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Investigating the Relationships Among Computer Self-Efficacy, Professional Development, Teaching Experience, and Technology Integration of Teachers

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Abstract

Research suggests that computer self-efficacy, professional development, and years of teaching experience are critical factors that influence teachers' integration of educational technology in their classrooms. Results of a pilot study conducted by the researcher suggested a strong relationship between the degree of self-confidence teachers demonstrated toward technology and its use in their classrooms. This study builds upon previous research to focus on the relationships among computer self-efficacy and the technology integration perceptions of high school mathematics and science teachers in a Midwestern metropolitan area. This exploratory study selected this particular population to examine factors that may inhibit or encourage technology integration among secondary teachers. These factors were self-efficacy beliefs, professional development, and teaching experience. Data were collected from teachers who volunteered to participate in the study through surveys, semi-structured interviews, classroom observations, and teaching materials. The data were analyzed quantitatively and qualitatively to determine whether relationships existed among the factors under consideration, as well as to detect other patterns that emerged. A moderate, statistically significant relationship was found to exist between perceptions of computer self-efficacy and technology integration among the participants, a finding that was supported by qualitative analysis. The results can inform future research, as well as professional development, continuing education, technology training, and teacher education programs.

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well spent and hope that it is appreciated by all who read this or use the results to launch their own investigations.

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Chapter 1. Introduction

"To keep its edge, high-quality teaching must be continually reshaped by the institutional structures that support it, i.e., by professional development, continuing education, the effective use of technology, and recognition and rewards."

Glenn, J. (2000)

The United States faces a future that will require an increasing number of college graduates to retain a competitive position in a global economy. Reports on the state of current education in the U.S. urge drastic increases in the quantity and quality of American college graduates, especially for the mathematics, science, and engineering areas (Committee on Prospering in the Global Economy of the 21st Century, 2007; Barron, 2003; Glenn, 2000; Kirsch, 2007). According to a Business Roundtable (2005) report titled *Tapping America's Potential: The Education for Innovation Initiative*, half of the doctoral degrees awarded in U.S. engineering colleges go to foreign national students. If current trends continue, more than 90 percent of all scientists and engineers could be living in Asia. The U.S. Domestic Policy Council reports (2006) that for the nation to maintain its position in a global economy, it "…must ensure a continuous supply of highly trained mathematicians, scientists, engineers, technicians, and scientific support staff as well as a scientifically, technically, and numerically literate population" (p. 15).

The full utilization of educational technology—defined here as computer hardware, software, and Internet access— in K-12 classrooms could play a significant role in enhancing student learning and stimulating interest in the sciences behind technologies. Yet, as Norris, Sullivan, Poirot, & Soloway (2003) pointed out in their research study on the impact of educational technology in classrooms, it is not unusual to find that:

> …schools go about their daily business ignorant of the profound changes caused by computing technologies in many other areas of everyday life, from new manufacturing processes to new scientific research methods, from new business practices to methods for creating art and music. (p. 16).

Despite the heavy investment in educational technology in the U.S., the improvements in learning outcomes that were expected have not occurred. This shortfall has been extensively studied, but the studies offer no simple explanation (Cuban, 1986, 2001; Delacruz, 2004; Ertmer, 1999; Norris, et al., 2003). Some researchers argue that the lack of access is a primary barrier to integrating technology in classroom instruction (Norris, et al., 2003), while others claim that use of technology alone cannot improve student outcomes (Cuban, 1986), or that other barriers beyond lack of access exist (Delacruz, 2004; Ertmer, 1999).

Although disagreement exists among researchers over just why there is a lack of technology integration in U.S. classrooms, most agree our students need to be technologically literate and they need to use technology in their learning. Good reason exists for this agreement. The Educational Testing Service's Policy Information Center recently released a report titled "America's Perfect Storm," that cites changing demographics, a shifting economic climate, and declining levels of literacy as forces that are becoming critical to the future of children in the U.S. Amid the educational reforms of the past few years, national test results show no evidence of improvement. Scores are flat and achievement gaps persist (Kirsch, 2007). Such reports increase the impetus to find and implement teaching strategies that result in improvements in student learning across socio-economic, cultural, and language boundaries, particularly in math, science, and technology content disciplines for secondary students.

One such strategy for improving student outcomes in these areas, one for which additional research has long been urged, is more effective integration of educational technology into daily