, location, teacher, and subject taught.

Videotapes. Videotaping occurred once toward the end of the study in a 15-minute interval while the students in each class were using the computer. I established the camera in a discrete location but near a computer. Videotaping the students provided additional opportunities for a more detailed study of the students' interaction with the teacher and the technology. The videotapes were reviewed for the purpose of substantiating the findings from the interviews and classroom observation. The videos were analyzed using the criteria for each stage of stages of teacher technology adoption (Sandholtz et al., 1997) and a count was taken of the number of observed instances of each criteria using a researcher made check list derived from language used in the ACOT and subsequent studies.

Current research. The value of conducting a secondary analysis on historical data came from fresh interpretations and making new connections, "revising perspectives of past times as well as introducing understandings of what we see around us" (Bornat, 2008, p. 2). Once the initial analysis of the data occurred, it was compared to current research thus allowing for the production of "new knowledge" (Bornat, p. 2).

To analyze the text, I compiled a matrix that divided the data by school into teacher professional practice knowledge, practice, thoughts, and perceptions around the use of technology. An additional layer was added by viewing the data through the lens of the stage theory that was used to consider professional practice (Sandholtz et al., 1997). The transcribed interviews were identified by color to represent each teacher. The transcripts were placed in an Excel file and then analyzed and sorted into categories by research question in order to capture recurrent themes in this new time period. Observations were transferred to another Excel file and coded for each teacher. Each observation note was numbered to identify where the observation belonged within the matrix. In this manner, the data was sorted by stage theory (Sandholtz et al.), emergent theme, and across individual teacher.

Organization of Data

The themes that emerged from the data were related to the Sandholtz et al. (1997) levels of teachers' adoption of technology and provided portraits of teachers and how they developed from adopting technology. I developed a matrix to identify the number of instances the teacher participants made references to any of the themes--both positive and negative comments. A second matrix that used the levels of teacher adoption of technology illustrated how the teachers' self-reported knowledge related back to actual classroom practices. As Spradley (1979) stated, "It is possible to analyze any phenomenon in more than one way" (p. 92). Specifically, I examined how introducing technology into the classroom changed levels of teacher practice in the classroom and influenced teachers' thinking about themselves as professionals.

The methodology for text analysis included the compilation of a matrix to divide the data into teacher professional practice knowledge, practice, thoughts, and perceptions around the use of technology. Content analysis was used in order to document and understand the "communication of meaning, as well as to verify theoretical relationships" (Altheide, 1987, p. 68). The transcribed interviews were analyzed and sorted into categories of recurrent themes. Observations were transferred to Excel files, which were coded for each teacher. Each observation note was numbered to identify where the observation belonged according to the matrix. This matrix was developed when the themes emerged through analysis.

The second matrix (Table 3) compared the teachers' disposition toward their performance and level of expertise to actual classroom practices. These were compared both within-case and cross-case analyses. Within-case analysis focused on providing insights for each individual school and the teacher participants in the school through ongoing descriptions and interpretations with supportive evidence. Cross-case analysis compared teachers with self-identified levels of professional practice knowledge, practice, thoughts, and perceptions around the use of and by identifying differences and similarities among teachers.

Table 3

A Sample Table Comparing Teacher Disposition Toward Performance and Level of Expertise to Actual Classroom Practices

	Stages of Teacher Adoption of Technology	Levels of Expertise in Pedagogy	Teacher Leadership
Interview			
Observational Diary			
Video			

In addition to purposive selection, each school was selected so that it either predicted similar results or produced contrasting results but for predictable reasons (Yin, 1994, 2008). Sustained reflection on the data helped relate findings to the research questions and generate recommendations for use of technology in classrooms and future studies. The review of literature was ongoing in order to compare the unfolding analyses with prior theoretical work and empirical findings.

Observation notes from my diary, interview transcripts, and the one brief videotape were collected and maintained throughout school visits using pseudonyms to identify individual teachers. The data were gathered and organized into a sequence that told the story of each research participant (Moustakas, 1990, 1994). Toward the end of my school visits I videotaped one 15-minute instructional segment in each classroom.

The data collection schedule was determined by the instructional schedule in the classroom. Each classroom was observed four times for at least three to four class periods each and video taped once for a total of 13 observations over 6 months. The discrepant case was described in chapter 4.

Chapter 4: Results

The purpose of this investigation was to capture an historical view of technology integration in 2002 in order to explore the process teachers underwent while adopting large-scale technological innovations. As this was the time period when computers were hitting critical mass in U.S. public schools (Education Week, 2005), this study afforded a unique opportunity to examine how teachers' perceptions and behaviors change during the increase of computer technology innovations in order to serve as the foundation for a structured guide tool for professional development to assist teachers through adopting innovations successfully in contemporary times and in the future. This study established a deeper understanding of key aspects of teachers' perceptions and their instructional technology practices, and the replicability of these practices across classrooms and schools, which are desired outcomes of qualitative studies (Fetterman, 1989; Yin, 1994, 2008).

The data used in this study are historical data that were collected in 2001-2002 as part of a previous dissertation study at Teachers College, Columbia University when technology adoption was hitting critical mass in U.S. schools, and grants were readily available to teachers and schools through outside sources. The historical data were collected using purposive sampling (Creswell, 1998), and followed the professional growth and development of eight classroom teachers from one school in each of three states in different regions of the United States that participated in some kind of a 3-year technology grant. In each location the administrator was given the option of selecting the participating teachers: those he or she felt were “good” teachers who were using technology in some manner.

Each teacher in the study applied for and was awarded a state or organizational grant from within the school setting in which they were located. This was done outside of this study, although only teachers who had received technology grants were included in the study. The grants were awarded to assist interested teachers in integrating technology into their individual classrooms. The technology grants provided computers at a ratio of one computer to four students, Internet access, and required ongoing professional development for integrating technology into the classroom of each teacher participant. All grants were of at least 3 years in duration, with two teachers voluntarily participating into the fourth year. The teachers participated during the period of time they received their grants. Three teachers from each of three schools were invited to participate in this study. It was determined that one of the participants did not meet the requirement of ongoing professional development and was eliminated from the participants.

A secondary analysis of historical data (Glass, 1976) collected in 2001 - 2002 occurred for the purpose of answering new research questions with the old data. The perceptions and feelings of the participants (2001 - 2002) were explored and analyzed against current research (2004 - 2010) that explored reasons why technology has not been more broadly embraced by teachers. In this manner, new knowledge was produced (Bornat, 2008). Based on that new knowledge, a structured guide tool that can be used by staff developers and policy makers in the future as innovations are introduced into schools was included in the findings. The structured guide tool provided suggested supports for teachers as they create viable learning for their students. A comparison to current research added validity to the findings and supported the ideas used to create the structured guide tool.

Research Questions

The lens for reanalysis of the data was focused by the following research questions:

Research Question 1

1. How do data from a study of teachers' use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice?

Research Question 2

2. How does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation?

Research Question 3

3. How can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced?

Organization

To better understand the data collected for this study, an idea of the characteristics of the teacher participants and the schools in which they work are needed. This chapter includes (a) a brief demographic description of each school as a case study with descriptions of the participants from each school, including the discrepant case; (b) description of the data analysis; (c) narrative reports that summarized research findings as they relate to each research question, which included identification of themes and patterns that emerged from the cases through the analysis of the data; (d) a comparison of the cases; and (e) a discussion of the quality of the evidence is presented to account for accuracy of the data.

The requirements of the grants were similar. All three grants required the participants to commit to 3 years. Participants agreed to attend training sessions several times a year at a location not within the boundaries of the school. Those trainings ranged from short duration of 1 full day to 3 days to 2-week intensive trainings, depending on the requirements of the individual grant. Districts agreed to provide Internet connectivity. All of the participants were required to produce evidence that they were using the technology in a manner that matched their curriculum, although one of the grants required a notebook with demonstrated evidence to be shared with other awardees. Project Venture had a tiered system whereby, depending on the level of expertise using computers, teachers in that study were not given professional development until the end of the first year in the grant.

The differences among the cases as it had to do with grant expectations came from the manner in which the participants were treated within the school. Each school personnel had different ways in which they provided support and the degree of support varied extensively. This was explored as an aspect of each case study.

Four dominant themes emerged from among the teachers' interviews during the original study: (a) management and control, (b) confidence in teaching, (c) confidence in using technology, and (d) a connection between philosophy and use of computers in instruction as evident in classroom practice. With the reanalysis of the data, new themes emerged.

Secondary analysis allowed new themes to emerge that were compared to recent findings in the literature. The comparative analysis of findings to recent research gave insights that were not available at the time when computers were hitting critical mass in U.S. schools. Analyzing the data from an historical perspective offered glimpses into why computers were not widely used in public schools as intended and gives contemporary researchers the ability to create a structured guide tool for policy makers and staff developers that can help ensure success when additional innovations are introduced into schools.

Case Studies

The reanalysis of historical data was organized around the three schools selected for this study. The research questions were used as the basis for summarizing each case and comparing and contrasting across case findings. Within each case study the participant's perceptions and classroom behaviors were described in order to support the research questions with data and to determine emerging themes and to discern patterns among the case and later described across cases (Yin, 1994, 2008).

Portraits

First, I looked at the teachers from the point of view of the stages of teacher technology adoption as reported by Sandholtz et al. (1997). Sandholtz et al. described the stages that are typical for adoption of technology innovations. Through the lens of this stage theory it was possible to begin analyzing how teachers respond when an event, like the introduction of computers experienced by each teacher participant, enters their professional practice.

With the introduction of the technology provided by the grants, the teachers all began to question and consider their teaching practices (Schön, 1983; Williams, 2006), which affected their perceptions toward teaching, pedagogy, and the use of technology integration in the classroom (White, Ringstaff, & Kelley, 2002). At the same time, they were required to adjust their practice to meet the needs of the professional development portion of the grant. Examining how they advanced and retreated through the stage theory made it possible to form an understanding of how the grant, and its professional development opportunities, affected both teacher perception and professional practice. By looking at the stages of teacher technology adoption (Sandholtz et al., 1997) through an analysis of the teachers responses to interview questions and subsequently observed professional practices, it was possible to get a sense of how teachers' progress through these stages. Comparing the findings of this study to recent research offered insights into perceived successes and barriers experienced during the time computers were hitting critical mass. These insights were used as the basis for constructing the structured guide tool.

I created portraits for each participant using the data sources as the basis for each portrait. The portraits were meant to provide a background on the participants in this study as people and teachers, as self-described during interviews and as observed in their classrooms. Because teachers ultimately organize and deliver instruction to students, how teachers interpret their level of expertise in practice with their thinking determines how they will use technology in their classrooms (Adey, 2006; Adwere-Boamah, 2010; Connelly & Clandinin, 1988, 1999; Lawrence-Lightfoot & Davis, 1997). Each teacher portrait was presented and followed by stories of teachers in their classrooms, with a focus on how they translated their thinking into practice.

Next, I reanalyzed the portraits through the lens of the new research questions. This was done in order to answer the research questions being pondered in 2011. The analysis was organized around the research questions. Support for newly emerging themes came from the original portraits, the findings of the original research questions from 2001 – 2002, and the reanalysis of the data in order to answer the current research questions.

Comparing the analysis of historical data to recent research made it possible to formulate a deeper understanding as to why computers have not been widely embraced by teachers (Li, 2007; Wei et al., 2008; Zhao & Frank, 2003, p. 807). The new emerging themes provided insights into the challenges that teachers faced as they worked to integrate technology into their professional practice (Matzen & Edmunds, 2007;

Schwartz, 2008). From these insights, a structured guide tool for policy makers and staff developers was created to support teachers when innovations are introduced into U.S. classrooms.

The text was de-contextualized and a content analysis (Marshall & Rossman, 1989; Merriam, 1998; Ryan & Bernard, 2000; Silverman as cited in Denzin & Lincoln, 2000, p. 785) was performed on the data. Open coding occurred using the characteristics specific to stage theories that consider professional practice. From there, I created portraits of each teacher as they were informed by the stages of teacher technology adoption (Sandholtz et al., 1997), teacher leadership (Riel & Becker, 2000, 2008), and answered the research questions posed in 2011. The individual portraits can be found in Appendix C.

The Cases

School 1. One of the schools, which I will call "Acorn Middle School," was in a somewhat isolated rural area in the Pacific Northwest. The community racial profile was 96.7% European-American, 0.3% African-American, 1.7% Asian Pacific American, and 1.3% other. This community had a median annual income of $51,615. Other salient characteristics were that more than half of the residents were over age 50; half were married couples with no children still at home, and nearly a quarter of these households were single-person. Their affluence came from long-term certificates of deposit; they ranked near the top among the markets for investments and savings. They also owned newer single-family vacation houses or condominiums in small towns and cities in

Florida and California (infods, 2001). Table 1 provides a graphic of the comparison between the school district and the school described in this case study.

Table 1

General Characteristics Profile (Summary) for Acorn Middle School

	District	School
Grade Range	PK-12	6-8
Total Persons	10,769	573
Percent Urban	0.00	0.00
Percent White	96.7	91.8
Percent Black	0.62	0.3
Percent American Indian/Alaskan Native	1.3	1.3
Percent Asian/Pacific Islander	0.33	1.7
Percent Hispanic	1.11	4.23
Percent Other	0.00	1.3
Median Housing Value	$129,107	$129,107
Median Household Income	$31,327	$51,615
Enrolled	1,897	537
Students per Teacher	21	21
Total Revenue per Student	$4,839	$4,839
Federal Revenue per Student	$122	$122
Total Expenditure per Student	$5,397	$5,397

Note, From “GOVERNMENT INFORMATION SHARING PROJECT Oregon State University ~ Information Services” (http://govinfo.kerr.orst.edu/, 1990; http://www.infods.com/freedata/, 2001).

Three sixth grade teachers from this school volunteered for the study. One taught science for a team of students, another taught science and math for a second team of students, and the third taught the elective courses of computers and drama, as well as one seventh-grade math class. Therefore, all students attended classes with the third teacher at some point during the school year. All three of these teachers participated in the technology integration grant. At the time of this data collection one teacher had participated for 3 years and was voluntarily in her fourth year of the grant, one was in her second year, and one was in his first year. All three teachers have 14 or more years teaching experience.

The library of Acorn Middle School was built in 1898. At the time of this study, the school consisted of grades 6 through 8 with a student population averaging 537. The student population reflected the community demographics and was fairly homogeneous. It included 91.8% European American (community average 96.7%), 1.3% Native American or Alaskan Native (community average 1.3% other), 3.0% Asian Pacific American (community average 1.7%), 2.0% African American (Community average .3%), and 1.9% Hispanic American (community average 1.3% other). Approximately half of the student population was male and half was female. In 2001, 17.6% of the students were eligible for Free or Reduced-Price Meals. During that same time period, 32.4% of the students tested met or exceeded the state standards in math (state average 22%), 53.7% met or exceeded the reading standards (state average 20.3%), 59.3% met or exceeded the writing standards (state average 21.4%), and 85.9% met or exceeded the listening standards (state average 20.3%) as measured by the Washington Assessment of Student Learning (WASL).

There were 36 faculty members on campus, which consisted of one principal, one vice principal, one counselor, one part-time psychologist, eight sixth grade teachers, nine seventh grade teachers, and nine eighth grade teachers. There were 12 support staff in the school, comprising office staff, para-educators, and maintenance staff. There were three special education teachers on staff. The library was staffed by a para-educator.

Acorn Middle School had in place a number of support systems for the students on campus. There was a mentoring program that paired adult volunteers with students who needed mentoring during the school day, community service learning components, the Youth in Philanthropy Project, and outdoor education. The electives that were offered to the students are the traditional shop, home economics, health, band, art, and computers. Extracurricular activities included basketball, wrestling, baseball, golf, football, chorus, band, and dance.

The school principal had been involved in public education for 27 years. Prior to becoming a principal at this school 21 years earlier, he served as a classroom teacher. Interview data and field observations from the teachers indicated that he was well respected by his faculty. Several faculty members reported that he was supportive of his faculty, and could be counted on to render fair judgments in disputes among teachers, students, and parents (personal communication, 2002). His office was always open to teachers, students, and parents. Due to the small size of the community, I observed him often wandering the school hallways greeting students, teachers, and visitors by name, and dealing with situations as they occurred. In addition, he was present at the celebratory events organized by members of the school. He was an active member of the community and was well known and respected.

Acorn Middle School was committed to supporting teachers who wanted to participate in grants that would get them the infrastructure to integrate technology into their curriculums. At the time of the data collection, there were a disproportionately large number of teachers who had participated in the Gates Teacher Leadership Grant on this campus (approximately 20%) since its inception in 1997. Additionally, the Gates Teacher Leadership Grant provided approximately $10,000 to the school district per participating teacher so that the district could purchase one computer for each four students enrolled in the class at the time of acceptance into the grant, as well as a projection device and a printer. It also included money to assist the district in providing the infrastructure so that the classrooms had Internet access. There were professional development opportunities that consisted of 2 weeks of training teachers to integrate technology into their classrooms in the summer and four 3-day weekends throughout the school year that were required of each participant. The faculty in-service trainings were scripted so each grant participant received the same experience. The professional development occurred off campus with other teachers who had received the grant for that year from around the state. The teachers in the grant who participated in this study reported there was a strong emphasis on using PowerPoint as a way to integrate the technology into the classroom curriculum (Anne, Amy, Andy). Amy reported her use of this software in the following manner,

> You could have said, well, you know everybody needs to know about photosynthesis, we'll just do that, as a PowerPoint and show them how to use the encyclopedia. So, instead, you have to think of, ok, what could I do with PowerPoint that's not going to cause them to have to, you know...not paraphrase, or research.

Additionally, I witnessed Andy using PowerPoint in the following manner, “During one visit, the students were working on putting together the information they had learned for the year into PowerPoint presentations in a portfolio type format" (2002). Anne, at one point during a visit to her classroom, alluded to the overemphasis of PowerPoint in the in-service trainings required by the Gates Leadership team. She was the only participant who did not use PowerPoint while I was observing.

The principal supported the use of technology as a tool that allowed students to have access to resources they might not otherwise have. In addition to a computer teacher, the school created a technology media position, which gave students the opportunity to engage in multimedia learning that was integrated into their general education coursework. In 1999, the district created a .6 position that was technical support for teachers using technology in their classrooms. This person made sure the computers and peripherals were kept running so they were available for student and teacher use. She was trained on both platforms (MAC and PC), so she could assist all teachers using computers. She was the only technical support for this district of four schools. The district used one of the two staff development days each year to encourage staff members to learn additional skills for using technology in their classrooms. Also, teachers were encouraged to write grants if they wanted further support for the use of technology in their classrooms.

Anne was a 22-year veteran teacher who taught mathematics and science on a sixth grade team, as well as a class called "Learning Science Through Models," at Acorn Middle School. Anne received her 3 year grant, the Gates Leadership Grant, in 1997, the first year of its inception. She was also able to voluntarily participate in the grant for an additional year, during this study.

Amy was a 14-year teacher at Acorn Middle School. This was her first year as the technology teacher for the school. She was working on her second year of the Gates Leadership Grant.

Andy, a 17-year teacher at Acorn Middle School, taught sixth grade science at Acorn for the past 10 years. This was his first year participating in the Gates Leadership Grant.

In this setting, I saw professional practices that seemed to support isolationist behaviors occurring on the part of the school and district. There were no common planning times, teachers did not meet together to discuss curriculum or use of technology, and one of the participants went so far as to say, “The district stance is that you can't ask for anything more because look what you've got, even though the district didn't supply it to me” (Andy, 2001), implying that support was not forthcoming.

School 2. The second school, which I will call “Bright Middle School,” was located in a city in the Southwest. The community racial profile was 89.2% European American, 2.6% African American, 4.9% Asian Pacific American, and 3.2% other. This community had a median annual income of $81,376. Other salient characteristics include that this community consisted mostly of what ESRI Business Information Solutions calls "Prosperous Baby-Boomers," born between 1949 and 1964, who had more pre-schoolers than the national average. They were well educated and had dual incomes. Most were homeowners in new housing developments in suburban neighborhoods (infods, 2001). Table 2 provides a graphic of the comparison between the school district and the school described in this case study.

Table 2

General Characteristics Profile (Summary) for Bright Middle School

	District	School
Grade Range (Districts)	PK-8	6-8
Total Persons	75,683	1170
Percent Urban	99.04	99.04
Percent White	84.96	81.41
Percent Black	2.05	1.98
Percent Amer Ind, Eskimo, Aleut	0.92	1.51
Percent Asian/Pacific Islander	2.90	3.28
Percent Hispanic	9.07	11.59
Percent Other	0.11	0.10
Median Housing Value	$112,078	$112,078
Median Household Income	$49,392	$81,367
Enrolled	11,354	1107
Students per Teacher	21	26
Total Revenue per Student	$4,311	$4,311
Federal Revenue per Student	$76	$76
Total Expenditure per Student	$5,015	$5,2015

Note, From “GOVERNMENT INFORMATION SHARING PROJECT Oregon State University ~ Information Services” (http://govinfo.kerr.orst.edu/, 1990; http://www.infods.com/freedata/, 2001).

Three sixth grade teachers volunteered for the study. One taught science and mathematics for one team of students, another taught science and social studies for a second team of students, and the third taught mathematics and social studies on the same team with the science and mathematics teacher. Two of these teachers participated in a technology integration grant called "Project Venture." At the time of the study, one had participated for 3 years and for one this was her first year. The third teacher acquired her classroom computers through other sources and has no additional professional development requirements as it related specifically to technology integration. Two of the teachers had 8 or more years teaching experience while the third, who was not participating in the technology grant, was in her third year of teaching. It was later determined that the third teacher did not meet the criteria for the original study (see Discrepant Case).

Bright Middle School was built in 1995 and included state of the art technology infrastructure. This was a predominately European American community with a large dual income, well-educated population. At the time of the data collection, Bright Middle School consisted of grades 6 through 8 with a student population averaging 1107. The student population was fairly homogeneous and included 81.41% European American (community average 89.2%), 1.51% Native American or Alaskan Native (community average 3.2% other), 3.28% Asian Pacific American (community average 4.9%), 1.98% African American (Community average 2.6%), and 11.59% Hispanic American (community average 3.2% other). Approximately half the student population was male and half was female. In 2001, 4.63% of the students were eligible for Free or Reduced-Price Meals. In 2000- 2001 the students scored 84 in math (state average 63), 77 in reading (state average 54), and 77 in language arts (state average 45) as measured by the Stanford Achievement Test, Ninth Edition (Stanford 9).

This middle school consisted of 63 faculty members, which included one principal, one vice principal, and two administrative "teachers on special assignment," so that there was one administrator for each grade level, with the principal available for other duties. There was one counselor, one half-time psychologist, 15 sixth grade teachers, 13 seventh grade teachers, and 15 eighth grade teachers. The school was set up using a middle school model (Van Til, Vars, & Lounsbury, 1961). They used a pod system that consisted of teams of teachers and students working together. There were 13 support staff in the school, comprising office staff, para-educators, and maintenance staff. There were four special education teachers on staff, and two librarians, who worked in a library that served both the middle school and an adjacent elementary school. The electives that were offered to the students were not as traditional as outlined in school one and mostly consisted of those with a technology emphasis. One day a week the school had a shortened day for teacher planning. This gave the teachers the opportunity to meet as teams, in addition to their normal daily individual plan time.

The school principal had been involved in public education for 37 years. Prior to becoming an administrator at this school 3 years before the time of data collection, he served as a classroom teacher and assisted the district as a staff developer. This was his second year as the principal of this school. Interview data and field observations from the teachers indicated that he was fairly well respected by his faculty by nature of his long-tenure in the district. His office was open to teachers, students, and parents. He was observed wandering the school hallways greeting students, teachers, and visitors, and dealing with situations as they occurred. Not his entire faculty considered him a “good” administrator, as described anecdotally in conversations with those who were not part of the study (personal communication, 2002). Some of his faculty felt he was too easily persuaded to change his mind. He retired at the end of the 2001-2002 academic year.

Bright Middle School was committed to supporting teachers and students in the use of technology. In 1994, the district asked the community to pass a budget override that would allow the district to tax the public for technology. The money was used to provide each classroom in the district with one new computer, each teacher with a laptop, each school with a new computer lab, and with the infrastructure that would give each classroom access to the Internet. A second project this state called "Project Venture" begun during the 1999-2000 school year. It was funded by private money and consisted of a consortium of state schools and a state university. Teachers were encouraged to apply within the district for the grant, which gave each participant five computers for their classroom, a projection device, and a printer, as well as professional development support for the integration of technology into the classroom. The grant was intended to increase the number of computers in the classrooms by ten percent. This grant was based on a tiered system whereby during the first year the teachers received the computers, but did not have the corresponding training or any significant support for integrating the technology into the curriculum. The professional development included mentoring within the participants' classroom, data collection, support for writing curriculum to support that integration, and video taping of lessons for self-critique and begun in the second year of participation in the grant. Participants had a 3-year commitment to the grant. Since its inception in 1999, only five teachers on this campus had participated in the "Project Venture" grant (approximately 7%). One of the teachers transferred her computers and grant from another school in the district. Particular to “Project Venture” was the expectation that the grant participants would videotape themselves teaching while using technology and it would be self-evaluated with a mentoring peer. According to Brenda, this typically happened toward the end of the second year participating in the grant. 2001 was the final year of the grant as there were no additional monies available to continue to support the grant components.

The district, with support from the community, believed that technology is a tool that will allow students to have greater access to resources. In addition to a computer teacher, the school created a technology media position, which gave students the opportunity to produce a newscast for the school each morning. The school's curriculum has several electives that included digital editing, CAD design, and other in-depth technology applications that could be used in their studies. The district supported common plan time by providing a shortened instructional day each week. Normally, this shortened school day was used to discuss curriculum, but occasionally it was used to discuss the grant and integration of computers into the curriculum.

District personnel provided technical support staff for teachers using technology in their classrooms. These people came to the school for one day twice a month to see the teachers for whom the librarian had made appointments. There was no one available for technical support between visits.

Betty was a ninth-year teacher who taught mathematics and social studies for one of the sixth grade teams. At the time of the study, it was her first year at Bright Middle School and in the "Project Venture" grant.

Brenda was in her eighth year of teaching. She taught social studies and science for one of the sixth grade teams. This was her third year in the "Project Venture" grant and her first year at Bright Middle School.

School 3. The third school, which I will call "Crossroads Intermediate School," was located in a suburban area in the Northeast. This community is made up of what ESRI Business Information Solutions calls "Successful Suburbanites." The community racial profile is 97.6% European-American, .5% African-American, 1.6% Asian Pacific American, and .3% other. This community has a median annual income of $64,819. Most of this group is between 35 and 54 years old and have school-aged children living at home. Their affluence is more than twice the U.S. average and comes from dual incomes and investments. Single-family houses built during the '80s and '90s in suburbs of metropolitan areas are home to Successful Suburbanites (infods, 2001). The following information located in Table 3 provides a graphic of the comparison between the school district and the school described in this case study.

Table 3

General Characteristics Profile (Summary) for Crossroads Intermediate School

	District	State	School
Grade Range (Districts)	PK-12		4-6
Total Persons	11,865		392
Percent Urban	65.95		65.95
Percent White	96.17		93
Percent Black	0.72		2.0
Percent Amer Ind, Eskimo, Aleut	0.05		>.1
Percent Asian/Pacific Islander	2.06		4.0
Percent Hispanic	0.99		1.0
Percent Other	0.00		0.00
Median Housing Value	$226,502		$226,502
Median Household Income	$50,896		$64,819
Enrolled	2,388		364

Students per Teacher	14 (State Average)	23
Total Revenue per Student	$6,850	$6,850
Federal Revenue per Student	$118	$118
Total Expenditure per Student	$6,763	$6,763

Note, From "GOVERNMENT INFORMATION SHARING PROJECT Oregon State University ~ Information Services" (http://govinfo.kerr.orst.edu/, 1990; http://www.infods.com/freedata/, 2001).

Three fifth grade teachers volunteered for the study. Due to the way the mathematics classes were set up, all three teachers saw all of the fifth grade students at some point during the school year. One teacher taught language arts, mathematics, and science, another taught language arts, mathematics, and social studies, and the third taught language arts, mathematics, science, and social studies. All three of these teachers participated in the Rhode Island model classroom initiative, a technology integration grant, and one of the teachers had participated in the "Working Wonders" grant. At the time of this study, one had participated for 3 years and two for 2 years. All three teachers had 16 or more years teaching experience. Also, at this location, the librarian was participating in the Rhode Island model classroom initiative and had participated in the "Working Wonders" grant. All three teachers used her extensively as a coteacher and planner for technology integration. Lessons were planned together so students had access to both written material and information on the Internet.

Crossroads School was a predominately European American community with a largely dual-income population. At the time of data collection, Crossroads School was an intermediate school consisting of fourth through sixth grades with a student population averaging 364. The student population was fairly homogeneous and included 93%

European American (community average 97.6%), less than .1% American Indian or Alaskan Native (community average .3% other), 4% Asian Pacific American (community average 1.6%), 2.0% African American (community average .5%), and 1% Hispanic (community average .3% other). Approximately half the student population was male and half was female. In 2001, 7% of the students were eligible for Free or Reduced-Price Meals. In 2000-2001 55% of the students tested met or exceeded the state standards in math (state average 44%), 83.25% met or exceeded the reading standards (state average 64.25%), and 53% met or exceeded the writing standards (state average 24%) as measured by the Rhode Island State Assessment.

There were 28 faculty members on campus, which consisted of a principal, a social worker, one part time psychologist, five fourth grade teachers, five fifth grade teachers, and six sixth grade teachers. There were 12 support staff in the school, comprising office staff, para-educators, and maintenance staff. There were three special education teachers on staff, as well as a reading teacher and a librarian.

The school principal had been involved in public education for 22 years. Prior to becoming a principal at this school 8 years ago, he served as a classroom teacher. Interview data and field observations from the teachers indicated that he was well liked and respected by his faculty. Frequent comments from the faculty and staff supported this finding. An example taken from my observation diary, “C. is just so supportive. He knows the families, the students, and the community. He doesn’t get in the way of the teachers, as reported by Cindy, but he is there to support them” (2002). His office was always open to teachers, students, and parents. He was frequently observed wandering the school hallways greeting students, teachers, and visitors, and dealing with situations as they occurred.

Crossroads School was committed to supporting teachers in technology integration. There were a disproportionate number of teachers on this campus (approximately 25%) who had participated in the two most readily available grants for the state. The "Working Wonders" grant began in 1999-2000, and provided each teacher with a laptop computer and two weeks intensive training during the summer. The grant also furnished additional funds for the school to hire a part-time technical person during the first year of the grant. The Rhode Island model classroom initiative, which began in 2000-2001, equipped each participating teacher with four computers for their classrooms, and provided professional development opportunities. It allowed both principals and district level administrators to also participate in the professional development. The Crossroads School principal and the district superintendent both were among those participating during the data collection period. Crossroads school housed all of the grant recipients in close proximity to each other so collaboration could easily occur. As one of the recipients was the librarian, and located within 10 feet of the other classrooms, she became a strong collaborative partner with the other three awardees in that building that participated in the study.

The principal revealed during a discussion that he believed that technology was a tool that would allow students to have access to resources they might not otherwise have available to them (principal, personal communication, 2002). The school librarian, who was one of the grant recipients, turned her library into a technology media center. As reported by her, that gave students the opportunity to engage in multimedia learning as part of their general education coursework. She also revealed she had an open library system, allowing teachers to plan and co-teach a combination of library skills in conjunction with media research skills (school librarian, personal communication, 2002). In 2001, the principal created one part-time position that provided technical support for teachers using technology in their classrooms. He made sure the computers and peripherals were kept running so they were available for student and teacher use. Because the money for the position came from the "Working Wonders" grant, classrooms participating in this initiative were given preferential treatment. Several teachers continued to write grants that further supported the use of technology in their classrooms.

At the time of this study, Cindy had 23 years of experience as a teacher. She taught a self-contained general education fifth grade class at Crossroads School and was responsible for all academic areas. Cindy had taught for 21 years within this school district and 8 years at this school. She had participated in two grants: the Rhode Island model classroom initiative for the past 2 years, and the "Working Wonders" grant for 2 years.

Cassie, a teacher with 22 years experience, had participated in the Rhode Island model classroom initiative grant for the previous year. She taught fifth grade social studies, language arts, and math at Crossroads School.

Carol was a 21-year teaching veteran who had participated in the Rhode Island model classroom initiative grant for the previous 2 years. She taught fifth grade science, mathematics, and language arts at Crossroads School.

Discrepant Participant

There was one discrepant participant, Bianca. I did not include Bianca's data in the analysis because she did not fit the criteria for the study. This teacher was awarded computers based on a student-won competition. She had a ratio of one computer for each four students in her classroom. Additionally, she had an extensive budget in which she could purchase additional items for her classroom. She used this to purchase items such as electronic microscopes that connected to the computers, a projection devise, and a printer. What was lacking was any kind of requirement to use the technology in an integrated manner to support student learning. During the second visit to her classroom, I determined that she was not using the technology in a way that supported student learning. She reported that she did in the interview, but then did not use it in the subsequent 13 visits. She used her projection device for teacher lectures on five of the visits. For that reason, I chose to eliminate her from the study.

Summary

These locations were chosen for convenience and to enrich the study by providing another lens by which to view the relationship of teacher thinking about computer use in their classroom to the demonstrated practices of the use of technology in classrooms. I wanted to see to what extent teacher perceptions of abilities to use technology in the classroom is consistent with actual performance. Another reason for selecting these schools is that by selecting schools with similar practices (i.e., inclusive practices, integrating technology, and teaching students in fifth and sixth grades), I built a multiple-case design (Yin, 1994) that predicted similar results or produced contrasting results but for predictable reasons.

Data Collection

Historical data being analyzed in this dissertation were collected from three distinctly different sources: interviews, observations, and videos in order to triangulate the data to identify emerging themes and show evidence of quality. Data were collected through initial interviews with each of 8 teachers, followed by 13 visits to each of their eight classrooms during which an observational diary was kept, and a 15-minute video was collected in each classroom of students using technology in some manner. The interview was audio-taped and transcribed by me within 2 weeks of the interview. Observations occurred for three to four days per visit, one class period per day of approximately 55 minutes. All impressions were entered into an observational diary immediately following each observation. Finally, a 15-minute video was recorded during the final week of observations in order to capture how technology was being used in each classroom. Data were collected over a 6-month period. For the purpose of this study, historical data is being re-analyzed for the purpose of answering new research questions.

Findings

A secondary analysis of historical data (Glass, 1976) collected in 2001-2002 occurred for the purpose of answering new research questions with the previously collected data. The perceptions and feelings of the participants (2001 - 2002) were examined and analyzed against current research (2004 - 2010) that explored reasons why technology has not been more broadly embraced by teachers. In this manner, new knowledge was produced (Bornat, 2008).

As would be anticipated, when data collected in 2001 – 2002 is revisited through the lens of 2011 knowledge, there are new themes that emerged that continue to persist in the literature. The themes that emerged with the reanalysis of the data were (a) novice reversion, (b) teacher self-perception and time to implementation, (c) perceived support, and (d) collaboration/openness to learning.

Research Question 1

Research Question 1 asked how do data from a study of teachers' use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice? In order to determine how teachers' use and perceptions of technology as it translated into classroom practices can be used to inform present understandings of the influences technology adoption has on classroom practice, it is important to understand the ebb and flow of practice and perceptions as teachers were constantly struggling to change their classroom behaviors to match the requirements of the grants. All participants wanted to use technology in their classrooms as all participants had volunteered to receive the grants.

Each case afforded different findings. Acorn Middle School and its teacher participants informed present understandings of the influence technology adoption has on classroom practice. Anne excitedly shared that she had written several grants and just received funding which allowed her to teach a class she had written for the school, as well as purchase additional software that matched her curriculum in science and mathematics when she related, “I got to write this class. It's called, ‘Learning Science Through Models.’ This is a model of something that happens in the real world” (personal communication, 2001). In my observational diary, there were many notations describing Anne using technology to support learning in ways that tied to real world events. An example was the Journey North Project (see Appendix C). In this manner, she gave her students access to learning they would not have received otherwise. Andy related, “Giving students the opportunity to see what they're doing in a very good, visual image” indicating a common understanding of how technology could be used as a tool for student learning.

Amy described technology as “leveling the playing field” (personal communication, 2001). She explained how teaching with technology had changed her teaching style, specifically with the award of the grant, “I think that … since I got the Gates grant, it’s really changed my teaching because I was a lot more controlling.” While my observational diary has 5 months worth of notations that Amy had the students working in a teacher-directed manner, the last month’s visit showed a teacher who had turned the learning over to the students through inquiry-based learning in which she was the facilitator (see Appendix C). Andy acknowledged that he was something of a controlling person when it came to any kind of perceived lack of control, “I am not comfortable losing the atmosphere of this being an academic setting for a sort of free-for-all use of technology and if I find that I don't know what I'm doing and the instruction starts to break down because of too many glitches, then I will retreat back.” A notation from my observational diary, “While visiting Andy’s classroom I saw a teacher who was mostly concerned with covering the material in the district-adopted textbook,” corroborates his reversion to more novice teaching behaviors and his focus on student behaviors.

Bright Middle School afforded a different lens for how studying data collected in 2001-2002 can inform present understandings of the influences technology adoption has on classroom practice. Brenda integrated technology spontaneously into her instruction. She gave the following example, “A student asked, "Where do [Pennies] come from?" So I go over to the ‘net … and show them the mint. It might be something … as simple as that. Or, something that comes up out of the blue.” Brenda revealed that she felt that what she had was never quite as much technology as she could put to good use in her classroom. Due to her level of expertise, she was allowed to enter the grant for her school at a higher level. My observational diary noted, “Brenda taught classes for the district and had some of her work show-cased in the manual provided for the district teachers who were grant participants.” Contrarily, Betty used the technology in her classroom for drill and practice, or teacher-lead learning (Arends, 2009). She used a district-purchased program that was linked to the adopted textbook for sixth grade math. The video showed that, “For those students who did not correctly answer the problems and were not moving forward in the unit, I noticed some behavior problems emerging.” I observed, “Betty showed the students how to connect several headsets to one computer on the couple instances when the students were using the computers in her classroom.” She expressed concern that she did not know how to use her technology to support student learning as, “I need more instructional knowledge of how to teach, everyday instruction (using computers).”

Crossroads Intermediate School had the highest level of collaboration and it showed in the findings. Cindy disclosed she had become one of the facilitators for an earlier state technology grant so that she could learn as much as possible and obtain another laptop for her classroom (observational diary, 2002). She shared her philosophy of how confidence plays into the integration of technology in the classroom, "You can't teach technology until you have a level of confidence. So there is a very necessary underpinning." Cindy worked closely with the school librarian, who was a participant in the school grant. From my observational diary, “Cindy and the librarian planned lessons together and cotaught them in the library as minilessons so the students had time to complete the gathering of information either from the computers or the printed material available in the library.” She went on to describe how she used technology to support student learning, “It (technology) jells the ideas in a different way. It's not use it for the sake of using technology, but when it really matches with what we are doing.” Cassie stated that she felt she was at the beginning stage of using technology in her classroom. As she put it, " I sometimes think I don't know how to use it, where to go with it." A note from the observational diary supported her thinking, “[Cassie] seemed to have a difficult time pushing herself to build new methods into lesson design that included the use of technology.” Another diary entry gave a glimpse into her observations and how that may have affected her feelings, “Part of this feeling of inadequacy may have come from watching her team members use the computers in new and exciting ways.” She seemed to be comfortable using the technology to support more traditional teaching practices. She described how easy it was to revert to old teaching styles when she felt overwhelmed. “The sad part is time. Our curriculum is loaded. We resort to the more traditional ways of teaching.” I later observed Cassie purposefully planning with the librarian to integrate technology into her classroom time, which is contrary to what she revealed in the interview. Carol realized that technology was always changing, which meant teachers needed to make the commitment to keep learning so as not to fall behind. She was emphatic that the technology needed to be used to support the curriculum as opposed to teaching basic technology skills. “It's not that I'm spending less time, I'm spending time doing different things” (personal interview, 2002). Carol recognized that some students had a lack of access outside school that would put them at a disadvantage; however, she also knew that without covering the curriculum, they would be at a different kind of disadvantage. Carol was especially grateful for the way she was introduced to the computers when she entered the grant, “I think the thing that did it for me was the two-week class, 8-10 hours a day on the computer. By using it 10 hours a day for 2 weeks, it teaches you not to panic.” Moreover, Carol explained, “We met as teachers and compared what we were all doing using rubrics. We wanted to make sure we were all on the same page” (personal interview, 2002). Carol collaborated quite extensively with the librarian in the building, who was also a grant recipient. From my observational diary, “Once permission was granted, some of the students left the classroom for the library. There was a lot of movement in the class, but it was all related to learning.”

Theme: Novice revision. All of these teachers were veteran teachers with at least 8 years of experience in the classroom. Of the eight participants, four reverted to more novice level behaviors when technology was introduced to classroom (Amy, Andy, Betty, and Cassie). Andy expressed that he was a controlling person. Amy said she was more of a facilitator, but my observations did not show that during the first 5 months of data collection. It was only during my last visit that I saw Amy shift from controlling all aspects of student learning to students' controlling their learning. Toward the end of my visits, Cassie showed evidence of creating inquiry-based lessons that integrated technology. Of these four teachers, two were in their first year of the grant (Andy and Betty), and two were in the second year of the grant (Amy and Cassie).

Theme: Teacher self-perceptions and time to implementation. Many of the participants expressed concern about the amount of time it took to integrate technology into their lessons. Five mentioned the amount of time integrating technology took from their classroom instructional time (Cassie, Carol, Betty, and Andy) or their preparation for teaching time (Cindy). Two from Crossroads expressed this in negative terms (Cassie and Carol). Cindy expressed it as a factual consequence that was outweighed by the positive affect it has on student learning. Betty and Andy were both in their first year of the grant.

Theme: Perceived support. Another theme that emerged from the analysis of the data was perceived support. The participants from Acorn Middle School felt the district stance was they had what they had, it was more than most teachers in the district had in their classrooms, and that needed to be good enough (Andy and Anne). Andy mentioned that the technology he received through the grant was, "This classroom I have right here should be the bare minimum, it should be what everyone has as far as technology is concerned." The person who supported the technical side worked for all four schools in the district and was not seen very frequently (notation in my observational diary, 2002). Betty from Bright Middle School commented that she needed to learn how to use the technology for student learning. Specifically, she wanted someone to model this for her so she could begin to emulate those practices. Brenda took care of all of her own technical issues. Her only complaint was that she did not feel she had enough technology in her classroom, but she laughingly disclosed she would probably always feel that way, no matter how much she had available to her. The participants from Crossroads Intermediate School were more concerned about getting additional items to support existing technology (projection device) or getting broken pieces fixed or replaced (Carol).

Theme: Collaboration and openness to learning. Finally, collaboration and openness to learning emerged as a theme. Andy and Amy both expressed they had presented to others within the school in spite of their reluctance to accept that level of expertise. Anne continued to take and give classes outside her school and grant environments. She wrote additional grants in order to get technology that would not otherwise have been available to her. Brenda from Bright Middle School shared her work with the administration for the grant that later became part of a manual for the grant, she taught courses, and she collaborated with others outside her school. Additionally, she read books that would extend her knowledge of different programs and technology. Crossroads Intermediate School offered the widest variation from the other two schools in this theme. All of the teachers collaborated extensively among themselves and with the librarian, who was another grant recipient. Cindy went outside the local school and became a state trainer so she could get additional technology equipment for her classroom.

Summary

The cases were relevant to the findings in the following ways: Theme 1, novice reversion, showed how experienced teachers reverted to more novice level behaviors when a sudden influx of technology was introduced to their classrooms. This information becomes helpful as it informs administration as to the types of support teachers need when there is a sudden change in their classroom environments (Berliner, 1988, 2004) such as an increase or change in technology with an expectation that it will be used for student learning.

Theme 2, teacher self-perception and time to implementation, was mostly a cause for concern among the participants. Four (Andy, Betty, Cassie, and Carol) expressed concern that there did not seem to be enough time to fit in the required curriculum and integrate the technology. The implication of this is an underlying need, on the part of teachers, to have time to muck around with new technology. Administrators can give teachers the luxury of time.

Theme 3, perceived support, meant different things to different participants. The common thread was the need to know they could teach without worrying about the technical side of keeping the technology up and running. Additionally, the participants wanted to know they had access to all the components they needed in order to successfully teach students using technology. The implication was that the participants did not feel they should be responsible for repairing the technology, and, thus, that fell to the school districts to provide that support.

Theme 4, collaboration/openness to learning, was expressed as the need to collaborate with others using technology. They wanted that ongoing interaction in order to reflect on what they, and others, were doing with technology, supporting the need of teachers to work with others, in their school environment, as well as with others outside that environment, in order to move their professional practice forward.

Research Question 2

Research Question 2 asked how does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation? The participants' perceptions, as they relate to professional growth and pedagogy, gave insights into how to work with teachers during periods of rapid technological innovation.

Case 1, Acorn Middle School, gave insights when Anne described her use of tables as, "this is just honed over a lot years of trying it different ways and this is the best use of space." She freely admitted that students frequently worked together after a short period of instruction. During the 13 classroom visits, I saw many instances of short spurts of instruction followed by students working together to cocreate knowledge. Amy shared that the year of the data collection was her first year as the technology teacher. She had helped write a new comprehensive curriculum for her class, complete with a scope and sequence. She described it as "really ambitious." Because this technology class was an elective, she articulated that the students had certain expectations for the level of difficulty. She expressed concern that the technology curriculum did not match her understanding of how technology should be integrated into existing curriculum. Andy, on the other hand, worried about the management issues surrounding the use of technology in his classroom. “It's a two edged sword, while I love the technology I want to make sure that things progress in an orderly fashion.” During the 6 months of my observations, I saw a very controlled, teacher-lead environment. Andy had all of his lessons developed, complete with grading criteria, which went from check-off lists to rubrics. Everything was clearly outlined and delineated for the students. They received full instructions at the beginning of each unit with the expectations clearly outlined.

As noted in the diary, in each instance Anne would make sure she modeled how to find the website using a big screen television attached to one of the computers, wrote the complete step-by-step instructions on how to find the specific information she wanted to students to explore, gave each student a role, and rotated the roles during the time the students were on the computers. Anne verbalized her basic assumption for making learning decisions, "I will assume you can do what I'm asking you to do until you show me otherwise." She felt she was especially good at presenting material in "a hundred different ways so that whatever the way they take in information" they get it. She described herself as trying to come at it (teaching) from a multirange of dimensions. She used technology in the classroom to "suit her purpose," as she put it. While she did not see computers as a toy, Anne did see them as an instructional tool. She stated, “I don't allow them to come in and just do any old thing they want. They're very purpose specific use."

Andy indicated that his teaching style was largely based on verbal dialogue, "A lot of my instruction is based on the type of teacher I am and, a lot of dialogue, I like a lot of dialogue I like to have dialogue with kids." He tended to spend a large portion of the class discussing the points he wanted to make. An except from my observation diary provided support,

> This was very evident in the amount of control Andy exercised over the lessons and expectations he had for the students in his classroom. Andy's lessons were very well organized and left little room for student exploration beyond those expectations he had for his projects. His lessons could be described as predominantly traditional lecture and textbook teaching methods. Overall, learning activities were mostly unchanged as drill and practice type activities were predominantly used with the technology. (2002)

Andy's reliance on verbal discourse in the classroom was validated through self-disclosure and observations.

Whenever Anne had a few additional minutes, she asked the students to get on the computers and search for something that complimented and extended the learning occurring in her classroom. Her statement, "Here's what I did yesterday. We had ten minutes left in class. I said, "Go to the computers, do a Google search for robotics and let's see what we find out." And somebody hit the robot museum on that one. Somebody over here found robotics-dot-com, which had tons of different robots" was reflective of how seamlessly she changed her teaching methods. She continued her line of thinking, “And then, so I, so my next question was, "OK, share your good sites." I mean we're talking moving very quickly. And so everybody had something and I said, "Now tell me some uses for robotics."

There were a few instances in which Anne’s experiences in the grant did not align with her pedagogical beliefs. In spite of no longer being a part of the training with Gates grant, she mentioned the trainer’s heavy reliance on PowerPoint as a way to use technology in the classroom. At no point did I witness the use of PowerPoint in Anne’s classroom. When asked, she related that she did not feel the use of that program lent itself to inquiry-based learning.

Amy reflected on her thoughts about technology in the classroom as it related to differences in how the students interacted with her: “The technology changes how kids work and there's no room for you. You have to step back. They're interacting with a machine not you, with whatever they're doing. You have to be supportive. You can't be the leader.” As she articulated, Amy felt she needed to allow students to explore while she supported their learning. Her understanding was contrary to the first 5 months of observations as she always used the projection device to teach the skill while the students followed along. Finally, during the last week of observations, I witnessed a change in Amy’s teaching. She created and taught a unit that allowed the students control over their learning as they worked to dramatize nursery tales using iMovie. She became the facilitator. This more closely matched her expressed pedagogical beliefs as related in the interview.

Andy thought that because students can complete certain learning tasks quicker using technology that they could make the connections between what they were learning in more meaningful ways, “We're able to do that on the paper graphs, but we're also able to use the spreadsheet to find our percentages, then immediately build graphs that are very visually appealing, very accurate.” However, this was not observed as part of his classroom practice. During one visit to Andy’s classroom, the students were working on PowerPoint presentations in a portfolio type format. Each student worked for a short period of time on the computer after they had completed all of the assignments on paper. From my observational diary, “This meant that those students who worked slower than the majority of the class, or who did not understand entirely how to complete each section, did not get a chance to use the computer for more than the rudimentary set-up of their presentation.” As there was little instruction on the use of the program, any student who did not know how to use PowerPoint spent most of their time trying to figure out how to use the program as opposed to advancing their understanding of the instruction (science units).

Anne occasionally collaborated with other sixth grade teachers as she had time. The most notable observation occurred when she planned a unit that would be using Excel spreadsheets and wanted to ensure the students knew how to use the program, so she corroborated with the technology teacher, who was also a grant recipient and a participant in this study. Toward the end of the 6-weeks period for the elective course, I observed Amy teaching the presentation component of ClarisWorks to the students. She gave them the rudimentary skills so they could begin, which took a class session of 53 minutes, then for the remaining three visits, she had the students work on a presentation that coordinated with assignments from either their science or social studies classes.

Andy discussed that he felt one period a day was not enough time to get to know the students in his classes and to recognize their learning styles. He went on to explain that, “my interaction with these students is very limited. I have a lesson to teach, and I can't really slow it down.” He felt that this was an injustice to his ability to connect with his students.

Bright Middle School contributed to understanding teachers’ perceptions of professional growth and pedagogy as a way to help inform present ways to work with teachers during periods of rapid technological innovation when Brenda described her classroom as busy and noisier that most people would accept, “I have a very flexible classroom. A lot of times it's very noisy but there's a lot of learning going on.” She was comfortable with her classroom and how it ran. She expanded by saying, “It's very flexible and I think if we get off on something and it goes somewhere else and we learn, that's fine with me. I'm flexible enough to make changes that are necessary for different learners.”

Betty described her normal mode of operating as beginning by teaching the concept in the same manner to all the students in the class. Once she had finished with the instruction, she would then re-teach the concept to the students who needed additional assistance, “The first go round of instruction is the same for everyone. Then I will pull the students … and do it differently.”

Brenda gave her philosophy of technology integration, "I think it can work really well if you know how to do it correctly. I think everyone can learn from each other. See, for me, computers are just a natural part (of teaching). It's like a book." During my visits to Brenda's classroom, I observed multiple instances of the computer being used to answer questions, show a point, and integrate learning in other manners. Frequently, the class would meet to see something on the computer projection device, then go back to their work at their tables. Betty described her philosophy of technology integration, "For me, using computers, calculators, anything that gets the concept to the student" (personal interview, 2001). Every 3 weeks, during her assigned rotation into the computer lab, Betty took her math class to work on RiverDeep, a purchased software program that complemented the textbook. I saw two instances of students using the computers in her classroom and, in both cases the students were using the RiverDeep program. Those who used the computers in her classroom were those who finished the assignment early, thus giving preference to those who had the greatest potential of mastering the material being presented.

On many visits the students asked questions that Brenda could not (or chose not to) answer. Her response was always to say, "Let's look it up." For Brenda, this did not necessarily mean in a book. From my observational diary, "Brenda would get online, put the question to the test, and begin to see the results from the search." She always did this using the projection device, and allowed the students to assist her in determining which of the possible hits/locations from the search engine would give them the best answers to their particular questions. If Brenda wanted to make a point for the use of technology for learning, and how to begin to recognize sites that would give information that could be trusted, she would hop on the computer and ask questions as she began to find the answer. “Brenda let the students lead the search, asking why they wanted to go to one site as opposed to a different site” (observational diary, 2002). In this manner, she taught searching skills as well as how to evaluate sites depending on the purpose of the search.

Brenda was very aware of the needs of the individual students in her classroom because, as she confided in me, she was somewhat dyslexic, and understood the frustration and stigma that can be associated with that

> I think that my biggest strong point is, first of all, being that my background is being dyslexic, I have a greater understanding of how it is to have learning disabilities and don't necessarily peg them into holes that "this is where they're at and that's where they'll stay" because it's not true.

She stated, “I'm very much a person that wants people to grow a far as can as an individual in whatever they're doing. I have a lot of flexibility that way and, I think I'm really good.” She explained her use of inquiry-based teaching methods, “I use a lot of cooperative groups where people learn from other people and I think that's really good for people that have learning disabilities because they can gather information different ways.” Furthermore, Brenda indicated that she strove to meet the needs of all students by presenting information in a variety of ways, “I think all of them are just as individual as any other individual student in your class. You take that all into consideration. That's just the same.” Students engaged in collaborative, inquiry-based learning approximately 75% of the time I spent in Brenda’s classroom during 13 visits over a 6-month period (observational diary, 2002). At one point during my visits, Brenda had the students cluster around the computer so she could show them how to access the US mint prior to letting them look up information for a project.

Brenda shared her collaborative experiences with the grant, "Last year part of project Century I I had to teach 15 hours of classes for the district. I'd always do PowerPoint. I've had a camera class. I did a scanning class." Betty expressed the following frustrations as it had to due with her ability to integrate technology into her curriculum,

> What I'd like to be able to do and can't is use it in my classroom for instruction. I know there's got to be people, others, who can just use it and know where to look (to get assistance).

For her, she did not feel she was supported or that others were offering to collaborate with her to advance her learning.

Crossroads Intermediate School offered the following findings, which were a little different. Cindy related that she found that she used a variety of teaching tools to get at the learning, that the most important thing was to make learning motivating and reach each student. She described the use of technology as one such vehicle, "Sometimes when they are dispersed at different points in the curriculum, it can be motivating because it presents it in different ways (of getting at the main point)." My observational diary included that Cassie frequently used cooperative learning groups as an avenue for learning. On one occasion, she had the students working together to create dioramas of the different living styles of the Native Americans found in the early 1600s. Each student has a role, but each group was expected to collaborate with all students participating. It was obvious from my observations that this type of learning was a frequent occurrence as the room had a low-level buzz as the students worked together with minimal assistance from Cassie. Carol recognized that her students came to school with varying skill levels. She stated, “We have to keep learning. You can't rest on your laurels. There is always something else” (personal interview, 2002). She elaborated with,

> You don't want to take the time to teach tech skills. We have a mandated curriculum we have to cover. We spent so much time teaching them how to turn the computers on and off, that we don't have time for the other. (personal interview, 2002)

Cindy found that she could, after 3 years of learning through various technology grants, begin to integrate the technology in a variety of ways. She commenced with how she used it for planning. “The ideas are endless - I found things I wouldn't have found under other circumstances.” She further expounded, " in fact sometimes I m overwhelmed by how much is available for planning." She described how she felt when the students were working on the computers, “It is so thrilling to hear everyone tap, tap, tapping on the computers. Everyone is being productive.”

Cassie revealed that she felt technology was a valuable tool, and that she used the computers in her classroom mostly for research and writing.

> I think it's basically where I need to grow. It’s a tool for writing. We have the children used the "Inspiration" program for webbing. We work collaboratively

> with xxxx [the librarian], or XX [the reading specialist] will come into my classroom, especially during Social Studies, and work with a group of children.

She articulated that she had increased her learning from watching the special education teachers' work with the students on their caseloads in her classroom.

> Essentially what we have done is create programs at different grade levels based on the needs of the children, we, at the fifth grade level, have always had a good relationship with the special education staff, at fifth grade, this has always been true.

Carol has learned to solve problems for herself.

> I'm pretty at ease with it. For what I do in here, … That is my biggest thing, when things don't work, what do you do? I've found if I go through the trouble shoot, it will fix itself. As for as the Word, I feel comfortable, the web pages, I feel comfortable, the things I do in here, I feel comfortable.

> Carol explained some of the different ways she used technology in her classroom,
>
> We usually have four news reports every day. They go online and find a news story. We use it as part of their oral presentation. They have to stand up, introduce themselves, and tell the important parts of the story. They have 15 minutes to pull that off. And, two people go to the Providence Journal and two to USA Today. They love to do this. (personal interview, 2002)

In this manner, Carol was using the technology to support life-long learning practices while ensuring the content in the curriculum was covered.

As she disclosed in the interview, Cindy made sure the students with special needs were the first to use the computers in her classroom. She said, "Because I have the computers, I can always give the priority to the special ed. kids." The students worked in groups for most of their assignments, which were inquiry-based. Cindy had reading circles, discussion groups, and a variety of cooperative learning opportunities. The 15-minute video of Cassie's students working in groups using both the technology (Internet searches) and their journals to access prior knowledge and construct new learning as they completed presentations about the Revolutionary War. All students had a chance to use the computers in the classroom, those who asked were granted permission to go to the library, and those at their desks were working productively. The students worked on each part of the activity at times individually, and others as a group.

Carol described her integration of technology into the classroom to support student learning. She explained, new teachings and learning practices continuously emerged many times due to collaboration with others. During the 6-month period of this investigation, I observed Carol's classroom as a busy learning environment. She frequently had the students working in groups trying to solve hypotheses they had developed. When Carol's class went to the library to conduct research, each student was paired up and the research was conducted either on the computers, or in books, depending of the desires of the students. Each student wandered back and forth using the books in some instances, and the computers in other. There seemed to be a seamless flow between the use of printed material and the Internet. All students seemed to be comfortable using both media.

The 15-minute video of Carol's classroom showed the students working on their science fair projects. Many of them were coming and going out of the classroom as they went to the library to use the resources there. The students in Carol's classroom were all busily working, some at the computers and some at their desks; some of the computers had two students working together, some had individuals. All students worked on the tasks, discussing among themselves.

The four themes, novice reversion, teacher self-perception and time to implementation, perceived support, and collaboration/openness to learning emerged again from the findings of research question two. While not every theme was evident for every participant, they emerged as those areas of greatest significance.

Theme: Novice reversion. Novice reversion was evident in the observations of Andy's instructional practices. His teaching style was mostly lecture, and, as he expressed, he would withdraw from using technology in his classroom if he felt it was out of control. Amy's perceptions were that she fully understood how to integrate technology into her curriculum in ways that added value to student learning, but that was not immediately evident in her teaching practices. It was not until the final week of observations that I witnessed Amy using student-centered teaching practices as the students used technology in her classroom. Betty expressed frustration that she did not know how to integrate technology. She used RiverDeep, a software program that was purchased by the district for additional student practice, as her sole integration of technology. Cassie stated she felt she did not fully understand the nuances of integrating technology into her curriculum and that her typical response would be to revert to previous styles of teaching.

Theme: Teacher self-perception and time to implementation. This theme emerged through comments and observations of the teacher participants. Amy conducted each lesson in the same way by modeling the use of software several times while the students followed along. Variations in her teaching were not witnessed until the last week of observations. Betty expressed that she taught all of her lessons the same the first time, and then would work individually with those who needed the additional assistance. Her perception was that she was reaching all of her students. Andy had a regimented style of teaching that was mostly dialogue-based. His integration of technology was rudimentary and followed the same format each time students used it in his classroom. He expressed that he wanted to know how to use the software prior to allowing students to use it. He also lamented that he had to give up several of his weekends each year in order to be part of his grant. I saw little evidence of change in his teaching style as a way to reach all his learners.

Brenda's perceptions were that she could spontaneously integrate technology into her curriculum. This matched my observations. When students asked her a question, she immediately defaulted to the computer as a way to gather information. Anne expressed concern that education did not have enough knowledge about how to reach all students, but she felt she got at teaching through a multitude of ways, and that was effective for her. Observations of her classroom revealed a teacher who could model technology use effectively and in a variety of ways to match the needs of her students as she differentiated instruction to meet the needs of all students in her classroom. Cindy used her technology extensively for planning. She mentioned there was so much available for her, that occasionally she spent hours exploring the Internet for material for her classroom. Cindy commented that her classroom could get a little noisy while she was working at setting up the technology. Observations revealed that her students were working and seamlessly went from using technology as directed by Cindy to the previous task. While using technology, her classroom was engaged in their learning, which was not different from any other observational period during the six months.

Cassie, on the other hand, verbalized she did not feel she knew how to use the technology, however, my observations showed a teacher who was using it for student learning. She did feel she was able to accommodate all of her learners. Carol explicitly stated that she felt it took quite a bit of time to integrate technology into her classroom, and she worried there wasn't enough time to cover the curricular expectations and integrate technology into the lessons. She disclosed that she wanted to use technology as she felt that added value to student learning. Furthermore, she discussed how her background as a special education teacher allowed her to work effectively with all students.

All of the teachers recognized that technology added value to student learning. Unfortunately, not all of them understood how to make that happen. Of the eight participants, the two who were in the first year of the grant (Andy and Betty) exhibited the highest level of frustration with using technology and were the most likely to withdraw from using it when they were unsure of how to use it. Those who had more experience using technology (Anne, Brenda, and Cindy) used it as a tool to support student learning in a more seamless manner.

Theme: Perceived support. Perceived support revealed Andy did not feel one period a day was enough time to get to know his students. He went on to explain that, "my interaction with these students is very limited." Brenda worked to meet the needs of all students in her classroom by presenting her lessons in a variety of ways. Betty expressed the following frustrations as it had to due with her ability to integrate technology into her curriculum. She felt certain there was someone who could work with her in a mentor capacity. Cassie credited the support staff as having the greatest impact on her learning to work with students in her classroom. Carol used the technology to support student learning. Pedagogically, the participants were evenly split as to those who didn't feel they were reaching all of their students (Andy and Betty) and who felt comfortable using technology for student learning (Brenda and Carol). Cassie's responses indicated she felt she was reaching all her students, just not necessarily through the use of technology.

Theme: Collaboration/openness to learning. This theme emerged through Amy's desire to collaborate with content teachers, but felt she was not allowed to do that based on district expectations for her elective course in technology. Andy had students working in a preprescribed manner, including when students were using technology. Andy did not instruct students on use of programs and no allowances made for those who worked at a slower pace (they actually had less time on the computers). Benda's students spent approximately 75% of the time engaged in collaborative, inquiry-based learning with 30% spent using technology. Cindy wanted all of her students with special needs to have the first opportunity to work with technology as she felt it significantly supported their learning. Carol explained that new teachings and learning practices continuously emerged many times due to collaboration with others. Cassie's collaboration with the librarian was so ingrained in her teaching practices she did not consider it important enough to remark on it.

Summary

The cases were relevant to the findings in the following ways: Theme 1, novice reversion, showed how experienced teachers reverted to more novice level behaviors when a sudden influx of technology was introduced to their classrooms. After the participants had been involved in the grant for about 2 years, their classroom behaviors more evenly matched their classroom perceptions (see Appendix C). This information becomes helpful as it informs administration as to the types of support teachers need when there is a sudden change in their classroom environments (Berliner, 1988, 2004) such as an increase or change in technology with an expectation that it will be used for student learning.

Theme 2, teacher self-perception and time to implementation, was mostly a cause for concern among the participants. Five (Andy, Betty, Cassie, and Carol) expressed concern that there did not seem to be enough time to fit in the required curriculum and integrate the technology. The implication of this is an underlying need, on the part of teachers, to have time to muck around with new technology. Administrators can give teachers the luxury of time.

Theme 3, Perceived support, as it has to do with pedagogy, meant different things to different participants. For this research question, the perceived support had to do with how the participants could work with their students for learning. The implication was that the participants wanted all students to be successful in their classrooms.

Theme 4, collaboration/openness to learning, was expressed as the need to collaborate with others using technology. This included mentoring and modeling type interactions. The participants from one case collaborated so frequently most of them did not feel it was worth mentioning. Evidence of openness to learning was expressed and observed as how the participants worked with their students. In five instances, the majority of each observation showed on-going collaboration among the students in the classroom. In two instances there was little collaboration among students, and in one instance, there was a change at the end of the study in which the participant went from little collaboration among students to almost total collaboration among the students.

Research Question 3

Research Question 3 asked how can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced? Secondary analysis of historical data allows for insights into those general support systems teachers feel they need in order to successfully integrate technology into their classrooms. By identifying common areas of success and concern at the time when computers were hitting critical mass in public schools, it is possible to tease out those that continue to exist in today's schools. The perceived needs of teachers remain the same as was established in the review of literature.

Case 1, Acorn Middle School, revealed needed supports as demonstrated through the perceptions and professional behaviors of the participants. The participants shared their experiences willingly in their attempt to understand for themselves what has worked for them and what they would like to have seen in place as they experienced the sudden influx of computers into their classrooms.

Anne freely admitted she was only slightly comfortable with word processing software, although, she stated her "daughter is an editor and assisted me when I got stuck." As Anne integrated technology into her classroom, she recognized the sheer volume of time it would take to teach certain programs. One way to avoid this was to wait until all of the students had received instruction on Excel spreadsheets during the technology special class before she began her unit on nutrition. In this way, she did not have to spend time teaching the program, but could immediately put the application to work in her classroom in a more practical manner (Observational Diary, 2002).

During the first ten visits to Amy's classroom, I saw a very controlled environment (observation diary, 2001 – 2002). Amy was teaching technology to all of the students in the school. She had helped write the district technology curriculum, and, as she explained, it did not leave much room for creativity. She described it as, "a forced march through the basic programs."

During the 15-minute video of Andy's classroom, students were working on PowerPoint presentations. Each student was given approximately 10 minutes on the computer before it was another student's turn. There were a number of students, who never got to work on the computers as they were struggling to complete the paper portion of the assignments. Some students spent the entire time trying to figure out how to begin the PowerPoint presentation, as they didn't have the skills to manipulate the program.

Andy felt he made reflective, context specific decisions about his teaching as evidenced by his statement, "If the computers are going to help me to the ends that I see most important for students, then I am very comfortable using them. If it's not, then I also don't have a problem setting them aside." He further implied that while he knew what he should be doing with the technology in his classroom to make learning more successful for all of his students, that because of his personal inability to have a classroom that he perceived as being chaotic, he would postpone or cancel the project rather than risk losing control

Amy recognized that her school, district, and students were not ready to embrace that level of integration when she said, "They actually try to go to the lowest common denominator and we'll still give them the skills." She expressed a level of hesitancy to use her knowledge in ways that engaged student learning around content level curriculum due to district expectations by articulating, "So I gotta say that everything I know is about integrating curriculum and yet this kind of program is not integrating at all. So, it's a fine line to walk." Andy expressed another kind of frustration with his district, as the message he was getting from the administration was that he should fell lucky to get the technology from the grant and not to expect anything else provided by the district. The reason this was bothersome to Andy was he had to take personal days to attend the required grant training.

During my last set of visits to Amy's classroom, I saw a teacher who was facilitating the learning by letting students explore their creative options (observation diary & video, 2002). This was a substantial shift in Amy's teaching behaviors. Amy was available as each student needed assistance, but she did not give unsolicited advice. The students were actively involved, made all decisions, and made cuts and transitions after collaborating as a group to determine the best portrayal of their nursery rhyme. She became the facilitator, just as she stated in her interview ("You have to be supportive. You can't be the leader"). After making sure the students had written their nursery rhymes, and knew the basics of how to work a digital camera, she gave them total control over what they wanted to record, edit, and produce.

Andy described his collaboration with his collegial peers as "presenting an in-service on a grade book program" he had written. He disclosed that, "it probably wouldn't work on most of the computers in most classrooms in the district."

Case 2, Bright Middle School, provided insights into supports systems the participants felt they needed as technology in education was introduced. Examples of how technology was used were demonstrated through an entry in the observational diary, "The students in Brenda's classroom took turns looking up facts from the Lewis and Clark Expedition. Once they had looked up their fact, they reported it to the class." All students had an opportunity to find an unusual fact and report it out to the class, either individually or with a partner. The students spent time at the tables working and when they needed to look something up on the Internet, they would get on a vacant computer and find what they needed, then return to the table.

Brenda expounded her openness to learning, “I was, you know, techie enough you can just jump to (level) four. We had to videotape ourselves teaching a lesson using the technology and we had to assess ourselves. That was one thing.”

Betty expressed her frustration with the lack of technical assistance provided by the district. She felt, for the amount of money the district spent to equip the schools with the technology, it was woefully under-equipped with technical support.

> For example one of these computers had a disk stuck in the disk drive. And nobody could come out until next week so no one can use the computer until they can come out. Also, today I got new mouses, which I have been asking for for 3 months.

Betty informed me that she would begin her professional development opportunities through the grant at the end of the school year at which time she would have 8 hours of instruction. She stated that she had not had any additional technology classes since she left college.

Case 3, Crossroads Intermediate School, was a bit of an anomaly. Due to the sheer volume of collaboration that occurred among the staff, it presented itself differently with different findings and needs.

Cindy indicated that it was easy for her to see how to present the information in a variety of ways so she was reaching each student in her classroom. One way she did this was through the use of the technology. She stated, "often technology is a vehicle for children as the way instruction and learning can take place." Carol felt that technology needed to be used as it made sense. As she described, " It goes in when it fits." She recognized that collaboration was important for using technology. She felt it was important to "learn from each other and to help each other out."

During one series of observations in Cindy's classroom, the students were asked to research one person who lived in Pre-Revolutionary War America. Cindy had the students research a key figure from the Revolutionary War era on the computer, write an oral book report, and dress in character to present it while being digital video taped. On another occasion, Cindy took the students to the library for a Revolutionary War scavenger hunt. Half of the groups used only online resources and the other half used only printed sources found in the library. A note from my observational diary shared Cindy's acknowledgement that, "this was the first year the students who were on the computers had gathered more answers than the students using printed resources."

After school, Cassie discussed with me how she sometimes worries that she is not using the technology to her best advantage in her classroom. We discussed how she uses it for research and to answer student questions. She reflected that she would like to find additional ways in which to add value to the students learning, while making sure she covers the content required by the district.

Carol expressed concern that the sheer number of students in a general education classroom was making learning more difficult for different learners because, as she stated, " It's not that the students can't work in your room, it's that you can't get to them to give them the help." In spite of this, of the students in the classroom, there were times when approximately half were on the computers with the other half worked at their desks on projects.

When Cindy started participating in the Wonders Classroom Grant, she had very limited familiarity with technology. She was only slightly comfortable with word processing software and had never used email. She forced herself to become a state trainer so that she could learn the technology as quickly as possible.

Within her classroom, Cassie acknowledged that her students taught her a lot about computers. She felt they were not afraid to use it and in fact, had taught her about technology.

> The children are so good at the computer that I have learned al lot. We have access to lots, and they (the students) are not afraid. They have a tendency to dive right in.

She was not afraid to let them teach her.

Carol described that because of the support she received from the librarian, who was also awarded a technology grant, most of her integration of technology was done in a cotaught manner in collaboration with the librarian.

Students in all three classes went to the computers to look up information as frequently as they looked up information in their textbooks. Many times this occurred in the library so the students had more opportunities to receive support from additional adults, namely the librarian, who was also a grant recipient. Students returned to the classroom with the information they sought and continued with their learning/project.

Cassie did not seem to take into consideration the amount of collaborating she did with her team, others in the grant, and the librarian. While she discussed some of that in the interview, it was more off-handed. When it came time to observe, I witnessed a group of educators who were constantly collaborating with each other around the curriculum and about how to integrate technology into that curriculum. Students were constantly moving among the rooms in order to take full advantage of both the expertise of the participants and the available technological resources.

Carol indicated she felt very lucky to have that support and the support of others who put their individual time into learning and sharing their expertise with her. She stated, “A lot of people learn on their own and share. There are 5 or 6 people in this building who share a lot” (personal interview, 2002). Carol stated in the interview that she frequently took advantage of the librarian, and the observations confirmed that this was, in fact, true. Whenever Carol had the students working on research several would go across the hall to work in the library. The students walked back and forth across the hall to the library to work on the computers after a brief minilesson that covered the area to be researched.

Theme: Novice reversion. Novice reversion emerged in a variety of ways. Three of the participants (Amy, Andy, and Betty) were observed teaching in more traditional teacher-centered practices even though all eight of the participants verbalized their perceptions as they were using inquiry-based student-centered teaching practices. Amy was the only participant who clearly articulated that she was held to a curriculum, that she helped write, that was contrary to her beliefs about how to integrate technology into classroom curriculum. Two of the participants indicated they would abandon the technology part of a lesson or revert to other teaching methods if they were uncomfortable (Andy and Cassie). Four of the participants (Anne, Brenda, Cindy, and Carol) were comfortable weaving technology into their classroom teaching.

Theme: Teacher self-perceptions and time to implementation. This theme emerged for this research question as time it took to use the technology. Three participants (Anne, Cassie, and Carol) lamented at the sheer time commitment it took to teach certain programs. One (Anne) got around that by waiting until her students had been taught the program she wanted to use in another class. One participant (Cindy) discussed time to implement from a planning point of view. Four of the participants (Anne, Amy, Brenda, and Cassie) became facilitators and allowed the students to teach them.

Theme: Perceived support. Perceived support emerged as the level of perceived support that affects advancement through the stages of technology innovation. One participant (Cindy) revealed she had forced herself to become a trainer for her state in order to learn and become comfortable using technology. All three participants from Crossroads Intermediate School collaborated frequently with their colleagues around student learning and the integration of technology. Brenda was a frequent trainer for her district, and Anne worked with those in her school and district. Contrarily, Amy and Andy lamented that the district did not seem to support their efforts in a manner that would help move them forward in their professional practice. Betty expressed hope that she would get some kind of support in the form of a mentor who could show her how to integrate technology into her existing curriculum. An undercurrent through all participants' dialogues was the lack of technical support offered by their schools and districts.

Theme: Collaboration/openness to learning. Finally, collaboration and openness to learning emerged as an issue of trust and interaction among teaching professionals. As the participants progressed through the grant, they become comfortable with their own teaching. They allowed students to teach the teacher, engaged in dialogue and work with colleagues, and allowed for a free flow of student movements.

Summary

The cases were relevant to the findings in the following ways: Theme 1, novice reversion, showed how experienced teachers reverted to more novice level behaviors when a sudden influx of technology was introduced to their classrooms. This information becomes helpful as it informs administration as to the types of support teachers need when there is a sudden change in their classroom environments (Berliner, 1988, 2004) such as an increase or change in technology with an expectation that it will be used for student learning.

Theme 2, teacher self-perception and time to implementation, was mostly a cause for concern among the participants. Four (Andy, Betty, Cassie, and Carol) expressed concern that there did not seem to be enough time to fit in the required curriculum and integrate the technology. The implication is that this may offer insights into how to encourage teacher to engage in more inquiry-based teaching behaviors in their classrooms as future innovations are introduced into schools.

Theme 3, perceived support, meant different things to different participants. As revealed in research question one, the most common thread was the need to know they could teach without worrying about the technical side of keeping the technology up and running. Additionally, the participants wanted to know they had access to all the components they needed in order to successfully teach students using technology. The implication was that the participants did not feel they should be responsible for repairing the technology, and, thus, that fell to the school districts to provide that support.

Theme 4, collaboration/openness to learning, was expressed as the need to collaborate with others using technology coupled with professional development opportunities. As the participants progressed through the grant, they become comfortable with their own teaching. They allowed students to teach the teacher, and allowed for a free flow of student movements. As revealed through the findings, collaboration must exist in order for this to occur. They wanted that ongoing interaction in order to reflect on what they, and others, were doing with technology, supporting the need of teachers to work with others, in their school environment, as well as with others outside that environment, in order to move their professional practice forward.

Among Case Comparison

In comparing the three schools examined in these case studies, there is substantial evidence to support critical areas of similarity. All three schools had principals who had been involved in their schools/districts for close to two decades each. This gave them, their faculty, the community, and the major stakeholders for the school a level of comfort and familiarity that may not have otherwise existed. The principal from Acorn Middle

School had been there for 17 years, the principal for Bright Middle School had worked at the elementary school that fed the middle school for 19 years prior to moving into the administrative position at Bright, and, finally, the principal at Crossroads Intermediate School had been in that position for more than 15 years. In all three cases, the principals knew the teachers, parents, and students in their schools and called them by name when speaking to them. The principals lived in the community that fed into the schools. All three principals expressed interested in this study, and wanted to hear the outcomes when they were made public.

The three schools were in locations that were above the national socio-economic levels. In spite of that, there were discrepancies among the socio-economic levels of the students at all three schools. Carol worried about those who did not have access to computers at home and how that would eventually cause them to be left behind in some manner. Additionally, all three school districts supported teacher involvement in the technology grants offered in their states. This support was expected as part of the grant, so it is unclear as to the level of additional support the teachers could have expected if they had not received the grants.

There were some differences among the schools that affected the perceived level of success each teacher participant. Acorn School was seen as a school that did not readily embrace new ways of teaching. While walking around campus, it was evident that many of the classrooms were set up in rows with the teacher as the “sage on stage” (Observation Diary, 2001). The electives offered to the students were stand alone and typical of what were offered throughout the 1900s. Elective examples would include wood shop, music, and band. The only exception to that was the technology class required of all sixth grade students, and, as expressed by Amy, it was not integrated into the curriculum and did not consist of what she knew, from her Masters program, as good teaching practices for teaching technology.

Bright School, on the other hand, offered a wide-range of electives that integrated technology into the curriculum. There were MCAD courses, a course that resulted in daily televised news within the school, and other electives that were modern and integrated technology into both the elective course, but could be used in future employment. While walking around campus, it was apparent that the teachers used student-centered educational practices (Arends, 2009). Students were frequently working together and the student work areas were set up to allow three to five students to work together. I saw teachers lecturing at the front of the classroom infrequently.

Crossroads School more closely resembled Bright School. Although Crossroads did not have electives one would expect to see at the middle school level due to its intermediate school status, there was free movement of students around the school that more closely resembled the middle school model (Van Til, Vars, & Lounsbury, 1961). Students moved among classes during all parts of the day. As mentioned earlier, teachers collaborated extensively with the librarian, and from that collaboration came free movements of the students among the classrooms in their quest for knowledge. Many of the classrooms had student work areas set up to encourage collaboration. Students were encouraged to move their chairs if that made collaboration and learning more accessible to the students.

Evidence of Quality

Historical data being analyzed in this dissertation were collected from three distinctly different sources: interviews, observations, and videos in order to triangulate the data to identify emerging themes and show evidence of quality. Data were collected through initial interviews with each of eight teachers, followed by 13 visits to each of their eight classrooms during which an observational diary was kept, and a 15-minute video was collected in each classroom of students using technology in some manner.

The original analysis occured in three phases.

1. In the initial phase, I analyzed teachers' perceptions about classroom use of technology and working with students. I grouped teachers by years of participation in the particular grant in which they were awarded through outside funding sources.
2. I examined the ways in which teachers used technology and whether that matched their perceptions of their teaching using technology for student learning.
3. Drawing on multiple data sources, I identified patterns both within and across groups. This analysis occurred to detect recurring themes. The stages of teacher technology adoption (Sandholtz et al., 1997) was used to analyze data from the participants to provide a matrix for teacher development.

The text was de-contextualized and a content analysis was performed on the data. Open coding occurred using the characteristics specific to stages theories that consider professional practice. A Thematic Conceptual Matrix was constructed for each participant to indicate stage of adoption (Sandholtz et al., 1997) and level of teacher leadership (Riel & Becker, 2000). These findings are included in the individual portraits found in Appendix C. An analysis of this matrix through clustering allowed for emerging themes. Cross-case analysis increased generability and reassured me that the events and processes that occurred during the time computers were hitting critical mass in U.S. schools is not idiosyncratic to one setting. Drawing on multiple data sources through visual displays, I looked for patterns both within and across groups (Yin, 1994, 2008). Data were sorted by stage theory, emergent themes, and across individual participant in order to assure accuracy of the data analysis and create evidence of quality.

As part of the reanalysis in 2010, current research was used to support or disclaim findings and/or add a layer of understanding to the mostly unanswered question of why teachers are not using technology in the manner it was intended in U.S. public schools. Each portrait was reanalyzed in order to determine if the original findings could answer the new research questions. Analysis occurred by source (interview, observation, and video), triangulated by participant, and decontructed by research question. Once the research questions were organized by case, it was possible to determine patterns and emerging themes. Through the reanalysis of the data, commonalities were identified and four main themes emerged. This analysis can be found in Appendices C and D.

Chapter 5: Discussion, Conclusions, and Recommendations

This study sought to capture a historical view of technology integration in 2001-2002 by analyzing the process of technology adoption of teachers who experienced it when computers were hitting critical mass in U.S. public schools (Education Week, 2005, p. 8; U. S. Census Bureau, 2003) and comparing that to recent research that supported or questioned how teacher perceptions as they related to professional growth and pedagogy informed ways to work with teachers during periods of rapid technological innovation (Ware as cited in Few, 2007, p. 2). Teacher perceptions and professional classroom practices were analyzed for the purpose of informing present and future technology innovations. Data collected during the period when computers were hitting critical mass in U.S. public schools provided insights into the development of successful support systems for teachers as new technological innovations in education are introduced.

Researchers have tried to address why many teachers are not using technology in their classrooms for collaboration in a way that supports student learning (Li, 2007; Zhao & Frank, 2003, p. 807). Hihlfeld et al. (2007) reported only 4% of students' use of technology involved collaborating on real-world problems with students using computers, while 59% of the time was spent on testing and skill practice. Wei et al. (2008) found many teachers were still at the beginning stages of technology integration with only minimum changes in educational practices occurring in the past 10 years. Insight into the perceptions of teachers at the time in history when computers hit critical mass in U.S. classrooms provided insight into the adoption process of teachers today and in the future as they integrate emerging technologies into their classes. The professional behaviors as they relate to perceptions became even more worthy of further study when discussing the integration of technology in the classroom because teachers' perceptions of how effective they may be could affect the degree to which they use it (Cheung, 2002; Wei et al., 2008; Zhao & Frank, 2003).

Qualitative data that were collected in 2001-2002 were reanalyzed in order to compare the findings to more current research (2004 - 2010). This qualitative, three-case study was designed to examine, document, and describe the schools and the eight teachers' professional practice and knowledge (Connelly & Clandinin, 1988, 1999) of technology use in their classrooms. It aided in determining the extent to which teachers' perceptions of their abilities to use technology were consistent with observed performance in classrooms at a time in history when the introduction of computer technology hit critical mass in public schools. The data were collected from three distinctly different sources (interviews, observations, and videos) in order to triangulate the data and show evidence of quality. Additionally, cross-analysis of the cases occurred in order to ensure any single case was not an anomaly (Yin, 1994, 2008).

A secondary analysis of historical data (Glass, 1976) collected in 2001- 2002 occurred for the purpose of answering new research questions with the previously collected data. The perceptions and feelings of the participants (2001/2002) were explored and analyzed against current research (2004 - 2010) that investigated reasons why technology has not been embraced by teachers (Hihlfeld et al., 2007; Wei et al., 2008). From this analysis, new knowledge was produced (Bornat, 2008). The findings can assist policy makers and staff developers in 2011 in better understanding what supports teachers need in order to successfully adopt emerging technological innovations, and respond to the technological demands society places on schools.

The lens for the secondary analysis of historical data was focused by the following research questions:

Research Question 1

1. How do data from a study of teachers' use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice?

Research Question 2

2. How does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation?

Research Question 3

3. How can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced?

The reanalysis of the historical data allowed for themes to emerge which, when compared to the review of literature and recent research, lent new findings as to the perceptions of these teachers who experienced this sudden influx of technology when computers were hitting critical mass in U.S. public schools. This was used as the basis for the structured guide tool.

This three case qualitative study comprised of eight participants from three schools from three states in the United States. Data were collected over a 6-month period and included semistructured interviews, an observational diary of 13 classroom visits for each teacher, and a 15-minute video taping of the classroom. This chapter includes an interpretation of the findings with a comparison to recent research collected through the review of literature, educational significance and impact that includes a structured guide that can assist policy makers and staff developers in 2011 in better understanding what supports teachers need in order to successfully adopt emerging technological innovations, and respond to the technological demands society places on schools. In addition, a reflection of my experience with the study, along with implications for social change and recommendations for further study are presented. A closing statement concludes the chapter.

Interpretation of Findings

When the findings were analyzed and compared to recent research, there were some underlying commonalities. During the time when computers were hitting critical mass, researchers (Apple, 2005; Penuel, 2006) discovered a problem with the acquisition and implementation of new technology. Contrary to the findings of Donovan et al. (2007) who found that most teachers during the time period when computers were hitting critical mass in U.S. schools were not consulted as to their desire to have computers in their classrooms, all of the participants in this study willingly volunteered for the grants that gave them increased access to computers and professional development. The analysis of the data showed that, in spite of this positive feeling about technology, these participants had similar concerns that teachers have expressed in recent research. However, these participants' articulation of their experiences offered some ideas as to how to move teachers toward increased levels of integration of technology for student learning.

The participants in this study were willing volunteers for grants that provided them with additional resources not always found in most classrooms. Most notable were four computers for every one student, high-speed Internet connections maintained by the schools, and ongoing professional development aimed at assisting these teachers in integrating the technology into their classrooms. It was the voluntary nature of participation in the grants that set these participants apart from many of the findings of teachers' perceptions and behaviors around the use of technology revealed in recent research. This caused some mismatches between the findings in current research and the findings in this study. Hartley and Strudler (2007) found that most teachers were not consulted as to their desire to have computers in their classrooms. Harwood et al. (2005), Lotter et al. (2007), and Arends (2009) found teachers' beliefs influence how they teach. Zhao et al. (2002) determined that it is the attitude of the teachers that makes the difference in how technology is used in classrooms. Fullan (2000) related that teachers must find value in a new concept or method for teaching before they will integrate it into their classroom practices. The voluntary participation of each participant and corresponding school suggested that those in this study would have been positively motivated to use the computers in their classrooms to support learning and that they had some level of support from their schools and districts. Each principal expressed their desire to have teachers in their buildings engaged in some form of technology. In the case of Crossroads School, the principal and the superintendent were both participants in the grant in addition to the three selected teachers. In spite of this fundamental difference, there were commonalities that existed that were used to inform the findings and creation of the structured guide tool in this study. The themes that emerged from the data used to answer the research questions can inform present practices and provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced.

For the first research question, the evidence revealed that the emphasis on knowledge or mastery of certain programs stilted the inclination of the teachers to continue to be curriculum experts (Sandholtz & Reilly, 2004). Additionally, most of the participants listed the requirement to learn programs as a barrier to progressing forward with their students toward more innovative practices (Sandholtz et al., 1997). Sandholtz et al. found that some teachers became stuck in the beginning stages of technology adoption because they remained focused on technical expectations and their lack of technical skills. Sandholtz et al. wrote this caused teachers to go for years using technology only in limited instructional ways as they spent more time addressing hardware, maintenance, and management issues. By remaining mired in the perception that they must be technical experts, this kept them from exploring technology as an educationally innovative tool. This was a concern expressed by the participants in this study (Carol, Betty, Andy, Cassie) and became a barrier to successful integration of innovations for student learning. Contrary to this finding in the literature was the expressed appreciation of Carol for the 2-week immersion prior to the first year in the grant.

The participants appreciated the training that was provided as part of the grants; however, they wanted and needed time to collaborate with each other on an on-going basis (Van Driel et al., 2008, p. 108; Fullan, 2006; Mouza, 2002/03; Sandholtz & Scribner, 2006). Betty wanted someone to model how to use the technology in her classroom. Amy expressed concern that she was not doing enough. Cassie worried she was not providing the students what they needed. Carol and Cindy lamented the lack of access their students had at home and how they did not have time to teach basic skills for using the computers.

Participants wanted support from their administrators, including financial support for additional equipment or replacing items that were broken (Andy, Betty, Carol, Anne), time for collaboration (Amy, Betty, Brenda, Cassie), flexibility in curriculum (Amy, Betty), and in-class professional development (Betty, Cassie, Carol). ChanLin (2007) provided ideas on to how to encourage teachers to use technology collaboratively as they take control of the learning environment, in addition to personal, social, and curricular decisions in their classrooms. Included are teacher perceptions, the physical properties of technology, the sense of support within the educational community, and having control of the curriculum (ChanLin). Significant to the requirements of the grants that were part of this study was the embedded requirement of some kind of proof of use. This ensured that the participants used the technology in new and creative ways for student learning (all had to do this at varying degrees – Brenda, Cindy, Carol, Cassie seemed to have the highest criteria expectation). Those who had the greatest requirements (Brenda, Cindy, Carol, Cassie) seemed to use the technology the most and advanced through the stages more quickly. Excitement was generated in both the participants and their students when the technology was used for learning in creative and spontaneous ways (not necessarily at the same time) as related in the portraits of Amy, Anne, Brenda, Cindy, Carol, and Cassie.

For the second research question, the results of this study indicated the method of professional development and the level of ongoing support were critical to the success of integrating innovations into the curriculum in a manner that supported student learning. Educators over the last decade have been recognizing that ongoing supportive professional development is more successful than inservice training (Adey, 2006; Desimone et al., 2002; Van Driel et al., 2008). The participants in this study received their support through more inservice type training. Because professional development by teachers can have an impact on student achievement (Adey, 2006; Darling-Hammond, 1999; Darling-Hammond & Bransford, 2005), it is important for educators to continue to learn and grow within the teaching profession (Hargreaves, 2003, 2007). The participants expressed a desire for increased levels of collaboration with others integrating technology into classroom currcula at various times throughout the study. More specifically, when teachers are engaged in the collaborative problem solving (Fullan, 2006; Sandholtz & Scribner, 2006), this increases the likelihood of successful and enduring innovation (Van Driel et al., 2008, p. 108). Mouza (2002/03) stated that ongoing, curricular-based, hands-on professional development that has follow-up support in the classroom is needed in order for there to be change in student achievement and teaching practices. This was specifically the type of support Betty, Cassie, Carol, and Brenda wanted.

The study supported that the participants moved toward more inquiry-based teaching practices. These findings provide support that new teaching practices that are meaningful and engaging help move student learning forward as they struggle to make connections to life experiences (Tapscott, 2008). This finding is contrary to what 4% of teachers do (Hihlfeld, Barron, & Rizhaupt, 2007). This finding may offer insights into how the use of future technologies can be used to encourage teachers to engage in more inquiry-based teaching behaviors in their classrooms as future innovations are introduced into schools.

For the third research question, the evidence suggested that in the past 10 years, the perceptions of teachers have not changed significantly as it has to do with technology adoption. However, teachers identified common barriers that kept them from successfully integrating and adapting innovations. The review of literature supported that these barriers still exist in 2011.

First, there was the lack of technical support to keep the computers running as expressed by Andy, Carol, and Betty. Specifically, when teachers have adequate technical expertise and support, sufficient access to technology in their classrooms, and an environment that supports meaningful learning around group work, they were more likely to adopt and integrate technology into their curriculum (Becker & Ravitz, 2001; OTA, 1995). Many of the participants mentioned it took substantial time to get a technician into their classrooms to fix the equipment. Some of them went so far as to learn those skills themselves. Financial acquisition of additional equipment that supported the equipment that came with the grant was a concern to many, as was the expectation that the technology would be kept in working order. This was anything from replacing broken mouses to setting projection devices.

Another area was the lack of support the participants felt they needed for additional on-going professional development. Traditionally, professional development opportunities have focused on computer literacy, particularly basic computer operation and application use (Gilmore as cited in Sandholtz & Reilly, 2004). This was consistent with the findings of some of the participants in this study (Andy, Anne, and Amy). Participants indicated through both the interview and observation of behaviors that they wanted and needed time to collaborate with each other on an on-going basis to integrate technology. Those who had those opportunities advanced through the stages more quickly than those who did not (Brenda, Cindy, Cassie, and Carol). For example, participants at one school consistently collaborated because their classrooms were near each other and near the librarian, who was also a grant recipient. This was not built into the grant, but was a result of happenstance. The other two locations did not have this advantage and, therefore, did not enjoy this type of collaborative support. Participants reported that having technology in their classrooms changes how they teach (perceptions); however, actual classroom behaviors did not change to support these findings until the end of the second year in the grant. Finally, the participants wanted support from the administration. This included time for collaboration, flexibility in curriculum, and in-class professional development.

A finding that may be substantial is one that was different from the national norm. All three principals had been involved in their school communities in excess of 10 years each. Fullan (1991, 2006), Schön (1973, 1983), and Senge (2006) stated how difficult it is to effect systemic change. Each of the three afore named authors described it as a process that takes time and commitment on the part of all stakeholders and can take somewhere between seven and ten years before it becomes embedded in the system. Additionally, Fullan (2006) wrote that administration is a key component toward encouraging systemic change. Fullan, Schön, and Senge agreed that it is not an easy process and normally is not successful. This begs the question, “why?” The answer is, by the general discussion of Fullan, Schön, and Senge, that change is uncomfortable, and even painful. Many of the steps they describe are similar: systems should begin with the idea, gather supporters, create a safe environment for the change to occur, those who are most supportive should lead the charge, make sure the leader continues to support the change, get stakeholders behind and involved in the change, and sustain it for the time it takes to become part of the system

Unstated in their writings is the assumption that the key players in this case the school principals, stay in their jobs long enough to get the job done. However, Papa, Lankford, and Wyckoff (2002) who conducted a study in New York that began in 1992 tracking the first 6 years on the job of first-time principals, found that 36% of first year principals were no longer in the same school at the beginning of their second year and after six years, only 34% of the original group had continued to serve as principal of the same school. If the writings of Fullan (1991, 2006), Schön (1973, 1983), and Senge (2006) were correct, this turnover would impede systemic change occurring at the school level. As outlined by Schön (1983), changes that are imposed upon the school, without input from those who work at the school, could continue to occur, but would probably be without the buy-in of the major stakeholders thus creating an environment of resistance to the change. Essentially, there would be an ingrained conflict. Fullan's (1991) assertion was in genuine conflict with modern day reality of job movement as reported by Papa, Lankford, and Wyckoff. These findings are contrary to the tenure experienced by the participants in this study, and may have caused for some of the differences between the findings and the comparison to recent research.

Conclusions

A body of research supports what research has unveiled since computers hit critical mass in U.S. schools. However, the systemic supports the participants would have liked to see are not currently uniformly in place. Again, it was possible to ask the question, "why isn't technology being used on a uniformly grand scale in schools for student learning?" It could be suggested that it takes most, if not all, of these supports to help teachers become comfortable using innovative technologies for student learning (Arends, 2009; Jones & Jones, 2010; Mouza, 2002/2003; Stiggins, 2007). Public schools are focused on accountability and the sense of making adequate yearly gains. This, in turn, creates an environment in which teachers are reluctant to do anything not directly supportive of passing state-mandated tests (Brinkerhoff, 2006). Cassie stated, "The sad part is time. Our curriculum is loaded. We resort to the more traditional ways of teaching. We fit these things at other times, and we really shouldn't" (personal interview, 1/2002).

There is a body of research that supports student-centered teaching models as a form of best practice (Arends, 2009; Jones & Jones, 2010; Wilson, 1995). Technology lends itself to inquiry-based learning (Riel & Becker, 2000, 2008; Sandholtz et al., 1997). It is up to policy makers to support schools and teachers in the use of technology for inquiry based, student-centered learning.

Table 4 provides a glimpse into the differences between the perceptions and professional behaviors of each participant. The participant's perceptions as they fit the criteria for each stage theory were listed first in each cell with the level determined by the observation and video listed under it in the same cell. These findings were listed in this manner so that it was visually easy to see if there was a match between participant perception and professional classroom behaviors. The chart also showed the number of years each individual had participated in his or her grant.

Table 4

Matrix Comparing Teacher Disposition to Observed Levels of Expertise, Adoption of Technology Innovation, and Teacher Leadership in Professional Practice Among Participating Teachers

	Expertise in Pedagogy	Adoption of Technology Innovation	Teacher Leadership	Match among levels	Changes over time of study	Years in Grant
Anne	Proficient to Expert	Appropriation to Invention	Teacher Leader	No	No	4
Amy	Proficient to Competent/ Proficient	Adoption to Adaptation finally to Appropriation	Teacher Professional to Teacher Leader	Yes*	Yes	2
Andy	Proficient to Competent	Adaptation to Adoption	Teacher Professional to Interactive Teacher	No	No (see ancillary data)	1
Betty	Proficient to Advanced Beginner/ Competent	Adaptation to Adoption	Teacher Professional to Interactive Teacher	No	No	1
Brenda	Proficient/ Expert to Proficient/ Expert	Appropriation/ Invention to Invention	Teacher Leader to Teacher Professional/ Teacher Leader	Yes	No	3
Cindy	Proficient/ Expert to Expert	Invention to Invention	Teacher Leader to Teacher Leader	Yes	No	4
Cassie	Competent to Competent/ Proficient	Adoption to Adaptation	Interactive Teacher to Teacher Professional	No	No	2
Carol	Proficient to Proficient	Adaptation to Appropriation	Teacher Professional to Teacher Professional	Yes	No	3

* - match occurred toward the end of the study (see portrait)

After reflection, findings seemed to show that when teachers first began to integrate technology into their classrooms that a disconnection occurred between their perceived level of expertise and what was actually exhibited by classroom performance (Amy, Andy, Betty, Cassie). With consistent, continued support and professional development opportunities provided over time, teachers tended to regain their previous perceived level of expertise. This change seemed to occur toward the end of the second year of the grant (Amy); however, teachers will likely advance at their own rate (Brenda, Cindy, Carol). Of interest was that one of the participants did not perceive her professional practice at the higher level of actual classroom behavior (Anne).

Participants indicated through both the interview and observation of behaviors that they wanted and needed time to collaborate with each other on an on-going basis to integrate technology. Those who had those opportunities (Brenda, Cindy, Cassie, and Carol) advanced through the stages more quickly than those who did not (Andy and Betty).

There might be a change in levels of teacher expertise in order to compensate for the new learning and the lack of knowledge during the first year or two of use. Later as the requirements of the grant (most notably the required integration of technology into the curriculum in a manner that adds value) become more automatic in teacher practice and the teachers begin to use the technology as a vehicle for changing their pedagogy toward a more constructivist approach, they may advance to higher levels of expertise as demonstrated in the portraits of Anne, Brenda, Cindy, and Carol.

The use of technology in education has been debated widely over the past several decades, both as a vehicle for adding value to the learning of students, and for the economical well-being of nations in creating the next generation of workers (Tapscott, 2008). The goal of this investigation was to provide information that would promote the use of support systems for teachers when innovations are introduced into classrooms, both to justify its integration into classroom curriculum, and as a vehicle for increasing levels of expertise in pedagogy of teachers.

Figure 1 addresses the interactions that existed among the three stage theories that were used to portray the perceptions and the behaviors of the participants in this study. All three theories described a continuum through which a teacher moves during his or her career. The theories depict the movement a teacher makes forward and backward through the stages' continua as different events enter the life of a teacher (Berliner, 1988, 2004; Sandholtz et al., 1997). Figure 1 creates a picture of how the three stage theories related to each other and how they informed the movement of the teachers as they progressed through the period of the grant at a time when computers were hitting critical mass in U.S. public schools.

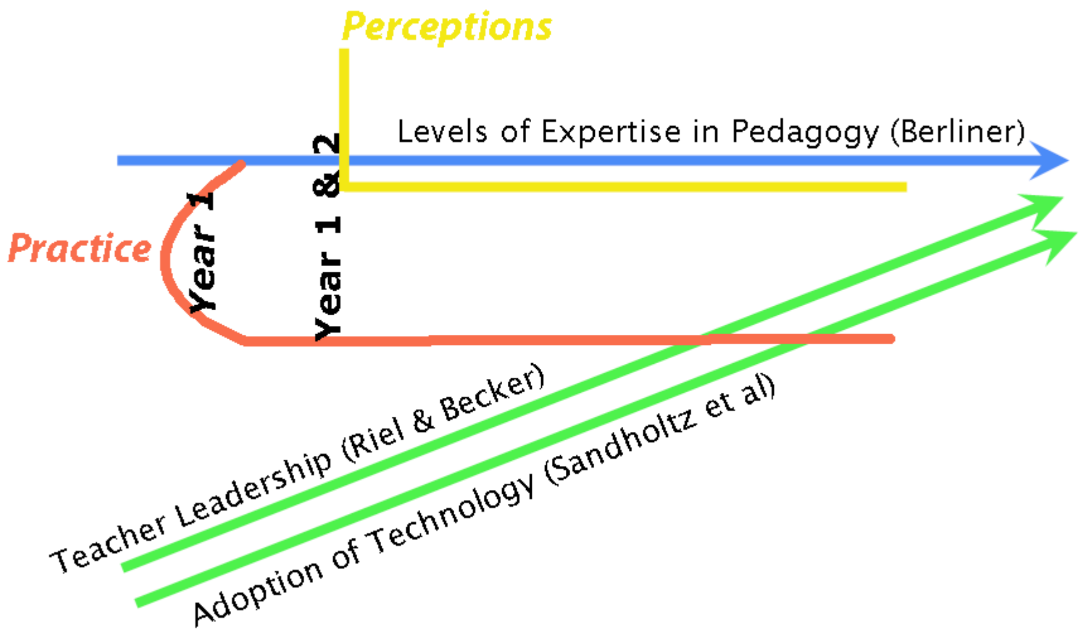

Figure 1. Movement of teachers through the stage theories. Copyright 2004 by D. R. Penland.

At the point teachers entered the technology grant, there seemed to be a disconnection between their perceptions and their classroom practice (Andy, Betty, Amy). This would be expected as discussed by both Berliner (1988, 2004) and Sandholtz et al. (1997). With the introduction of the technology provided by the grants, teachers began at the lower stages of teacher technology adoption (Sandholtz et al., 1997) and took on characteristics that would be expected of teachers at the beginning levels of the stage theories as they struggled to learn the technology for themselves (Berliner, 1988, 2004; Sandholtz et al., 1997). According to the findings of this study, teachers perceived their classroom practices as they were prior to becoming involved with the grant in a manner that was described by Fullan (1985) and Guskey (1986), bringing about this disconnection between perception and classroom practice.

As the teachers began and advanced through their second year of the technology grant, there was a closer match between their perceptions and their classroom practice, however, there was still a disconnection. At this point, the teachers were moving toward drill and practice type activities that were mostly teacher-directed as outlined by Sandholtz et al. (1997) and Arends (2009).

By the end of the second year and into the beginning of the third year of the technology grant, the perceptions of the teachers and their classroom practice began to match (Amy, Carol, and Cassie) indicating that the teachers achieved their previous levels of expertise in pedagogy (Berliner, 1988, 2004) and teacher leadership (Riel & Becker, 2000, 2008). The participants were integrating the technology into their classroom practices in more inventive ways as would be expected (Sandholtz et al., 1997) and as required by the grants.

Of interest was that toward the end of the third year of involvement in the technology grant, the perceptions of one of the participants and her actual classroom practice experienced another disconnection (Anne). The professional practice exhibited by the rest of participants began to reflect attainment of higher components as listed in the stage theories. However, some of the participants, those who had been teaching for over 20 years, were still articulating their professional practice using vocabulary that fit lower stages of the theories (Anne and Cassie). The exceptions were two participants, who were presenting their technological practices at the district and state level (Cindy and Brenda). Their classroom practice included inquiry-based learning and they were reconstructing their curriculum as they were becoming increasingly closer to the invention level in their stages of teacher technology adoption (Sandholtz et al., 1997; Sandholtz & Reilly, 2004) and becoming more extensively involved in professional activities, which equated to (a) teaching philosophies more compatible with constructivist learning theory, (b) teaching in ways consistent with a constructivist philosophy, and (c) using computers more and in exemplary ways (Riel & Becker, 2000, 2008). At the same time, they were sharing their expertise and knowledge with their colleagues in an attempt to build a community of learners, both within and beyond their schools indicating that perceptions do not need to match classroom practices in order for teachers to attain higher levels of expertise in pedagogy (Berliner, 1988, 2004). This was supported by the later findings of Riel and Becker (2008) who determined that those teachers who undertake leadership roles among their colleagues and are professionally active are the most active computer users.

Unlike previous studies, these teachers progressed through the stages at a much quicker rate than those described by Sandholtz et al. (1997). In the original ACOT study, teachers took 4 to 5 years to progress to the higher levels of integration of technology. Sandholtz and Reilly's (2004) follow-up study resulted in teachers moving through the stages within 2 to 3 years. This is more in keeping with the findings of this study.

In addition, the study conducted by Sandholtz and Reilly (2004) included teachers working together within their school community. Riel and Becker (2000, 2008) found that those teachers who exhibited successful teaching practices were also highly collaborative with their colleagues, both within the school setting and outside. This study did not have a collaborative community within the school setting. All three locations required professional development that took the teachers out of their school environment to work with teachers and professionals from other locations. One of the schools had no interactions among the teachers at the school around the technology grant and the integration of technology into the curriculum, another school included some voluntary assistance from the technology teacher for all teachers on campus, and the third school had teacher initiated collaboration among those who were participating in the grant outside of the required professional development opportunities.

The movement teachers experienced when faced with a sudden influx of technology was similar in nature, taking into consideration where they began their journey. The correlation among the stage theories indicated how that movement occurred in the eight teachers who participated in this investigation.

Table 4 indicated that when teachers first began to integrate technology into their classrooms, a disconnection occurred between their perceived level of expertise and what was actually exhibited by classroom performance. With consistent, continued support and professional development opportunities provided over time, teachers tended to regain their previous perceived level of expertise. This change seemed to occur toward the end of the second year of participation in the technology grant, however, each teacher advanced at his or her own rate. Additionally, those who share their expertise, tend to move to higher levels of the stage theories more quickly.

Educational Significance and Impact

The longer a teacher had been part of a technology grant, the more consistent the match between his or her perceptions and observed practices were tied to the stages of adoption of technology and level of teacher leadership. Those teachers who participated in the grant for 2 or more years had higher matches between their beliefs and the observed level of teacher professional development, as opposed to those who participated less than 2 years in the technology. This seemed to verify that the use of technology in the classroom had to be supported and it took time to develop a comfort level in its use. Once there was a comfort level established with the integration of technology into the curriculum, the teachers either resumed their perceived level of expertise, or in fact, lifted to higher level(s). This does not seem to be relative to the years of experience teaching, but to the time of engagement in the grant including the ongoing professional development.

Also of note was that those teachers who were relatively new to the teaching profession showed marked similarities to the lower levels of expertise in pedagogy as outlined by Berliner (1988). At the same time, their perceptions of their practice were at a markedly higher level. This could indicate that teachers should gain a certain level of expertise prior to having a significant increase of technology enter their practice. It might be too much for relatively new teachers to learn the profession and the integration of technology into their classrooms at the same time unless they are explicitly taught that as part of their teacher preparation programs (Duran, Fossum, & Luera, 2007).

Unlike the study conducted by Sandholtz and Reilly (2004) where the entire school system became a learning community that supported the use of technology integration, these participants made up their own learning communities from those who were participating in the grant and through the ongoing professional development. With the exception of one school, this was not necessarily occurring within the school environment, but more within the grant environment. In a manner similar to the follow-up to the ACOT study (Sandholtz & Reilly), the teachers in this study consistently progressed to their perceived or the higher stages of teacher technology adoption in 2 to 3 years.

Implications for Social Change

The impact of these finding has implications for funding professional development opportunities as it relates to technology integration. If teacher development is supported as they design curriculum and are given opportunities to collaborate with others engaged in the same types of activities (Hargreaves, 2003; Harris et al., 2009; Mishra & Koehler, 2006; Riel & Becker, 2000; Weber, 2005; Zhao & Frank, 2003), learning communities can occur both within and outside the actual school building. By creating online learning communities around these practices, greater access to global teaching practices may occur encouraging social change (Charalambos et al., 2004; Dobrovolny, 2006; Revill et al., 2005). This provides ongoing support that is part of the learning of teachers thus encouraging growth in pedagogy (Berliner, 2004; Darling-Hammond, 2001, 2008).

Where support in schools can be expensive, support that is timely to the needs of the teachers, provides teachers with the ability to discuss their learning environments, and gives them the opportunity to build on prior knowledge in online learning communities can be maintained without significant financial investment on the part of the school system. Online learning communities may support teachers in a manner that would move forward their use of innovations at a significant savings of professional development dollars. Implicit in this model is the need for the technical aspects to be supported by others who are not necessarily teachers. Support must be provided at the building and district level and curricular decisions must be left in the hands of the teachers (Sandholtz & Reilly, 2004). If some professional development dollars are freed for technical support, that may create funding sources that have been heretofore lacking. Thus, online learning environments can become an important aspect of collaboration, teacher perception through co-creation of content, and teacher change.

Fullan (as cited in Adey, 2006), Guskey (1986), Richardson et al. (1991), and Baird et al. (1991) wrote about teacher change as it has to do with teacher perceptions, ways of thinking, and professional practice in the classroom. As teachers begin to change their perspectives about how to teach, their professional behaviors in the classroom will change. The use of new technologies will be used as tools to engage students in learning.

Furthermore, providing support for adoption of innovations as they are introduced to school systems gives teachers and students advanced learning opportunities, not only among their colleagues in their physical schools, but through collaboration with others in the global market. Anne explained it best when she shared how she was providing her students with the opportunity to participate with others around the globe. This was a learning opportunity that would not have ordinarily been available to her students. One example she gave was of her students' experiences as part of the Journey North Project. As teachers engage in communities of learning and dialogue with others around the globe, support for additive learning occurs. Additionally, friendships and collegial relationships will be built thus promoting positive social change through changed perceptions and professional behaviors.

The results of this study allowed for the creation of a research-based structured guide tool. This structured guide tool offers the possibility of wide-spread systemic change as educational systems understand the supports teachers need in order to successfully adopt innovations, and respond to the technological demands society places on schools. It is through these supports that change in teacher perceptions and professional practices will occur thus effecting positive social change as innovations are used more extensively for student learning and meeting societal demands by preparing students for their futures as contributing members of changing global markets.

Recommendations for Action

Understanding teacher perceptions from the past as they related to professional growth and pedagogy helped inform present ways to work with teachers during periods of rapid technological innovation in the following ways:

- The perceptions of the participants, as it came to the pedagogical practices reviewed in the literature, did not match the behaviors, especially for those in the first 2 years of the grant. This led one to question why that mismatch might have occurred and if it was it due to lack of knowledge of what technology can do or a lack of understanding of different types of pedagogy, either the actual teaching methods or the vocabulary associated with the pedagogy. One solution is to make sure teachers know the current vocabulary of teaching.

- Systemic change as it has to do with preservice and in-service teacher preparation programs could help move the use of technology forward. One way to do that would be to embed the use of technology into the methods courses teacher candidates take, making sure candidates know how to use technology as part of their pedagogy and not only at a skill level (Duran, Fossum, & Luera, 2007).
- Those teachers who naturally collaborate will continue those practices with little consideration as to the innovations being introduced into the classrooms. Encourage collaboration by building in incentives for this practice. Create professional learning communities around the use of technology.
- Harwood et al. (2005), Lotter et al. (2007), and Arends (2009) supported the notion that teachers' beliefs influence how they teach. Those with more traditional teaching styles will continue to teach in that manner unless there is a catalyst for change. Create mentors who can work with those who are reluctant to use technology in their classroom.
- The right kind of support increases the likelihood that teachers will learn to use innovative technology sooner for student learning using student-centered

teaching practices (Arends, 2009; Riel & Becker; Sandholtz & Reilly) as they move through stages more quickly (Sandholtz et al., 1997)

- This change in teaching behaviors can be accelerated with in-school, just-in-time professional development and support for using new innovations in new and creative ways (Brenda, Cindy). In addition, those teachers who undertake leadership roles among their colleagues and are professionally active are the most active computer users (Riel & Becker, 2008). Only one teacher (Anne) mentioned writing a grant to finance additional materials and technology for her classroom, however, Cindy articulated that she had participated in two different grants and became a trainer for the first grant in order to get additional laptops for her classroom, and Brenda described how she brought in personal components to increase the amount of technology available in her classroom. Therefore, a conclusion was that only one in each school engaged in some kind of additional activities for the express purpose of acquiring additional materials. In each instance, these teachers had participated in the grant for longer than two years.

The Structured Guide Tool

The following structured guide tool was developed after determining those factors that were consistently found in recent research (2004 – 2010) and the findings in this study of data collected at a time when computers were hitting critical mass in U.S. public schools (2001 - 2002). By distilling the essence of what was available in the literature, the structured guide tool provides a research-based outline for introducing and providing ongoing support for teachers when innovations are introduced into their classrooms. When used by professional developers and policy makers as a guide for creating a viable instructional learning environment for teachers as innovations are introduced, those who are participants of the learning environment should show evidence of increased engagement, collaboration, and interpersonal connectivity that will help move the instructional practices and perceptions of the participants to use the innovations in a manner that supports student learning (Arends, 2009; Jones & Jones, 2010) and provides a quality education (Darling-Hammond, 2000, 2006) for all children that meets ongoing and changing societal needs.

The structured guide tool was broken into several parts depending on the intended user. There was a section for those who make monetary and policy level decisions at the district or school level. A section followed it for the teachers who will be expected to integrate the innovative technology into their classrooms. Finally, there was a section that specifically addressed changes in institutions of higher learning, specifically those who prepare teachers. This was not specifically addressed in the review of literature, however, considering how teachers are prepared to work in schools using innovations in ways that support students' learning can foster social change through curricular revision (Darling-Hammond, 2000, 2006; Goodlad, 1990, 1994). Specifically, Darling-Hammond and Bransford (2005) considered how to help teachers become professionals who are "adaptive experts" (p. 359). One way to become an "adaptive expert" would include becoming comfortable with innovations while being prepared to become a teacher as modeling of innovative practices occurs throughout the teacher preparation program

(Duran, Fossum, & Luera, 2007). Through introduction to (Carol) and use of innovations at the same time one is learning teaching practices, Goodlad's contention that teachers teach as they were taught could be funneled into practices that include the use of innovations for student learning.

Table 5

Checklist of Present Practices in the School/District

Present Practices in School/District	Yes	No
Innovations available		
Money set aside to support innovation (does this money re-generate?)		
Needed additional equipment		
Repair		
Update		
Professional development		
Teacher input into purchases of innovations		
Provide modeling support in teachers' classrooms (for student learning)		
Professional Learning Community		
Support for presenting teaching strategies at conferences/district		
Time		
Money (travel expenses, conference fees, etc.)		
Allow teachers to make curricular changes in order to use innovations for student learning		
Survey student population to determine their needs and ideas for use		
Support different styles of teaching (teacher centered/student centered)		
Support from Administration		
District level		
School level		
Allow for teacher experimentation and occasional failure while using innovations		
Time for teachers to collaborate		
Within school setting		
With others outside school setting		
Access to innovations		
Monthly		
Weekly		
Daily		
Hourly		
Requirement to use innovations		
Monthly		
Weekly		
Daily		
Hourly		
Checks in place		
Infrastructure in place		

Present Practices in School/District	Yes	No
Infrastructure supported in a timely manner		
Ongoing		
Upgrades		
High-speed access		
Firewalls		
Technical support		
How to use		
Fixing problems		

This checklist allows schools and districts to begin to assess the level of preparation for innovations. Apple (2005) and Penuel (2007) outlined the problems with the acquisition and implementation of new technology. Through the use of this instrument, it may be possible to more closely determine the level of readiness of school systems to adopt innovations. It may also be used as a way to begin preparation plans for adoption.

Table 6

Checklist of Teacher Behaviors and Perceptions

Teacher Behaviors and Perceptions	Yes	No
Use innovation		
Find value in students' use of innovation		
Prepared to experiment and possibly not feel successful		
Collaboration with Colleagues		
Within school		
Outside school		
Prepared to present teaching strategies/use of innovation at conferences/district level		
Collaborate with students		
See yourself as a facilitator in the classroom		
Voluntary participation in using innovation		
Cocreate content		
Teachers		
Students		
Lesson plans include use of innovations for student learning and success		
Use different kinds of teaching styles (teacher - centered/student-centered)		
Choices for evidence of student learning		
Survey students to determine their needs and ideas for use		
Collaborate with businesses and industry by asking:		
What do they want?		
What do they think they want?		
Participate in online learning communities		

Donovan et al. (2007) suggested it is important to assess teachers as to their desire to adopt innovations. This checklist assesses the level of preparedness of teachers and their level of acceptance to change as it has to do with introduction of innovations and innovative practices.

Table 7

Checklist for Institutions of Higher Learning that Prepare Teachers

Institutions of Higher Learning that Prepare Teachers	Yes	No
Conduct a needs assessment – current knowledge and skill level of faculty		
Model innovative practices in methods courses		
Webquests		
Problem-based learning		
Inquiry-based learning		
Model technology use in methods classes		
Faculty supports change		
Support exists for faculty as they learn to integrate the innovations		
Professional learning communities		
Modeling of practices		
Decreased load to allow for time to integrate innovations		
Courses in skill development of innovations		
Lesson plan templates require use of innovations		
Practica/student teaching requires use of innovations when working with children for student learning		
Collaboration with schools/districts supporting innovative practices		
Provide modeling in schools/classrooms by institution's faculty		
Provide school-based meetings to support innovations		
School administration is actively involved in the collaboration		

It is important to determine the level of support that exists and begin to plan for increasing that support as innovations are gradually included in the methods courses. Dallmer (2004) and Duran, Fossum, and Luera (2007) found that programs that include collaboration among the instructors, students, and practica (schools and teachers in the schools) have increased levels of success when students leave the program to become teachers.

Recommendations for Further Research

This was a small study with a small sample size that occurred over a relatively short period of time. It is recommended that future studies be conducted in order to validate these tentative findings. Additionally, while the three stage theories that were used have many similarities, they are also somewhat different, and as such, focus on different aspects of the findings. It would be interesting to determine if the degree of overlap found in this study held true in a larger investigation.

Future studies could consist of an impact study (Song & Herman, 2010) to compare recent findings to the findings in this study. For all intents and purposes, the demographics of the teachers in this study were virtually the same as those used in recent research. Specifically, the recent research reports an array of findings on teachers and this study reported findings on perceptions and behaviors of teachers. The major difference between the teachers used in this study and those used in research conducted more recently was the intervention in the form of voluntary participation in the technology grants that awarded each teacher a ratio of one computer for each four students and the requirement of ongoing professional development for the period of the grant. Impact studies analyze the differences in similar populations in which an intervention is introduced to see how the intervention affects those individuals in some way (Song & Herman). By teasing out those studies that are specific to perceptions and behaviors of teachers using technology in their classrooms for student learning and comparing those findings to the findings from this study, it may be possible to determine the affect involvement in the grants had on the participants in this study and to what degree it helped them in their movement toward more student-centered (Arends, 2009) teaching practices.

An interesting phenomenon occurred as an outlier from the findings. Anne was the only teacher who mentioned writing a grant to finance additional materials and technology for her classroom. However, Brenda discussed in the interview how she had brought in certain personal components and cobbled them together to create her system. Additionally, she discussed how she shared her work and it was used to create the grant pamphlet. And, Cindy related that she had agreed to become a trainer in her first grant in order to “earn” additional laptops for her classroom. A question for future study could be, why did only three teachers engage in these types of behaviors? Is it significant that it was in each instance the teacher with the most experience using technology and who participated outside their schools in professional development (Riel & Becker, 2000, 2008)? In future studies, it seems important to answer these questions.

Another possible future study would include locating the teachers in this study to see where they are now and what they are doing. Entirely by accident, I observed one of the participants two years after the data was collection for this investigative study. At the time of the study, Andy was in his first year of the Gates Leadership Grant. At the point where he was toward the end of his third year of the grant, I was able to observe a significant change in his professional classroom behaviors. Not only had changes occurred in how he worked with technology in his classroom, but also there were changes in his level of expertise. Andy had given up some of the control that he so highly valued at the time of the study. Students were allowed to make their own decisions about how to use the computers for a research project. While the curriculum had not changed significantly as students were still researching endangered species, there was a level of student driven learning occurring that was lacking during the original data collection stage. Students moved freely around the classroom working with others outside their table-group. Andy acted in a more facilitative role. He roamed the classroom, but was always open to any questions and students were obviously allowed to find him in order to ask for assistance. By providing the students with a rubric that included minimum requirements without any directions as to how to produce the final product, he was able to give up the control to the students and they could begin to explore ways to create and cocreate self-directed knowledge (Dobrovolny, 2006; Revill et al., 2005).

Finally, it would be interesting to determine if the structured guide tool introduced in this study provides support systems for teachers as innovations are introduced to classrooms. A study that includes ongoing evaluation of the tool to assess its level of effectiveness in supporting the participants increasing levels of expertise in pedagogy as their perceptions and use of technology for student learning change.

Researcher's Reflection on and Changes in Thinking

I engaged as a participant-as-observer (LeCompte & Preissle, 1993) who was the primary instrument for data collection and analysis (Merriam, 1998). I had an undeterminable effect on the teachers and students being observed. More specifically, as I became a familiar presence in the classroom, it was increasingly difficult for me to stay uninvolved, especially when either the teacher or the students requested my assistance. Barab and Kirshner (2001) discuss "agent-in-setting as a unit of analysis, and . . . that cognition occurs and is given meaning through the dynamic relations among the knower, the known, and the evolving context through which knowing occurs" (p. 9). Consequently, by developing an in-depth embedded analysis of case studies, I have uncovered details about selected issues, identified the multiple meanings of how technology integration can impact teacher pedagogy surrounding these issues, and made assumptions based on lessons learned (Creswell, 1998). Furthermore, I looked at the data through the lenses of my experiences (Peshkin, 2001). Moustakas (1990) stated,

> To know and understand the nature, meanings, and essences of any human experience, one depends on the internal frame of reference of the person who has had, is having, or will have had the experience. Only the experiencing persons-by looking at their own experiences in perceptions, thoughts, feelings, and sense-can validly provide portrayals of the experience. (p. 26)

Personal knowledge gained through my teaching career helped me gain a better understanding of the individual experiences and led to portrayals of each participant.

After 28 years in the teaching profession, with over 17 of those spent in the Kindergarten thru 12th grade classroom working with students with special needs, I believe that students need to create meaning from prior knowledge (Brooks & Brooks, 1993). This belief was shaped over several years of working with curriculum and assessment from the classroom level to the state level. I found if I could anchor learning on real-life experiences, and give students ways in which they could make connections to prior learning, or some other context in their lives, the impact on learning greatly increased. My work at the district, state, and university level has reinforced this belief.

This has assisted me in looking at the experiences of other professional educators in order to work to create portraits that captured the essence of their perceptions and their actual classroom behaviors.

After creating the portraits I went back to look at the more recent research and found, to my dismay, that there had been little change in how teachers are using technology for student learning (Wei et al., 2008). This led me to begin considering why this may be happening. When I consider some commonalities among the participants, two important factors surface. First, they were all veteran teachers. If they followed my pattern as a teacher, they did not have time to keep up with peer-reviewed research articles. While I made sure to read the more activity-based articles from organizations to which I subscribed, I did not have time to read the more research-based articles. This may have contributed to the lack of knowledge of vocabulary associated with technology integration and certain types of pedagogy (Anne). Second, they all had voluntarily embraced technology by applying for and being awarded the grants. This put them in a different category than teachers who had little or no control over the influx of computers into their classrooms during this critical time period creating differences among their perceptions and corresponding professional behaviors and those reported in the recent research. As a researcher, I gained appreciation for the value of volunteerism when there are changes in educational practices.

What insights have I gained into the teaching professional? As Fullan (2001) noted, teachers must find value in any change to educational processes and procedures in order to embrace them and use them in their classrooms. All of these participants saw the value, while their teaching counterparts who did not volunteer for grants, but were expected to use technology may not have seen the value to student learning.

On a more personal note, after spending over 6 months in 2001 – 2002 collecting data, then the next nine years decoding, analyzing, changing the research questions so they were relevant in 2011, reanalyzing the data, and revealing the findings from this study, I have found that I went through the transformation of my thinking as described by Mezirow (1991). This process was not easy. Mezirow described it as "wrenching" and, for me it was incredibly difficult to let go of my original thinking and research questions in order to move my transformed thinking and the findings for this study forward into 2011. However, by doing this, I have added value and can help inform educators in 2011 as innovations are introduced to educators and classrooms. I have learned the value of "mucking around," or taking time to revisit data in order to let it speak to me. In some ways, this was the process of crystallization, or looking at data from multiple perspectives, so I had a better lens through which to view qualitative research designs and their components (Janesick, 2000; Richardson, 1994). Finally, I can honestly say I have become a better writer, thanks to the sheer volume of writing required by this program. I have found I am a good researcher, but I am not good at taking the time to analyze and reanalyze data. I tend to jump to conclusions, and I do not like to take the time to go back and look at my finding repeatedly. In spite of this, I have learned the importance of revisiting my work. I have a new appreciation for those who make researching their life work.

Conclusion

In order for innovations to be widely accepted by teachers, certain critical elements need to be present. It takes more than teachers being told they are going to use something in their classrooms (Fullan, 2001). Several factors work together for successful integration of innovations that support student learning. First, teachers must support the changes that will occur in their classrooms through an understanding of how it adds value to student learning (Fullan, 2007). Second, teachers must be supported by the administration through built-in time to collaborate and from learning communities, ongoing support for the infrastructure and equipment needs (Sandholtz & Reilly, 2004; Sheingold & Hadley, as cited in Byrom, 1998), and ongoing professional development that includes modeling in the teachers' classrooms (Hughes, 2008; U.S. Department of Education, 2005). Finally, preparing teachers to use innovations in their teacher preparation programs will give them the confidence they need to integrate them in a manner that supports societal expectations as they are introduced. At the point educational systems understand the supports teachers need in order to successfully adopt innovations, and respond to the technological demands society places on schools, systemic change will occur leading to positive social change as doors are opened (Freire, 1994; Gordon, 2009) to students who are prepared to meet the changing needs of the global market.

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Appendix A

TEACHERS COLLEGE
COLUMBIA UNIVERSITY

OFFICE OF SPONSORED PROGRAMS
BOX 151

Institutional Review Board

June 15, 2010

Walden University
Institutional Review Board
irb@waldenu.edu
FAX: 626 605 0472

REF: Diane Penland, IRB Number 02-070

To Whom It May Concern:

Please be informed that as of the date of this letter, the Institutional Review Board for the Protection of Human Subjects at Teachers College, Columbia University grants permission to Diane Penland to conduct a secondary analysis on historical data she collected for her doctoral research study entitled *"Understanding the Effects of Computer-Based Instruction on Students Labeled as Learning Disabled who are Included in General Education Classrooms"* [Protocol 02-070], which was approved on May 13th, 2002 after a full committee review.

Please don't hesitate to contact the IRB office with any questions or concerns you may have on this matter.

Sincerely,

William J. Baldwin
Vice Provost
Interim Chair, IRB

cc: Diane Penland
File, IRB/OSP

525 WEST 120TH STREET, Box 151, 422 K THOMPSON HALL
NEW YORK, NY 10027-6696
IRB and Research Compliance (212) 678-4105
OSP Director (212) 678-4106

Appendix B

TEACHERS COLLEGE
COLUMBIA UNIVERSITY

OFFICE OF THE ASSOCIATE DEAN
BOX 151

Institutional Review Board

May 13, 2002

Diane Penland

New York, NY 10023

Dear Diane:

Please be informed that as of the date of this letter, the Institutional Review Board For The Protection Of Human Subjects at Teachers College, Columbia University has given full approval to your study entitled "Understanding the Effects of Computer-Based Instruction on Students Labeled as Learning Disabled who are Included in General Education Classrooms" after a full committee review. The approval is effective for a one-year period from the date of this letter.

The IRB Committee must be contacted if there are any changes to the protocol during this period and six weeks prior to the expiration of the approval if a renewal is necessary. The IRB number assigned to your protocol is 02-070. Do not hesitate to contact the IRB Committee at (212) 678-4105 if you have any questions.

Please note that your consent form bears an official IRB authorization stamp. Copies of this form with the IRB stamp must be used for your research work.

Best wishes for your research work.

Sincerely,

William J. Baldwin
Chair, IRB

Cc: File, OSP

Teacher's information section

This study is designed to observe students labeled learning disabled (LLD) in 5th through 8th grades. Three teachers, who volunteer for the project, will be selected. One student LLD will be jointly selected from each classroom by the teacher and me.

The significance of this study is that it will enable me to provide additional layers of understanding about the interactions between teachers and students as it relates to technology and how that translates into behavior patterns of students LLD when they use technology in an inclusion setting. Presently, the literature does not include information about how teachers' and students' interactions around technology relates to what students do with technology. Given the data that supports teacher student interactions in classrooms, I contend that it is important that researchers in the area of special education begin to acknowledge the influences between teacher student interactions and students' use of technology.

This study will benefit the teachers and students by encouraging both groups to reflect on their interactions, both with each other, and with others around technology. It is hoped this reflection will extend into other aspects of their interactions.

I will be in your classroom as a participant observer for approximately 13 visits. During that time, I will be audio-taping each class session. Each audio-tape will be transcribed and analyzed for interactions that occur between you and the students as it relates to computer-based instruction. In addition, I will need to meet with you for approximately 45 minutes in order to conduct a preliminary interview, and an additional 45 minutes to conduct a concluding interview. I will video-tape the student twice when they are using computers in the classroom.

Maintaining confidentiality is a very important part of this study. In order to maintain the anonymity of the teachers, students and schools in which I will be working, I will use pseudonyms throughout the transcribed documents. The video-tapes will not be viewed by anyone other than myself and the participants. Furthermore, I will not include any descriptors that would lead readers to identify the particular school being studied. Finally, I will keep all documentation in a secured, locked location. Toward the end of the study when I know of interesting findings that I might like to present at educational meetings, I will ask you to give permission for specific sections of audio- and/or video-tape to be used to demonstrate the findings. If you agree, you will be asked to sign a consent form. You have the right to rescind your permission at any time.

Teachers College, Columbia University

Institutional Review Board for the Protection of Human Subjects

Informed Consent Part II

Teacher Consent Form

PARTICIPANT'S RIGHTS

Principal Investigator: Diane R. Penland

Research Title: Understanding the Effects of Computer-Based Instruction on Students Labeled as Learning Disabled who are Included in General Education Classrooms

I have read and discussed the Research Description with the researcher. I have had the opportunity to ask questions about the purposes and procedures regarding this study.

My participation in research is voluntary. I may refuse to participate or withdraw from participation at any time without jeopardy to future medical care, employment, student status or other entitlements.

The researcher may withdraw me from the research at his/her professional discretion.

If, during the course of the study, significant new information that has been developed becomes available which may relate to my willingness to continue to participate, the investigator will provide this information to me.

Any information derived from the research project that personally identifies me will not be voluntarily released or disclosed without my separate consent, except as specifically required by law.

If at any time I have any questions regarding the research or my participation, I can contact the investigator, who will answer my questions. The investigator's phone number is XXX.

If at any time I have comments, or concerns regarding the conduct of the research or questions about my rights as a research subject, I should contact the Teachers College, Columbia University Institutional Review Board /IRB. The phone number for the IRB is XXX. Or, I can write to the IRB at Teachers College, Columbia University.

I should receive a copy of the Research Description and this Participant's Rights document.

If video and/or audio taping is part of this research, I ( ) consent to be audio/video taped. I ( ) do NOT consent to being video/audio taped.

Written, video and/or audio taped materials ( ) may be viewed in an educational setting outside the research ( ) may NOT be viewed in an educational setting outside the research.

My signature means that I agree to participate in this study.

Participant's signature: ______________________________________
Date:____/____/____

Name: ____

Appendix C

Teacher one. “I am an information junkie” (personal interview, 2001). Anne was in her 22nd year of teaching and her fourth year in the technology grant. This was beyond the scope of the grant making her a voluntary participant with no professional development or monetary support from the grant. She taught sixth grade science and mathematics. She was a self-proclaimed "information junkie," having at least 150 credits beyond her Masters of Education as indicative of a teacher leader as described by Riel and Becker (2000, 2008). She reported that she was highly motivated and constantly searching for opportunities to increase her capacity as a teacher and teacher leader. In addition, she collaborated extensively with her school community. Anne reported that she was an officer in her school association, and an active member of the district inservice team, as well as taking advantage of professional development opportunities that were offered outside the district.

Research question 1 asked how do data from a study of teachers’ use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice?

In her fourth year of the grant program, Anne excitedly shared that she had written several grants and just received funding which allowed her to teach a class she had written for the school, as well as purchase additional software that matched her curriculum in science and mathematics.

Anne detailed how she helped her students construct knowledge, “I went down to the Science and Technology Museum and took a class on Mars City Alpha...” and “So, now I've got the grant, we're going to build the robots, I've got the camera.” She explained further,

> Why would it be important in a class on Science? Because I got to write this class. This is a model of something that happens in the real world. And, so therefore, why would we care about robotics? And bam! They were so, oh, it was great! All right so that's how I use my computers.

During classroom observations, the students frequently clustered around the computers, three per computer. In each instance, each student had a rotating role. On one occasion, they were directed to two separate sites, one that gave information about the rats that had been used in a nutrition unit (one was albino, and the students had been asking about this genetic disorder, so Anne had them look up the information), and the other was an extension of the Journey North project, called the Great Backyard Bird Count.

Anne went on to describe some of the learning going on in her classroom as she used technology in, for her, new and exciting ways,

> I am always looking for new opportunities to use it and the best examples are our Journey North garden out here. This project is so amazing because I type in our latitude and longitude just yesterday and put in our planting date and there are probably a 150 schools that have already reported in from all over the world! So the kids are getting this wonderful worldview but all these kids are doing it.

Anne also described barriers that influenced integration of technology into her classroom curriculum. She mentioned after an observation that the district had hired a part-time technician who was responsible for "keeping the computers up and running" (Observation Diary, 2002). She expressed concern that this position could be eliminated due to declining enrollment. I wrote in my observation diary, that I got the sense, from what Anne said, that this person did not spend much time assisting Anne as she had figured out some of the basic problem-solving for keeping her configuration of computers up and running (2002).

Anne discussed that there was limited support from the grant once the computers were in place. Other than 3 times a year when the participants in the grant came together for a 2 day training, there was little additional contact from the people coordinating the grant. Additionally, there is a notation in my diary that she did not expect to have her computers upgraded at any point, either by the district or through the grant (2001).

Another notation in the observation diary was that in 6 months of observations, I had not seen anyone providing support for Anne in her use of technology, either from the district or from the grant (2002). This would be as expected if her machines were all working, which they seemed to be when I was there, and her involvement as a volunteer in her fourth year in the grant.

Research question 2 asked how does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation?

As noted in the diary, in each instance Anne would make sure she modeled how to find the website using a big screen television attached to one of the computers, wrote the complete step-by-step instructions on how to find the specific information she wanted to students to explore, gave each student a role, and rotated the roles during the time the students were on the computers.

Anne described her use of the tables as, “this is just honed over a lot years of trying it different ways and this is the best use of space.” She freely admitted that students frequently worked together after a short period of instruction. During the 13 classroom visits, I saw many instances of short spurts of instruction followed by students working together to cocreate knowledge.

Anne discussed her method of thinking about teaching all students in the following manner, "I'm an information junkie and I don't have nearly enough information to feel like I can, "A: diagnose" and "B: I can specifically help." She further expanded her thoughts, "How do I get information to help that child?" Anne verbalized her basic assumption for making learning decisions in the following manner, "I will assume you can do what I'm asking you to do until you show me otherwise." She felt she was especially good at presenting material in "a hundred different ways so that whatever the way they take in information" they get it. She described herself as trying to come at it (teaching) from a multirange of dimensions.

She used technology in the classroom to "suit her purpose," as she put it. While she did not see computers as a toy, Anne did see them as an instructional tool. She stated, “I don't allow them to come in and just do any old thing they want. They're very purpose specific use.”

Whenever she had a few additional minutes, she asked the students to get on the computers and search for something that complimented and extended the learning occurring in her classroom. Her statement, “

> Here's what I did yesterday. We had ten minutes left in class. I said, "Go to the computers, do a Google search for robotics and let's see what we find out." And somebody hit the robot museum on that one. Somebody over here found robotics-dot-com, which had tons of different robots.

was reflective of how seamlessly she changed her teaching methods.

She continued her line of thinking, “And then, my next question was, "OK, share your good sites. What have we got?" I mean we're talking moving very quickly. And everybody had something and I said, "Now tell me some uses for robotics." Additional examples included her description of online learning. “We're going to watch the Rufus hummingbird come north from Mexico because we have them here so my intent is to get a feeder set up out here and see if we can't be watching them, too.”

Then she described another online event in which she and her students were engaged, “The kids and I very sporadically have been following the whooping crane migration where they're bringing them with the ultra-light from Wisconsin to Florida. They're still carrying bird number four in the car because he won't fly.” Students engaged in collaborative, inquiry-based learning approximately 84% of the time I spent in the classroom for 13 visits over a 6-month period according to my observational diary.

There were a few instances in which her experiences in the grant did not align with her pedagogical beliefs. In spite of no longer being a part of the training with Gates Teacher Leadership grant, Anne mentioned the trainers heavy reliance on PowerPoint as a way to use technology in the classroom. At no point did I witness the use of PowerPoint in Anne's room. When asked, she related that she did not feel the use of that program lent itself to inquiry-based learning. Additionally, Anne was not engaged in collaboration with others outside of school as it had to do with the grant. She did collaborate with teachers around her. The most notable collaboration experience witnessed during the observations occurred when she planned a unit that would be using Excel spreadsheets and wanted to ensure the students knew how to use the program, so she corroborated with the technology teacher, who was also a grant recipient and a participant in this study.

Research question 3 asked how can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced?

Anne freely admitted she was only slightly comfortable with word processing software, although, she stated her "daughter is an editor and assisted me when I got stuck." As Anne integrated technology into her classroom, she recognized the sheer volume of time it would take to teach certain programs. She waited until all of the students had received instruction on Excel spreadsheets during the technology special class before she began her unit on nutrition. In this way, she did not have to spend time teaching the program, but could immediately put the application to work in her classroom in a manner that supported student learning of her curriculum (Observational Diary, 2002).

Summary. The findings, when analyzed using criteria from Sandholz et al. (1997), Berliner (1988), and Riel and Becker (2000, 2008), showed that Anne's perception of her teaching and her professional practice mostly aligned.

Table 8 illustrates that she had some tendency during the interview to judge herself more harshly when it came to management and control (her responses correlated 75% to the criteria in the proficient stage (Berliner, 1988), 71 % in the adaptation stage of adoption of technology (Sandholtz et al., 1997), and an even split of 45% each for interactive and teacher leader for criteria established by Riel and Becker (2000, 2008) for teacher leadership. All other area Anne met the criteria (71% or better) in the invention (Sandholtz, et al.) and teacher leader (Riel & Becker) stages.

Table 8

Comparing Teacher one's Disposition Toward Performance and Level of Expertise to Actual Classroom Practices

	Stages of Teacher Adoption of Technology	Levels of Expertise in Pedagogy	Teacher Leadership
Interview	Adaptation to Invention	Proficient to Expert	Teacher Leader
Observational Diary	Appropriation to Invention	Expert	Teacher Leader

Video	Invention	Expert	Teacher Leader

Anne’s involvement with the technology grant entered her life 3 years before the collection of this data. She had 3 years to explore, implement, and establish expertise in the use of technology. However, as she explained in the interview, she was constantly looking for additional avenues to stretch the learning and engagement of her students, as well as for her own growth.

Teacher two. "*technology levels the playing field*" (personal interview, 2001). Amy was in her 14th year of teaching and her second year with the technology grant at the time the data were collected. In addition to teaching seventh grade math, it was her first year as the school technology teacher. This class was considered an elective by the school and, as such, all students in the school rotated through this course for a 6-week period in order to learn basic technology use. Amy described technology as “leveling the playing field.” As she worked with the students in her technology class, she saw that all students could be successful when they use technology. While Amy stated she was not a "techie," she recognized that her “mind is really good at trying to figure out exactly how we could use the technology."

Research Question 1 asked how do data from a study of teachers’ use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice?

Amy explained how teaching with technology had changed her teaching style, specifically with the award of the grant:

> I think that … since I got the Gates grant, it's really changed my teaching because I was a lot more controlling. I'm really a casual teacher but I still don't want everybody going off different directions. I want everybody doing the same thing.

She articulated her feelings about managing her classroom,

> Sometimes you don't feel comfortable with kids being at the computers. It's chaos. If you're a controlling teacher, it's really hard to let 'em go and be at all these places and they all want you at the same time and they're not looking for direction and then they want direction.

Amy confided she didn't, "mind being the facilitator when it comes to teaching technology," however, she then contradicted herself by revealing she used the projection device to, "ensure the class followed along" while she was teaching the skills. Her way of resolving that for herself was explained, "So doing it on the projection screen is a great way to bring technology in but not be scared." She expressed her insecurities, "It's just going to go wild on you," offering insights that were supported in many of the observations of her inability to give up that control.

Amy reported the following frustrations in the make-up of the class and the district level expectations, "The students, yeah, it's more of a fun class and we're not really going to learn extra hard-core hard stuff."

My last several visits showed Amy in an entirely different light. As a spring special elective, she allowed the students to use technology in a manner not previously observed. She went from controlling each step of the learning in the computer lab, to allowing students to explore different technology media. The students had learned iMovie skills, which were then used to create a movie from individual acting, filming, and editing. The students performed, either individually or with selected classmates, a nursery rhyme, which was taped by the students using a digital video camera. The tape was imported to iMovie, and each student was directed to edit their portion of the tape so it could be later exported back to videotape and shown to the class. All students were involved in every aspect of the project.

Research Question 2 asked how does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation?

Amy shared that the year of the data collection was her first year as the technology teacher. She had helped write a new comprehensive curriculum for her class, complete with a scope and sequence. She described it as "really ambitious." Because this technology class was an elective, she articulated that the students had certain expectations for the level of difficulty

All lessons were initially presented in a similar manner; she taught the instruction twice, modeled while the students followed along on their computers at their seats, and finally she gave them the opportunity to practice on their own, with assistance as needed. She integrated this basic instruction with activities that were engaging for the students. An example would be using spreadsheets to play “Battleship,” or using word processing to generate a list of favorite candies.

Toward the end of the 6-week period for the elective course, I observed Amy teaching the presentation component of ClarisWorks to the students. She gave them the rudimentary skills so they could begin, which took a class session of 53 minutes, then for the remaining three visits, she had the students work on a presentation that coordinated with assignments from either their science or social studies classes based on material that was stored on the school's server that housed all students' individual folders. The students accessed the material from other classes that either they, or another teacher had put on the system for their use.

Amy reflected on her thoughts about technology in the classroom as it related to differences in how the students interacted with her: "The technology changes how kids work and there's no room for you. You have to step back. They're interacting with a machine not you, with whatever they're doing. You have to be supportive. You can't be the leader." As she articulated, Amy felt she needed to allow students to explore while she supported their learning.

Research Question 3 asked how can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced?

During the first 10 visits, I saw a very controlled environment (observation diary, 2001 – 2002). Amy was teaching technology to all of the students in the school. She had helped write the district technology curriculum, and, as she explained, it didn't leave much room for creativity. She described it as, "a forced march through the basic programs."

Amy recognized that her school, district, and students were not ready to embrace that level of integration when she said, “They actually try to think, you know, let's try to go to the lowest common denominator and we'll still give them the skills.” She expressed a level of hesitancy to use her knowledge in ways that engaged student learning around content level curriculum due to district expectations by articulating, “So I gotta say that, that, you know, everything I know is about integrating curriculum and yet this kind of program is not integrating at all. So, it's a fine line to walk.”

During the final week of my observations in Amy’s classroom, her teaching experienced a change. The students were actively involved, made all decisions, and made cuts and transitions after collaborating as a group to determine the best portrayal of their nursery rhyme. Amy was available as each student needed assistance, but she did not give unsolicited advice. I saw a teacher who was facilitating the learning by letting students explore their creative options (observation diary & video, 2002). In this manner, the video supported and expanded the data from the interview and observations. She became the facilitator, just as she stated in her interview (“You have to be supportive. You can't be the leader”). After making sure the students had written their nursery rhymes, and knew the basics of how to work a digital camera, she gave them total control over what they wanted to record, edit, and produce.

Summary. Statements like, "I can just kind of see a unit and see in my mind where are the places that we could be enriched by being on the Internet or by doing a spreadsheet or whatever we need to do," characterized her perception. She alluded to being holistic in her teaching practice when she said, "The technology changes how kids work and there's no room for you. You have to step back. They're interacting with a machine not you, with whatever they're doing. You have to be supportive. You can't be the leader."

While she articulated that she needed to give up control in the interview, I observed very little of that during my initial observations of her teaching her computer class. She used a projection device to teach the lesson, and then had the students follow along while she modeled the lesson again matching the criteria for the adoption stage of adopting inventions in technology (Sandholtz et al., 1997). She shared what she wanted to do with this course, but was limited by the expectations of the educational community as to the role her class played. Table 9 summarizes the movement Amy made among the continua.

Table 9

Comparing Teacher two's Disposition Toward Performance and Level of Expertise to Actual Classroom Practices

	Stages of Teacher Adoption of Technology	Levels of Expertise in Pedagogy	Teacher Leadership
Interview	Appropriation	Proficient	Teacher Professional
Observational	Adoption to	Competent to	Teacher Leader
Diary	Adaptation	Proficient	
Video	Appropriation*	Proficient	Teacher Professional

* - match occurred toward the end of the study

During my final visits, I observed a teacher giving the students the freedom to create products that linked learning with the skills they had learned in her class. Amy went from the adoption stage (61%) as she used technology for self productive purposes and to supporting traditional teaching practices for the visits during the first 5 months to the adaptation stage (39%) where she moved to automate her existing practices and began to use technology in ways that were connected to the curriculum during the last visit. Finally, she moved from meeting the criteria for professional teacher level (35%) in teacher leadership stages as she attempted to integrate her curriculum with those of other teachers (Riel & Becker, 2000, 2008) to teacher leader (56%) during the same set of visits.

The analysis of the data showed examples of a teacher who begun to take her students from working individually in a strictly controlled environment to students working together to draw meanings in an inquiring manner, in keeping with her perceptions during the interview. In this manner, Amy moved to meeting the criteria toward the top of the continuum for teacher leaders (Riel & Becker, 2000, 2008) and an appropriative teacher (Sandholtz et al., 1997). Toward the end of the data collection period, there was a substantial shift in how Amy integrated technology into her classroom.

Teacher three. "It's a two-edged sword, while I love the technology I want to make sure that things progress in an orderly fashion" (personal interview, 2001). Andy was in his 17th year of teaching at the time of this study, and had just begun his participation in the technology grant. His classroom was set up using tables with four students per table. There was an IMAC in the center of each table. The computers were wired to the Internet during the 6-months of the data collection, so that during the beginning of the study there was only the teacher computer with Internet access.

Research Question 1 asked how do data from a study of teachers' use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice?

Andy acknowledged that while he loved using the technology in the classroom, he was something of a controlling person when it came to any kind of perceived lack of control.

> Controlled chaos is not normally ok with me. I am not comfortable losing the atmosphere of this being an academic setting for a sort of free-for-all use of technology and if I find that I don't know what I'm doing and the instruction starts to break down because of too many glitches, then I will retreat back.

Andy stated he was very confident using the computers, however, whenever he felt things were, as he put it, "out of control," he would pull back and teach in his more traditional way until he could figure out how best to use the technology in his classroom.

Andy was most worried about being in control; this included the learning occurring in his classroom. "While I'm very comfortable using technology, I have to be comfortable in understanding it before I try to turn the kids loose on it because it winds up being a management issue."

Andy explained his use of computers, "We use it daily with the weather data. So we use it daily to some degree." His school had one of the weather stations for the state attached to the roof. As he explained, “They [the students] did even before I got this grant, because we have the computerized weather station. They were getting those numbers and before that I had the analog barometers and things like that they were using.” Andy had been using different types of technology for quite a few years to assist students in data collection.

Research Question 2 asked how does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation?

Andy expressed worry about the management issues surrounding the use of technology in his classroom. “It's a two edged sword, while I love the technology I want to make sure that things progress in an orderly fashion.” Additionally, he wanted to be the person who gave the information to the students. He portrayed this when he stated, “Not a lot of canned teaching units, if they are canned, I try to disassemble them and reassemble them in a way I feel is meaningful to me and the students.”

During the six months of my observations, I saw a very controlled, teacher lead environment. Andy had all of his lessons developed, complete with grading criteria, which went from check off lists to rubrics. Everything was clearly outlined and delineated for the students. They received full instructions at the beginning of each unit with the expectations clearly outlined.

He indicated that his teaching style was largely based on verbal dialogue, “A lot of my instruction is based on the type of teacher I am and, a lot of dialogue, I like a lot of dialogue I like to have dialogue with kids.” During my observations, Andy tended to spend a large portion of the class discussing the points he wanted to make. An excerpt from my observation diary provided support.

> This was very evident in the amount of control he exercised over the lessons and expectations he had for the students in his classroom. Andy's lessons were very well organized and left little room for student exploration beyond those expectations he had for his projects. His lessons could be described as predominantly traditional lecture and textbook teaching methods. Overall, learning activities were mostly unchanged as drill and practice type activities were predominantly used with the technology. (2002)

Andy discussed that he felt one period a day was not enough time to get to know the students in his classes and to recognize their learning styles. He went on to explain that, “my interaction with these students is very limited. I have a lesson to teach, and I can't really slow it down for....” He felt that this was an injustice to his ability to connect with his students.

Andy thought that because students can complete certain learning tasks quicker using technology that they could make the connections between what they were learning in more meaningful ways, “We're able to do that on the paper graphs, but we're also able to use the spreadsheet to find our percentages, then immediately build graphs that are very visually appealing, very accurate.”

During one visit to Andy’s classroom, the students were working on putting together the information they had learned for the year into PowerPoint presentations. Each student worked for a short period of time on the computer after they had completed all of the assignments on paper. This meant that those students who worked slower than the majority of the class, or who did not understand entirely how to complete each section, did not get a chance to use the computer for more than the rudimentary set-up of their presentation. Also, as there was little instruction on the use of the program, any student who did not know how to use PowerPoint spent most of their time trying to figure out how to use the program as opposed to advancing their understanding of the instruction (science units).

Research Question 3 asked how can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced?

Andy felt he made reflective, context specific decisions about his teaching as evidenced by his statement, "If the computers are going to help me to the ends that I see most important for students, then I am very comfortable using them. If it's not, then I also don't have a problem setting them aside." He further implied that while he knew what he should be doing with the technology in his classroom to make learning more successful for all of his students, that because of his personal inability to have a classroom that he perceived as being chaotic, he would postpone or cancel the project rather than risk losing control

Andy described his collaboration with his collegial peers as “presenting an inservice on a grade book program” he had written. He disclosed that, “it probably wouldn’t work on most of the computers in most classrooms in the district.”

Summary. Overall, 71% of Andy's comments place him in the proficient stage (Berliner, 1998, 2004), 49% placed him in the professional teacher stage with 36% at the interactive teacher stage (Riel & Becker, 2000, 2008), and 46% at the adaptation stage and 37% at the adoption stage.

Sixty-three percent of the total observations in Andy's classroom met the criteria for the competent stage for expertise in teaching (Berliner, 1998, 2004). Sixty-eight percent met the criteria for a teacher at the adoption stage (Sandholtz et al., 1997). Finally, 62% of all observations showed an interactive teacher (Riel & Becker, 2000, 2008) across all themes. The remaining observed behaviors fell almost equally between the stages directly below or above those identified as his strongest areas.

The video portrayed a teacher at the middle of the scale for expertise in pedagogy as 75% of the observed instances met the criteria for a competent teacher. Documenting the level of adoption of technology indicated a teacher who met the criteria at the adoption stage with 85% of observed instances. Finally, the documented instances for a teacher leader showed Andy as an interactive teacher at 70%. Table 10 summarizes the movement Andy made among the continua.

Table 10

Comparing Teacher three's Disposition Toward Performance and Level of Expertise to Actual Classroom Practices

	Stages of Teacher Adoption of	Levels of Expertise in Pedagogy	Teacher Leadership

	Technology		
Interview	Adaptation	Proficient	Teacher Professional
Observational Diary	Adoption	Competent	Interactive Teacher
Video	Adoption	Competent	Interactive Teacher

My observations of behaviors and notes from the observational diary indicated that Andy's perceptions about his teaching as articulated in the interview and his level of expertise frequently did not match. Andy's behaviors demonstrated he was more in the competent stage of teacher development as described by Berliner (1988; 2004). He freely admitted he liked an organized room with little interactive noise, which he described as “chaos.” In this manner, Andy met the criteria for being at the lower end of the continuum for teacher leaders (Riel & Becker, 2000, 2008), competent in pedagogy (Berliner, 1988), and an entry to adoption level teacher (Sandholtz et al., 1997).

Teacher four. " If you're into technology you have to have it. You have to do what you have to do (to get it)" (personal interview, 2001). Brenda was in her eighth year of teaching and her third year of the technology grant. She came from a family who used different technologies for many years, and she considered herself “very technologically literate.” As she stated in the initial interview, " I had a book on Front Page. This is it. People were talking about, "What are you reading?" I said, "I'm reading this book...for pleasure!"

Research Question 1 asked how do data from a study of teachers' use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice?

Brenda gave the following examples of how she used technology integration for instruction:

> Right now what we're doing is an experiment on the penny. We're seeing how many drops of water go on it and we're talking about pennies, and you find Lincoln on the penny and so forth. And someone would say, "Where do they come from?" So I go over to the net and I put in and I show them the mint on the Internet. You know, just anything! It might be something like that, as simple as that. Or, something that comes up out of the blue.

Brenda had brought in many components from home, and put them together herself, so that her system was unique. “I've learned I'm very good at self sufficient so most of the stuff, if you give me the places where I can plug it in to the net and do the things I pretty much can put together my own system.” She was able to tape from both the TV and the Internet, and use those tapes in instruction, as needed.

She went on to explain another lesson she was completing with the students.

> We went to the "Consumer Reports" site and I showed it because they had to make their own consumer report about something showing the scientific method because that was when we were learning scientific method. And we showed how they tumble shoes or they tumbled suitcases. So that gave them all these ideas that when they went back to do their (projects).

Brenda revealed that she felt that what she had was never quite as much technology as she could put to good use in her classroom. She said, “I have been working with computers for a very, very long time, since the beginning of time. So I don't think that I've ever thought that technology matches what my needs are.”

Brenda taught classes for the district and had some of her work show-cased in the manual provided for the district teachers who were grant participants. She detailed,

> Last year part of project Century I had to teach 15 hours of classes for the district. And, this is what I sent in for myself (Brenda showed me the district guide for the grant). It turned out they used it in the booklet.

Because of her level of expertise using computers, she was allowed by the grant administrators to move to a higher level, which gave her the computers for her classroom sooner than if she had began the grant at the entry level

Research Question 2 asked how does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation?

“I probably won't be growing with so many other people as I usually would. For the reason that I have to get my own classroom back down and, and get the curriculum and start integrating myself again.” Brenda described her classroom as busy, and, maybe, noisier that most people would accept, “I have a very flexible classroom. A lot of times it's very noisy but there's a lot of learning going on.” She was comfortable with her classroom and how it ran. She expanded by saying, “It's very flexible and I think if we get off on something and it goes somewhere else and we learn, that's fine with me. I'm probably not as structured as other teachers."

Brenda gave her philosophy of technology integration, "I think it can work really well if you know how to do it correctly. I think everyone can learn from each other. See, for me, computers are just a natural part (of teaching). It's like a book." During my visits to Brenda's classroom, I observed multiple instances of the computer being used to answer questions, show a point, and integrate learning in other manners. Frequently, the class would meet to see something on the computer projection device, then, go back to their work at their tables. On many visits the students asked questions that Brenda could not (or chose not to) answer. Her response was always to say, "Let's look it up." For Brenda, this did not necessarily mean in a book. She would get online, put the question to the test, and begin to see the results from the search. She always did this using the projection device, and allowed the students to assist her in determining which of the possible hits/locations from the search engine would give them the best answers to their particular questions. If Brenda wanted to make a point for the use of technology for learning, and how to begin to recognize sites that would give information that could be trusted, she would hop on the computer and ask questions as she began to find the answer. She let the students lead the search, asking why they wanted to go to one site as opposed to a different site. In this manner, she taught searching skills as well as how to evaluate sites depending on the purpose of the search.

Brenda was very aware of the needs of the individual students in her classroom because, as she confided in me, she was somewhat dyslexic, and understood the frustration and stigma that can be associated with that,

> I think that my biggest strong point is, first of all, being that my background is being dyslexic, I have a greater understanding of how it is to have learning disabilities and don't necessarily peg them into holes that "this is where they're at and that's where they'll stay" because it's not true.

She stated, “I'm very much a person that wants people to grow a far as can as an individual in whatever they're doing. I have a lot of flexibility that way and, I think I'm really good.” She explained her use of inquiry-based teaching methods, “I use a lot of cooperative groups where people learn from other people and I think that's really good for people that have learning disabilities because they can gather information different ways.” When she had a few additional minutes, Brenda would ask the students to get on the computers and search for something that complimented the learning occurring in her classroom

Furthermore, she indicated that she strove to meet the needs of all students by presenting information in a variety of ways. “I'm flexible enough to make changes that are necessary for different learners. I think all of them are just as individual as any other individual student in your class.”

Students engaged in collaborative, inquiry-based learning approximately 75% of the time I spent in Brenda’s classroom during 13 visits over a 6-month period. Examples of lessons I observed were students looking at topographic maps and building a three-D model of their map as a group. During another observation, the students were learning about Lewis and Clark expedition. As they listened to the diary accounts of the journey, they were drawing their thoughts in their journals. At one point during my visits, Brenda had the students cluster around the computer so she could show them how to access the U.S. mint prior to letting them look up information for a project.

Research Question 3 asked how can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced?

The students took turns looking up facts from the Lewis and Clark Expedition during the 15 minute video of Brenda's class. Once they had looked up their fact, they reported it to the class. All students had an opportunity to find an unusual fact and report it out to the class, either individually or with a partner. The students spent time at the tables working and when they needed to look something up on the Internet, they would get on a vacant computer and find what they needed, then return to the table.

She expounded on her progress through the grant, "I was, you know, techie enough you can just jump to (level) four. We had to videotape ourselves teaching a lesson using the technology and we had to assess ourselves."

Summary. Ten percent of Brenda's comments met the criteria for appropriation of technology, with the other 85% falling in the invention level (Sandholtz et al., 1997). In all other areas, Brenda's stated perceptions about her professional practice put her in a range for meeting the criteria with 67% at the expert level and 23% at the proficient level

(Berliner, 1988, 2004). Finally, 75% of her comments met the criteria for teacher leader (Riel & Becker, 2000, 2008). All other comments fell immediately above the dominant stages.

Observations revealed Brenda's professional practice as having met 84% invention level for innovative practices (Sandholtz et al., 1997). Her professional practice and interactions met the criteria of 90% at teacher leader (Riel & Becker, 2000, 2008). When scores were analyzed using the top two stages for each theory, Brenda fell as an expert teacher with 69% as in the expert range and 31% as proficient (Berliner, 1998, 2004). The remaining observed behaviors fell in the stage directly above those identified as her strongest areas.

The video substantiated the findings of the observations and the interview data. The video displayed a teacher on the upper end of each scale with a range among 72% at the bottom level and 87% at the top. This placed Brenda meeting the criteria with highest scores at the invention stage of adaptation of technology at 87% (Sandholtz et al., 1997) and as a teacher leader in the teacher leadership stages at 79% (Riel & Becker, 2000, 2008). When scores were analyzed using the top two stages for each theory, Brenda fell very strongly as an expert teacher with 72% (Berliner, 1998, 2004). While these scores were inflated, probably due to the abbreviated duration of the video, the scores followed the same patterns established in the interviews and the observations. Table 11 summarizes the movement Brenda made among the continuums.

Table 11

Comparing Teacher four's Disposition Toward Performance and Level of Expertise to Actual Classroom Practices

	Stages of Teacher Adoption of Technology	Levels of Expertise in Pedagogy	Teacher Leadership
Interview	Appropriation to Invention	Proficient to Expert	Teacher Leader
Observational Diary	Invention	Proficient to Expert	Teacher Professional to Teacher Leader
Video	Invention	Proficient to Expert	Teacher Leader

My observations of behaviors and notes from the diary indicated that Brenda matched her beliefs with her practice. There is a strong correlation between her thinking as indicated during the teacher interview and her practice in the classroom. The analysis of the data showed examples of students working together to draw meanings in an inquiring manner. In this manner, Brenda met the criteria for being toward the top of the continuum for teacher leaders (Riel & Becker, 2000, 2008), as proficient to expert in pedagogy (Berliner, 1988, 2004), and an innovative to inventive teacher (Sandholtz et al., 1997).

Teacher five. "For me, using computers, calculators, anything that gets the concept to the student" (personal interview, 2001). Betty was in her ninth year of teaching at the time of the study and her first year of the technology grant. She had transferred into Bright Middle School from another middle school in the district, which meant she was familiar with the culture of the district, if not the school.

Research Question 1 asked how do data from a study of teachers' use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice?

Betty had several different integrated lessons that the students completed over time that complimented and reinforced the learning in her class. She described her lessons:

> Pre-algebra uses stocks on Internet, graphs, fantasy baseball units, statistics, and research, we will be doing a research project on a mathematician, probably in Feb. All of the kids in my classes will do that. The Stock Market is a real life experience. Then we will do Fantasy Baseball. That is for Statistics. Then there is River Deep, which is aligned completely with our curriculum, not with math books, but the company took state standards and aligned the program with the standards.

During the video, all of the students were actively involved in the RiverDeep unit at the beginning. Each student had to correctly answer a series of problems to a pre-assigned rate in order to move up to the next level of difficulty. For those students who did not correctly answer the problems and were not moving forward in the unit, I noticed some behavior problems emerging. They began to complain and fidget. A couple of the students actually took items out of their backpacks from other classes, or other distracters so they were doing something other than working on the RiverDeep program. As Betty circled the room, she directed the students to put the items away and continue to work on the RiverDeep program.

Betty disclosed that she was very comfortable using technology, in part, due to her minor in technology information. She knew how to use the programs and she was able, for the most part, to fix her own problems. Betty explained that she used the computers frequently, 1 or 2 times every 3 weeks, which corresponded to the weeks her team was assigned to the computer lab. "I use computers frequently, 1 or 2 times every 3 weeks. Twenty-five to 30 kids rotate through and use the computer lab every other week (only as frequently as she can get in)."

I observed Betty assisting students with the technical side of using technology. Her explanations for accessing RiverDeep were clear and easily followed by all students in the classroom. She solved a problem in her classroom with a computer that was not working properly, and she showed the students how to connect several headsets to one computer on the couple instances when the students were using the computers in her classroom.

Betty disclosed that she felt there has to be a better way in which to learn how to use the computers effectively in her classroom with students.

> I need more instructional knowledge of how to teach, everyday instruction (using computers). I'm comfortable using computers, but not with the instruction in the classroom. My background is in computers - (minor) and compared to other

> teachers, I'm far up on the scale in comparison. I can break them down and build them back up again.

She further indicated that she had taken a class on the use of the program from River Deep that matched the district mathematics curriculum and text. “I took a class for River Deep, actually I'm a trainer for River Deep - I've held two trainings here for other teachers to use River Deep.”

Research Question 2 asked how does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation?

Betty described her normal mode of operating as beginning by teaching the concept in the same manner to all the students in the class. Once she had finished with the instruction, she would then reteach the concept to the students who needed additional assistance. “The first go round of instruction is the same for everyone. Then I will pull the students with LD and do it differently, so there are a lot more go-arounds.”
Betty stated. “For me, using computers, calculators, anything that gets the concept to the student.”

Every 3 weeks, during her assigned rotation into the computer lab, Betty took her math class to work on RiverDeep, a purchased software program that complemented the textbook. I saw two instances of students using the computers in her classroom and, in both cases the students were using the RiverDeep program. Those who used the computers in her classroom were those who finished the assignment early, thus giving preference to those who had the greatest potential of mastering the material being presented.

Betty expressed the following frustrations as it had to due with her ability to integrate technology into her curriculum,

> What I'd like to be able to do and can't is use it in my classroom for instruction. I know there's got to be people, others, who can just use it and know where to look (to get assistance).

Research Question 3 asked how can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced?

Betty expressed her frustration with the lack of technical assistance provided by the district. She felt, for the amount of money the district spent to equip the schools with the technology, it was woefully underequipped with technical support.

> For example one of these computers had a disk stuck in the disk drive. And nobody could come out until next week so no one can use the computer until they can come out. Also, today I got new mouses, which I have been asking for three months. That is frustrating. It seems to me anymore that actually putting technology in front of the kids, we have spent millions and millions of dollars in this district on technology, and then we don't get the support.

Betty informed me that she would begin her professional development opportunities through the grant at the end of the school year at which time she would have 8 hours of instruction. She stated that she had not had any additional technology classes since she left college.

Summary. While Betty made comments that are confident, 67% of her comments met the criteria for adaptation of technology, with the other 33% falling mostly evenly between entry and adoption levels, with 4% meeting the criteria for appropriation level (Sandholtz et al., 1997). Fifty-three percent of her comments met criteria for the proficient level, with 26% meeting criteria for competent and 21% for advanced beginner (Berliner, 1998, 2004). Finally, 54% of her comments met the criteria for the professional teacher stage (Riel & Becker, 2000, 2008), again, with 30% at the Interactive stage, 12% at private practice, and 4% at teacher leader.

Fifty-three percent of the total observations in Betty's classroom met the criteria for the competent stage for expertise in teaching (Berliner, 1998, 2004). Sixty-seven percent showed a teacher at the adaptation stage (Sandholtz et al., 1997). Finally, 54% of all observations showed an interactive teacher (Riel & Becker, 2000, 2008) across all themes. The remaining observed behaviors met criteria for a teacher at lower levels in each stage theory. She exhibited behaviors at a rate of 21% for an advanced beginner and at a 26% rate for a competent teacher (Berliner). My observations showed Betty's innovations within her professional practice was 14% for both entry and adoption (Sandoltz et al.) and 12% private practice and 30% interactive (Riel & Becker).

The video demonstrated a teacher at the middle of the scale for expertise in pedagogy as 60% of the observed instances met the criteria for advanced beginner and 40% competent (Berliner, 1988, 2004). Documenting the level of adoption of technology showed a teacher at the adoption stage at 81% (Sandholtz et al., 1997). Finally, the documented instances for teacher leadership showed Betty as interactive teacher at 69% (Riel & Becker, 2000, 2008). Table 12 summarizes the movement Betty made among the continuums.

Table 12

Comparing Teacher Five's Disposition Toward Performance and Level of Expertise to Actual Classroom Practices

	Stages of Teacher Adoption of Technology	Levels of Expertise in Pedagogy	Teacher Leadership
Interview	Adaptation	Proficient	Teacher Professional
Observational Diary	Adoption	Advanced Beginner to Competent	Interactive Teacher
Video	Adoption	Advanced Beginner to Competent	Interactive Teacher

While most of Betty's attributes, as they related to technology integration, seemed to better match the advanced beginner to competent stage of teacher development, she was very knowledgeable about her field, and felt personally responsible for the students' learning, which would indicate that in many ways she felt she was at the proficient stage of teacher development (Berliner, 1988, 2004). An entry from my journal highlighted these attributes.

> Betty expressed frustration and anxiety about this particular class as about 50% of the students were at-risk or receiving special education services. One student in

> the class had his own para-educator as prescribed on his Individual Education Plan (IEP). Otherwise, this class was not a cotaught class and did not receive additional assistance from outside resources. Betty is very frustrated because she sees herself as not providing enough for the students who can move at a faster rate than others.

She was also concerned about the results of the state tests and how that would reflect on her teaching. She indicated that she was use to teaching students who were either gifted or highly motivated to achieve academically.

None of the observations showed examples of students working together to draw meanings in an inquiring manner. In this manner, Betty met the criteria for being toward the bottom to middle of the continuum for teacher leadership (Riel & Becker, 2000, 2008), an advanced beginner to competent level teacher in pedagogy (Berliner, 1988, 2004), and an adoption teacher (Sandholtz et. al, 1997).

Teacher Six. "The ideas are endless - I found things I wouldn't have found under other circumstances" (personal interview, 2002). Cindy was in her 23rd year of teaching and her fourth year in some form of an awarded grant. Since 1998, she had participated in every technology grant available in her school and state for which she qualified. Cindy had become one of the facilitators for an earlier state technology grant so that she could learn as much as possible and obtain another laptop for her classroom. She noted that she was always looking for ways to give students new educational experiences and ways in which she could integrate technology into her curriculum (Sandholtz et al., 1997). She declared, "The ideas are endless - I found things I wouldn't have found under other circumstances."

Research Question 1 asked how do data from a study of teachers' use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice?

Cindy shared her philosophy of how confidence plays into the integration of technology in the classroom, "You can't teach technology until you have a level of confidence. So there is a very necessary underpinning." Cindy indicated that sometimes the amount of time needed for set up allowed students to take advantage and begun to create some chaos in the classroom. However, she had no problem with the confusion, as long as it related to learning. "Sometimes the children get too chatty when they shouldn't have. The time it took to set-up, and it makes for a bit of confusion. I actually can deal with a bit of confusion."

During a week of observations, Cindy brought in the AlphaSmarts so students could type up their reports and download them onto the computers for final editing. The students had completed the research portion of the project and needed to type up their reports. Cindy worked closely with the school librarian, who was a participant in the school grant. They planned lessons together and cotaught them in the library as minilessons so the students had time to complete the gathering of information either from the computers or the printed material available in the library.

Cindy felt that technology was a wonderful way in which students could view the world and could add to the vast store of information available to teachers and students. She explained:

> It (technology) jells the ideas in a different way. It presented the concepts differently that our hands-on experiments. Only when we have something that good and that relevant to what we are doing does it work for instruction. It's not use it for the sake of using technology, but when it really matches with what we are doing.

Research Question 2 asked how does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation?

Cindy related that she found that she used a variety of teaching tools to get at the learning, that the most important thing was to make learning motivating and reach each student. She described the use of technology as one such vehicle, “Sometimes when they are dispersed at different points in the curriculum, it can be motivating because it presents it in different ways (of getting at the main point).”

She found that she could, after three years of learning through various technology grants, begin to integrate the technology in a variety of ways. She commenced with how she used it for planning. “The ideas are endless - I found things I wouldn't have found under other circumstances.” She further expounded, " in fact sometimes I m overwhelmed by how much is available for planning." She described how she felt when the students were working on the computers, “It is so thrilling to hear everyone tap, tap, tapping on the computers. Everyone is being productive.”

As she disclosed in the interview, she made sure the students with special needs were the first to use the computers in her classroom. She said, "Because I have the computers, I can always give the priority to the special ed. kids."

The students worked in groups for most of their assignments, which were inquiry-based. Cindy had reading circles, discussion groups, and a variety of cooperative learning opportunities.

Research Question 3 asked how can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced?

Cindy indicated that it was easy for her to see how to present the information in a variety of ways so she was reaching each student in her classroom. One way she did this was through the use of the technology. She stated, "often technology is a vehicle for children as the way instruction and learning can take place"

During one series of observations, the students were asked to research one person who lived in Pre-Revolutionary War America. Cindy had the students research a key figure from the Revolutionary War era on the computer, write an oral book report, and dress in character to present it while being digital video taped. On another occasion, Cindy took the students to the library for a Revolutionary War scavenger hunt. Each group was given a set of seven questions (only two groups had the same set of questions).

Half of the groups used only online resources and the other half used only printed sources found in the library. At the end of the 30 minutes, Cindy pulled the group back together to find out which groups had found the most answers. A note from my observational diary shared Cindy's acknowledgement that, "this was the first year the students who were on the computers had gathered more answers than the students using printed resources." Students went to the computers to look up information as frequently as they looked up information in their textbooks. Many times this occurred in the library so the students had more opportunities to receive support from additional adults, namely the librarian, who was also a grant recipient, as well as Cindy. Notations from my observation diary stated that students frequently went to the library, usually without interrupting the flow of learning in Cindy's classroom. Students returned to the classroom with the information they sought and continued with their learning/project.

When Cindy started participating in the Wonders Classroom grant, she had very limited familiarity with technology. She was only slightly comfortable with word processing software and had never used email. She forced herself to become a state trainer so that she could learn the technology as quickly as possible

Summary. The interview revealed that Cindy did not mind being the facilitator when it came to teaching. Seventeen percent of Cindy's comments met the criteria for appropriation of technology, with the other 78% falling in the invention level (Sandholtz et al., 1997). In all other areas, Cindy's stated perceptions about her professional practice met the criteria with 77% at the expert level and 23% at the proficient level (Berliner, 1988, 2004). Finally, 78% of her comments met the criteria for teacher leader (Riel & Becker, 2000, 2008). All other comments fell above the dominant stages.

The observations showed Cindy's professional practice met the Invention level criteria at 83% for innovative practices (Sandholtz et al., 1997). Her professional practice and interactions fell at 89% of teacher leader (Riel & Becker, 2000, 2008). When scores are analyzed using the top two stages for each theory, Cindy strongly met the criteria with 88% of the observed instances as an expert teacher and 12% as proficient (Berliner, 1998, 2004).

The video validated the findings of the observations and the interview data. The video showed a teacher on the upper end of each scale with a range among 81% at the bottom level and 89% at the top. This placed Cindy with highest scores at the invention stage of adaptation of technology at 87% (Sandholtz et al., 1997) and as a teacher leader in the teacher leadership stages at 81% (Riel & Becker, 2000, 2008). When scores are analyzed using the top two stages for each theory, Cindy met the criteria very strongly as an expert teacher at 79% (Berliner, 1998, 2004). While these scores were inflated, probably due to the abbreviated duration of the video, the scores followed the same patterns established in the interviews and the observations. Table 13 summarizes the movement Cindy made among the continuums.

Table 13

Comparing Teacher Six's Disposition Toward Performance and Level of Expertise to Actual Classroom Practices

	Stages of Teacher Adoption of	Levels of Expertise in Pedagogy	Teacher Leadership

	Technology		
Interview	Invention	Proficient to Expert	Teacher Leader
Observational Diary	Invention	Expert	Teacher Leader
Video	Invention	Expert	Teacher Leader

My observations indicated that Cindy had a very solid match between her disposition and her practice in the classroom. She was very perceptive about her continuing inservice needs, and took care of those needs herself, as opposed to waiting for someone to offer the professional development opportunities to her, as evidenced by her participation in multiple technology grants over the past several years (Berliner, 1988, 2004; Riel & Becker, 2000, 2008). She was an active member of the district technology committee, which showed her commitment to the future use of technology in this district as well as her need to contribute to the educational community (Riel & Becker).

Teacher seven. "*They have a tendency to dive right in*" (personal interview, 2002). Cassie was a teacher with 22 years experience who had participated in her school's grant for the past year. She taught fifth grade social studies, language arts, and math at Boeing School.

Research Question 1 asked how do data from a study of teachers' use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice?
Cassie stated that she felt she was at the beginning stage of using technology in her classroom. As she put it, " I sometimes think I don't know how to use it, where to go

with it." Cassie lamented that she was not using the computers to their full potential. She seemed to have a difficult time pushing herself to build new methods into lesson design that included the use of technology. Part of this feeling of inadequacy may have come from watching her team members use the computers in new and exciting ways. She seemed to be comfortable using them to support more traditional teaching practices.

Cassie worried about the different teachers' uses of the technology and how time consuming it seemed to be. She described how easy it was to revert to old teaching styles when she felt overwhelmed. "The sad part is time. Our curriculum is loaded. We resort to the more traditional ways of teaching. We fit these things at other times, and we really shouldn't."

I further observed Cassie purposefully planning with the librarian to integrate technology into her classroom time (Riel & Becker, 2000, 2008). She took her students to the library and cotaught a lesson on research so that the students could begin to work on a project in her class, indicating that Cassie had rational goals and means.

Research Question 2 asked how does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation?

My observational diary included that Cassie frequently used cooperative learning groups as an avenue for learning. On one occasion she had the students working together to create dioramas of the different living styles of the Native Americans found in the early 1600s. Each student has a role, but each group was expected to collaborate with all students participating. It was obvious from my observations that this type of learning was a frequent occurrence as the room had a low level buzz as the students worked together with minimal assistance from Cassie.

Cassie revealed that she felt technology was a valuable tool, and that she used the computers in her classroom mostly for research and writing.

> I think it's basically where I need to grow. It's a tool for writing. We have the children used the "Inspiration" program for webbing. We work collaboratively with xxxx [the librarian], or XX [the reading specialist] will come into my classroom, especially during social studies, and work with a group of children.

Cassie indicated that she had increased her learning from watching the special education teachers' work with the students on their caseloads in her classroom.

> Essentially what we have done is create programs at different grade levels based on the needs of the children, we, at the fifth grade level, have always had a good relationship with the special education staff, at fifth grade, this has always been true.

The 15-minute video of the students working in groups using both the technology (Internet searches) and their journals to access prior knowledge and construct new learning as they completed presentations about the Revolutionary War. All students had a chance to use the computers in the classroom, those who asked were granted permission to go to the library, and those at their desks were working productively. The students worked on each part of the activity at times individually, and others as a group.

Research Question 3 asked how can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced?

After school, Cassie discussed with me how she sometimes worries that she is not using the technology to her best advantage in her classroom. We discussed how she uses it for research and to answer student questions. She reflected that she would like to find additional ways in which to add value to the students learning, while making sure she covers the content required by the district. Within her classroom, Cassie acknowledged that her students taught her a lot about computers. She felt they were not afraid to use it and in fact, had taught her about technology. She was not afraid to let them teach her.

> The children are so good at the computer that I have learned al lot. We have access to lots, and they (the students) are not afraid. They have a tendency to dive right in.

Cassie didn't seem to take into consideration the amount of collaborating she did with her team, others in the grant, and the librarian. While she discussed some of that in the interview, it was more off-handed. I witnessed a group of educators who were constantly collaborating with each other around the curriculum and about how to integrate technology into that curriculum. Students were constantly moving among the rooms in order to take full advantage of both the expertise of the participants and the available technological resources.

Summary. Seventy-five percent of Cassie's responses met the criteria for the competent stage and 25% fit the proficient stage (Berliner). She alluded to making conscious, deliberate teaching decisions ("We have the children used the inspiration program for webbing. We work collaboratively with Connie (the librarian) or Catlin (reading specialist) will come into my classroom, especially during social studies and work with a group of children."), setting priorities and plans ("we use it for research in social studies - different types of search engines. We have a problem of the week club on line for problem solving in math"), and having rational goals and means (It's mostly collaborative. I have the support of my staff and student support. Students are terrific").

Eighty-seven percent of Cassie's responses met the criteria for adoption with 13% meeting the criteria for adaptation (Sandholtz et al., 1997). Most of her responses suggested she used technology to support traditional teaching practices. Occasionally, she stated she used technology to support the curriculum in new ways and that her practices were becoming more automated.

Finally, 75% of her responses met the criteria for interactive teachers with 25% in the professional teacher level (Riel & Becker, 2000, 2008). While she collaborated quite extensively with her team members, most of whom were recipients of the technology grant she had been awarded, very infrequently did she suggest she worked with others outside that group.

The observational data showed a teacher whose professional practice met the criteria for two levels almost equally. She met the criteria for the competent stage 46% of the time as evidenced by her conscious and deliberate decisions about teaching context (Berliner, 1988, 2004) and at the proficient stage 54% of the time as her teaching was equally effortless and holistic. When analyzing the stages of teacher adoption (Sandholtz et al., 1997), Cassie met the criteria for the adaptation stage (94%) where she evidenced automated teaching practices and used technology in ways that are connected to the curriculum. Occasionally, she met the criteria for the adoption stage (6%) as she used technology for self-productive purposes and to supporting traditional teaching practices. Finally, she met the criteria for professional teacher (93%) in teacher leadership stages as she collaborated quite extensively with those on her team and other grant recipients in her school (Riel & Becker, 2000, 2008). In this manner, Cassie was exhibiting professional practices that were more inquiry-based and worked with others in order to ensure the success of her students.

The video showed a teacher whose professional behaviors fit the criteria for competent (42%) and proficient (58%) in her expertise in pedagogy (Berliner, 1988, 2004). She met the criteria for adaptation at 93% (Sandholtz et al., 1997) and as a teacher professional in the teacher leadership stages at 100% (Riel & Becker, 2000, 2008). These scores followed the same patterns established in the observations. Table 14 summarizes the movement Cassie made among the continuums.

Table 14

Comparing Teacher seven's Disposition Toward Performance and Level of Expertise to Actual Classroom Practices

	Stages of Teacher Adoption of Technology	Levels of Expertise in Pedagogy	Teacher Leadership
Interview	Adoption	Competent	Interactive Teacher
Observational Diary	Adaptation	Competent to Proficient	Teacher Professional
Video	Adaptation	Competent to	Teacher Professional

Proficient

Here is an example of a teacher who was at the competent to proficient stage of expertise in pedagogy (Berliner, 1988, 2004), teacher professional stage as described by Riel and Becker (2000, 2008), and adaptation stage of adoption of technology (Sandholtz et al., 1997). As would be expected of a teacher who was in the latter part of the second year of her grant, she was exhibiting behaviors that showed she was using technology in ways that supported student learning.

Cassie's responses to the interview indicated that she felt she was in the competent stage of teacher development as outlined by Berliner (1988, 2004) and Garmston (1998). She felt she made conscious decisions about her teaching as evidenced by her statement, "It's a tool for writing. We have the children used the "Inspiration" program for webbing" (personal interview, 2002).

The observations showed examples of students working independently in a classroom that had routines. In this manner, Cassie met the criteria for being at the teacher professional level of the continuum for teacher leadership (Riel & Becker, 2000, 2008), proficient in pedagogy (Berliner, 1988, 2004), and the adaptation level for teacher technology adaptation (Sandholtz et al., 1997). Cassie clearly was beginning to use technology as a way to add value to student learning even if she did not realize she was engaging in those types of teaching practices.

Teacher eight *"We have to keep learning. You can't rest on your laurels."* Carol was a 21-year teaching veteran who had participated in the grant for the previous 2 years at the time the data was gathered. She had taught for 16 years at this school spending the first 6 years as a special educator before moving to general education, where she spent the next 6 years teaching sixth grade and the prior 4 years teaching fifth grade science, math, and language arts on a team with two other teachers.

Research Question 1 asked how do data from a study of teachers' use and perceptions of technology and classroom practice collected during the time period when computer technology hit critical mass in U.S. schools inform present understandings of the influences technology adoption has on classroom practice?

Carol realized that technology was always changing, which meant teachers needed to make the commitment to keep learning so as not to fall behind. Carol was emphatic that the technology needed to be used to support the curriculum as opposed to teaching basic technology skills. "It's not that I'm spending less time, I'm spending time doing different things" (personal interview, 2002). Carol recognized that some students had a lack of access outside school that would put them at a disadvantage, however, she also knew that without covering the curriculum, they would be at a different kind of disadvantage.

Carol was especially grateful for the way she was introduced to the computers when she entered the grant.

> I think the thing that did it for me was the two-week class, 8-10 hours a day on the computer. To do it a little bit in an inservice and try to go home and make it work doesn't work at this time in my life. By using it 10 hours a day for 2 weeks, it teaches you not to panic. And if you lost it you will find it.

This assisted her in gaining a comfort level she felt would not have existed otherwise.

Carol was concerned over the increased number of students, stating it was due to overcrowding.

They have very little space. We've tried different things, on tables, and the problem is we have to be near the Internet hookup.

Carol explained some of the collaboration that occurred at her school, “We met as teachers and compared what we were all doing using rubrics. We wanted to make sure we were all on the same page” (personal interview, 2002). From this collaborative meeting came the integration of technology for student learning. Carol continued, “ Each student has a web template. [I gave them the chance to] practice and put something else on later. The students developed web pages with two pieces of work” (personal interview, 2002).

Research Question 2 asked how does understanding past teacher perceptions as they relate to professional growth and pedagogy help inform present ways to work with teachers during periods of rapid technological innovation?

Carol recognized that her students came to school with varying skill levels. She stated, “We have to keep learning. You can't rest on your laurels. There is always something else” (personal interview, 2002). She elaborated with,

> You don't want to take the time to teach tech skills. We have a mandated curriculum we have to cover. We spent so much time teaching them how to turn the computers on and off, that we don't have time for the other. (personal interview, 2002)

Carol has learned to solve problems for herself.

> I'm pretty at ease with it. For what I do in here, … That is my biggest thing, when things don't work, what do you do? I've found if I go through the trouble shoot, it will fix itself. As for as the Word, I feel comfortable, the web pages, I feel comfortable, the things I do in here, I feel comfortable.

Carol explained,

> We usually have four news reports every day. They go online and find a news story. We use it as part of their oral presentation. They have to stand up, introduce themselves, and tell the important parts of the story. They have 15 minutes to pull that off. And two people go to the Providence Journal and two to USA Today. They love to do this. (personal interview, 2002)

In this manner, Carol was using the technology to support life-long learning practices while ensuring the content in the curriculum was covered.

Carol described her integration of technology into the classroom to support student learning. She explained, new teachings and learning practices continuously emerged many times due to collaboration with others.

During the 6-month period of this investigation, I observed Carol's classroom as a busy learning environment. She frequently had the students working in groups trying to solve hypotheses they had developed. When the class went to the library to conduct research, each student was paired up and the research was conducted either on the computers, or in books, depending of the desires of the students. Each student wandered back and forth using the books in some instances, and the computers in other. There seemed to be a seamless flow between the use of printed material and the Internet. All students seemed to be comfortable in both environments. The 15-minute video showed the students working on their science fair projects. Many of them were coming and going out of the classroom as they went to the library to use the resources there.

Research Question 3 asked how can data collected during the period when computers were hitting critical mass in U.S. public schools provide insights into the development of successful support systems for teachers as new technological innovations in education are introduced?

Carol felt that technology needed to be used as it made sense. As she described, " It goes in when it fits." She recognized that collaboration was important for using technology. She felt it was important to "learn from each other and to help each other out."

Carol expressed concern that the sheer number of students in a general education classroom was making learning more difficult for different learners because, as she stated, " It's not that the students can't work in your room, it's that you can't get to them to give them the help."

Carol described that because of the support she received from the librarian, who was also awarded a technology grant, most of her integration of technology was done in a cotaught manner in collaboration with the librarian. Carol indicated she felt very lucky to have that support and the support of others who put their individual time into learning and sharing their expertise with her. She stated, “A lot of people learn on their own and share. There are five or six people in this building who share a lot” (personal interview, 2002). Carol stated in the interview that she frequently took advantage of the librarian, and the observations confirmed that this was, in fact, true. Whenever Carol had the students working on research several would go across the hall to work in the library. The students walked back and forth across the hall to the library to work on the computers after a brief minilesson that covered the area to be researched.

Summary. Seventy-six percent of Carol's comments met the criteria for proficient (Berliner, 1988, 2004). Sixty-seven percent of her comments met the criteria of adaptation of technology (Sandholtz et al., 1997). In all other areas, Carol's perceptions about her professional practice put her at 68% Invention. Twenty-eight percent of her comments fell at the appropriation level. Finally, 70% of her comments fell at teacher professional stage (Riel & Becker, 2000, 2008).

Seventy-one percent of the total observations in Carol's classroom met the criteria for the proficient stage for expertise in teaching (Berliner, 1998, 2004). Forty-seven percent showed a teacher at the adaptation stage while 54% met the criteria for the appropriation stage (Sandholtz et al., 1997). Finally, 88% of all observations showed a teacher professional (Riel & Becker, 2000, 2008). The remaining observed behaviors fell almost equally between the stages directly below or above those identified as her strongest areas.

The video showed a teacher who met the criteria for the upper end of each scale with a range among 76% at the bottom level and 79% at the top. This placed Carol's highest scores at the appropriation stage of adaptation of technology at 79% (Sandholtz et al., 1997) and as a teacher professional in the teacher leadership stages at 76% (Riel &

Becker, 2000, 2008). When scores were analyzed using the top two stages for each theory, Carol fell very strongly as a proficient teacher at 78% instances from the video meeting these criteria (Berliner, 1998, 2004). These scores followed the same patterns established in the interviews and the observations. The only discrepancy occurred between her perceptions and her professional behaviors with the stages of teacher adoption of technology (Sandholtz et al., 1997). Her perception was that she fell in the adaptation level but her behaviors indicated she was more at the appropriation level. Table 15 summarizes the movement Carol made among the continuums.

Table 15

Comparing Teacher eight's Disposition Toward Performance and Level of Expertise to Actual Classroom Practices

	Stages of Teacher Adoption of Technology	Levels of Expertise in Pedagogy	Teacher Leadership
Interview	Adaptation	Proficient	Teacher Professional
Observational Diary	Adaptation to Appropriation	Proficient	Teacher Professional
Video	Appropriation	Proficient	Teacher Professional

Carol was the only participant who went into detail about the level of collaboration that occurred at this school and how that supported the learning and growth of each teacher who had a grant. She discussed the ongoing collaboration among the participants and the librarian. Added to that was that all the participants had classrooms near each other and the librarian, a grant recipient who cotaught with her when she wanted to expand her integration of technology in new and different ways (Arends, 2009; Jones & Jones, 2010; Mouza, 2002/2003). Additionally, she discussed how the 2-week immersion at the beginning of the grant helped her understand how to use the technology and gave her confidence to begin using it quickly in her classroom for student learning (Rudestam & Schoenholtz-Read, 2002).

Appendix D: Teacher Interview Questions

I'd like to ask you about your classroom. Today's interview will be to gather information about your classroom, your thoughts about technology and its use in education, and your thoughts on students with learning disabilities who are included in your class.

(Warm ups)

*What grade do you teach?

1. Subject area?

*How long have you taught?

- Have you taught in other schools? Where?

*Would you share with me why/how you decided that you wanted to teach in an inclusion setting?

- Philosophy
- Teaching experiences
- Anyone in the family LLD

*Would you describe the educational preparation experiences that you feel were instrumental in your choosing to include students who are labeled learning disability? Did you feel well prepared?

- College
- Influential people
- Outside school

*What do you understand a learning disability to be? How would you describe a learning disability?

*How do you think students labeled learning disability learn?

- Compared with typical learner in general-education classes?

*How is instruction different/same for these groups and students not labeled?

*What do you think you do especially well in working with students labeled as learning disabled?

*What do you think would be helpful for you in working with students labeled as learning disabled?

*Do you have anything else to add?

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*How many computers do you have in your classroom?

- Do they work?
- Do you feel the school/district is responsive to you when you need assistance?
- Technical
- Software use

*What do you like/dislike about your classroom set-up (location of computers and other equipment?)

* How would you describe using technology for instruction?

*What types of training or professional development have you had that prepared you to use technology for instruction?

*What types of things do you do in your classroom using technology?

*How do you integrate technology into your curriculum and goals for your classroom?

Why did you choose to do it in this manner?

*How frequently do you use technology in your classroom?

What does that look like? Can you describe it for me?

*At what level would you describe your comfort level using computers in your classroom for instruction?

Describe the criteria you use to base this on?

*Is there anything else you'd like to tell me about your classroom?

Curriculum Vitae

Diane R. Penland

EDUCATION

Ph.D. Walden University, 2011, Education, General
ABD Teachers College, Columbia University, 2000, Certified ABD, Areas: Instructional Technology and Media
M.A. Northern Arizona University, 1984, Areas: Administration (Elementary Education Principal Certification)
B.A. Arizona State University, 1981, Areas: Special Education (Teacher certifications in Special Education, Learning Disabilities, Mental Retardation, Orthopedic Handicaps) and Elementary Education (certification)

EXPERIENCE

2004– Present, Walden University, Richard W. Riley College of Education and Leadership, Contributing Faculty, Teacher Leadership and Curriculum, Instruction, and Assessment, M.S. in Education program
Major Assessment Coordinator, MS in Education
Contributing Faculty, Public Policy and Administration

Walden University Curriculum and Policy Committee, member (2007)
M.S. in Education, Major Assessment Coordinator (2010 - present)
M.S. in Education, Course Lead Faculty (2010 -present)
M.S. in Education, Assessment Committee, member (2010 -present)
M.S. in Education, Specialization Coordinator, Teacher Leadership (2010 - present)
CIA Curriculum Revision Committee, member (2005 – 2009)
M.S. in Education Curriculum and Policy Committee, member (2006-2007, 2009 - 2011)
M.S. in Education Date Committee, Chair (2006)
M.S. in Education Scholarship Review Committee (2009)
M.S. in Education Task Stream Committee (2010 - 2011)
Courses Taught:
EDUC 6610 – Teacher as Professional
EDUC 6671 – Curriculum, Instruction, and Assessment, Part I
EDUC 6615 – Effective Teaching Using Learning Styles and Multiple Intelligences
EDUC 6672 – Curriculum, Instruction, and Assessment, Part II
EDUC 6620 - Collaborative Action Research
EDUC 6673 – Literacy and Learning in the Information Age
EDUC 6647 – Dynamic Teacher Leadership
EDUC 6650 – Enhancing Learning Through Linguistic and Cultural Diversity

EDUC 6651 - Teacher Leadership in the Classroom: Increasing Learning and Achievement
EDUC 6653 – Introduction to Educational Research
EDUC 6659 - Teacher Leadership in Professional Learning Communities
EDUC 6674 - Designing Curriculum, Instruction, and Assessment for Students With Special Needs
EDUC 6600 – M.S. in Education Portfolio
MMAP 6210 – Managing the Boundaries

2002 – Present. Western Washington University, WA
Academic Program Director, Teacher Education Outreach Program, Everett
Adjunct Faculty, Elementary Education and Special Education
Co-Chair, Literacy Revision Committee
Member, Essentials Of Teaching Revision Committee
Member, Woodring College of Education Assessment Committee
Undergraduate teacher prep; use of BlackBoard instruction, Curriculum revision work for re-designed program (SPED major, with Elem Ed. Certification and Sped endorsement)

1998 – 2002, Teachers College, Columbia University, New York
Instructor; use of BlackBoard instruction
Staff Developer, Integrating Technology into Classrooms in NYC PS 191, a grant through NCREST
Assistant Director of Technology, New Teacher Institute
Administrative Associate/Staff Developer, Center for Technology and School Change – provided support for the Center, staff development for integrating technology into curriculum in Yonkers School District, and member of NY State PT3 Catalyst Grant,
Administrative Assistant, Curriculum and Teaching, Preservice Program

9/94-1/98	Kyrene Elementary School District, Tempe, AZ Teacher of Resource 7th/8th Grade (Inclusion Model)
5/95	Northern Arizona University, Tempe, AZ Instructor of extension class
9/91-7/94	Madison School District, Phoenix, AZ Teacher of Cross Categorical Self-Contained Students (Middle School)
1/90-9/91	Westbridge Center for Children, Phoenix, AZ Instructor of Middle School Age students
3/88-12/89	Charter Hospital of Glendale, Glendale, AZ Instructor for the Children’s and Adolescent's Unit
8/84-3/88	Deer Valley Unified School District, Phoenix, AZ

Teacher of Elementary Level Students with Learning Disabilities (self-contained)

9/82-7/84 Apache Junction Unified School District, Apache Junction, AZ
Teacher of Elementary level Mildly Mentally Handicapped

1/81-7/82 Mesa Unified School District, Mesa, AZ
Itinerant Teacher for Physically Handicapped (K-12)

OTHER PROFESSIONAL EXPERIENCES

6/03 Consultant, Phoenix Elementary School District # 1, Phoenix, AZ
Learning Community Academy for the teachers at Phoenix Elementary School District #1, Three week writing academy covering the Six Trait Writing Rubric, including a morning summer school enrichment component for students in grades K - 8

10/02 – 6/03 Consultant, Yonkers School District, Yonkers, NY
Understanding by Design as vehicle for integrating technology into the classroom using Web Quests

9/92-1/98 Arizona State Department of Education, Phoenix, AZ
Planner for training of Mediated Arizona State Assessment Plan (ASAP) - committee that determined mediation for the state of Arizona on state mandated assessments
State Trainer of scorers of ASAP Form D (2 years)
Presenter at Yavapai County Inservice Day on mediation of ASAP for students with special needs, and how to teach students with special needs using state standards
Select Class Instructor (Alignment of State Essential Skills and Individualized Education Plans)
ASAP Planning Committee (Special Ed. and ASAP Unit - state committee that developed ASAP Form A., B, C, and D, including pilot testing to determine validity and reliability)

SCHOLARLY AND CREATIVE PRODUCTIVITY

PUBLICATIONS

Penland, D. R. (2010). *Online learning communities: Assessment instrument.* Paper presented at the 16th Annual Sloan-C International Conference on Online Learning – The Possibilities of Online Learning: Stimulating New Possibilities, Orlando, Florida.

Penland, D. R. (2004). *Understanding Teacher Behaviors: A Study of the Impact of Technology on the Development of Expertise and Teacher Beliefs.* Gigabytes, Ghouls & Grad Students, Teachers College, Columbia University, New York.

ARTISTIC OR OTHER CREATIVE CONTRIBUTIONS

Web Page Development

Penland, D. R. (2001). Development of web pages for New Teacher Institute. Teachers College, Columbia University, New York.

Videotapes/ CD ROM

Walden University (2004). *Research Approaches for the Teacher Leader.* (EDUC 8015). Ed. D. with a Specialization in Teacher Leadership (invited panelist).

Resource Materials

Meier, E., & Penland, D. R. (2000 -2001). Development of brochure for Center for Technology and School Change. Teachers College, Columbia University (invited contributor).

PARTICIPATION AT PROFESSIONAL MEETINGS

NATIONAL PRESENTATION

Paper presentation at the 16th Annual Sloan-C International Conference on Online Learning – The Possibilities of Online Learning: Stimulating New Possibilities. *Online learning communities: Assessment instrument.* Orlando, FL, November, 2010.

Paper presentation at the Hawaii International Conference in Education. *Working with NetGeners.* Honolulu, HA, January, 2010.

Poster presented at the 1st Walden University Poster Symposium for Faculty and Students. *Online Learning Communities Explore Aspects of Human Development*. Dallas, TX, January, 2008.

Paper presented at the 1st CCTE conference on research in technology and education. *Understanding Teacher Behaviors: A Study of the Impact of Technology on the Development of Expertise and Teacher Beliefs.* Teachers College, Columbia University. New York, NY, October, 2004.

REGIONAL PAPERS AND PRESENTATIONS

Penland, D. R. *Mediation of ASAP for students with special needs, and how to teach students with special needs using state standards.* Invited presentation for the Yavapai County Inservice Day. Prescott, AZ, February, 1992.

LOCAL PRESENTATIONS

Integrating Power Point into Your Curriculum using Understanding by Design. East Rutherford School District, NJ. 2001.

Using the Analytical Rubric. Presented to Kyrene School District teachers. Phoenix, AZ. February, 1994.

ASAP Scoring for Communication Arts Teachers. Presented to Kyrene School District teachers. Phoenix, AZ. 1994 – 1997.

ABACUS as a Resource. Presented to Kyrene School District teachers. Trainer of Trainers model. Phoenix, AZ. 1996 – 1997

Using the Analytic Rubric. Presented to Madison School District teachers. Phoenix, AZ January, 1992.

Working with students with Attention Deficit Disorders in the General Education Classroom. Presented to Way Out West (WOW) Whole Language Conference. Glendale, AZ. March, 1989

Curriculum Ideas for Special Educators. Presented to Deer Valley School District teachers. Phoenix, AZ. November, 1986.

OTHER SCHOLARLY OR CREATIVE ACTIVITIES

Professional Society Membership

AERA (American Educational Research Association)
Kappa Delta Pi (International Educational Honorary)
ASCD (Association for Supervision and Curriculum Development)
Phi Delta Kappa
National Staff Development Council
IRA (International Reading Association)
National Council of Teachers of English
Rethinking Schools

Honors

Kappa Delta Pi
Phi Delta Kappa
Who's Who in America, Millennium Edition
Scholarship from Teachers College, Columbia University

OTHER PROFESSIONAL ACCOMPLISHMENTS

<u>Course Development</u>
Introduction to Exceptionality - 2003
Students with Special Needs in the Elementary Classroom - 2003
Families, Professionals, and Exceptional Children – 2004
Supportive Learning Environments - 2004
Practical Assessment in the Elementary Classroom – 2003 (this course includes a quarter of Understanding by Design)
Curriculum-Based Evaluation - 2004
Promoting Resiliency in Vulnerable Students– 2005 – converted to an online course 2009-2010
Integrating Technology into Curriculum Using Web Quests -2002
Alignment of State Essential Skills and Individualized Education Plans - 1995

ACADEMIC SERVICE

WESTERN WASHINGTON UNIVERSITY
Teacher Education Outreach Program (TEOP) curriculum revisions
Essentials Of Teaching and Literacy blocks, and practica
SPED TEOP Program Level Assessments lead
Woodring College Education Assessment Committee

WALDEN UNIVERSITY
CIA Curriculum Revision Committee, 2005 – 2008
M. S. in Ed Data Analysis Committee, 2005-2006
M.S. in ED Education Curriculum and Policy Committee, 2006, 2009-2011
M. S. in ED Scholarship Review Committee, 2009
M. S. in ED Program Specialist, 2010

KYRENE SCHOOL DISTRICT
District Committee; 1994 - 1998
Arizona State Assessment Program (ASAP)-developed district assessment plan to match the state assessments and make them accessible to teachers via intranet,
Integrated Curriculum Committee (development of 7th and 8th grade curriculum using state and district standards)
Inservice Developer
Rubric Training (Assessment Advocates and Altadena staff using state mandated analytical rubrics)
ASAP scoring for Communication Arts teachers
Special Education Issues
District Regional ASAP trainer
ABACUS (computer program developed by NCS to match up standards with specific lesson plans to be distributed over the district network - trainer of trainer model)

Assessment Advocate for Altadena Middle School - charged with training staff for all assessments used by the school, maintaining security of all assessments, and producing reports of results for the school and parents
Site Council Member for Altadena Middle School
ABACUS/MCADD aligned Special Education Curriculum - alignment and entry of all standards and curricular options for the special education faculty for the district
ABACUS resource critique (administrator of the ABUCUS system for the district and final decision maker in regards to inclusion of submitted entries)Intranet resource administrator (district internal resources)

MADISON SCHOOL DISTRICT
Advisor of the Kiwanis Builders Club
Advisor of Youth in Philanthropy Project - Self-contained Cross Categorical classroom wrote a grant, received funding, and carried out plan to work with students at the city school for the homeless (Thomas Pappas Elementary School)
School Coordinator of ASAP, Mediated ASAP - charged with training staff for all state assessments used by the school, maintaining security of all assessments, and producing reports of results for the school and parents
District Committee Member; ASAP, district level decisions as to staff training and use of scores for future curricular planning
    Language Arts, textbook adoption, and curricular decisions
    Portfolio Evaluator, evaluated all district students' Language Arts portfolios
Inservice developer
    Special Education Issues
    ASAP
    Rubric Training

WESTBRIDGE CENTER FOR CHILDREN
Inservice Staff Developer   Doctors
    Staff
    Other facilities
    School Districts around Arizona

CHARTER HOSPITAL
Member of Speaker’s Bureau In-hospital
Schools around metro-Phoenix
Presenter at WOW (Whole Language Way-Out-West) Conferences

DEER VALLEY SCHOOL DISTRICT
Completed Administrative Intern for Principal, Desert View Elementary School and Curriculum Department
District Inservice Presenter Curriculum ideas for Special Education teachers

APACHE JUNCTION SCHOOL DISTRICT

Developed curriculum program and ordered materials for classroom
Developed district forms for classroom
Inservice trainer to staff and public (Staff Development)
District Coordinator of Special Olympics
North Central Accreditation Committee – 1982

MESA SCHOOL DISTRICT
District Committee for future planning of programs for Physically Handicapped

SCHOLARLY AND PROFESSIONAL SPECIALIZATION/INTERESTS:
Inclusive education practices
Integration of technology into existing curriculum
Teacher levels of expertise in pedagogy
Assessment practices
Curriculum development and integration
Staff Development issues

RELATED PROFESSIONAL DEVELOPMENT
2010 Sloan-C –International Conference on Online Learning
2010 International Hawaii Conference in Education
2007 NECC (National Education Computing Conference)
2005 Centrum's Creative Teaching Weekend
2004 ASCD conference
2000 AERA (American Educational Research Association)
1999 Understanding by Design
1989-1998 Yearly attendance at either IRA (International Reading Association) or NCTE (National Council of Teachers of English) annual conferences
1997 Assessment Institute in Portland, OR (Rick Stiggins)
1997 Problem-Based Learning Institute (ASCD) (Bill Stepien)
1996 ABACUS training (SASI)
1997 Facilitative Leadership Training
1997 Strategic Planning Training - year long as part of site council startup
1995, 1996 Cognitive Coaching I and II (Art Costa)
1995 Portfolio Workshop (NCTE)
1993, 1995 Total Quality Management

PUBLIC SERVICE

After Business Hours Coordinator, Freeland Chamber of Commerce, 2005 – 2006

345 W. 70th Street Coop Board, 2000 – 2002

Member of Nature Conservancy, 1990 – present

Youth in Philanthropy Project, 1993 - 1994

Gila County Special Olympics Board Member, 1982- 1984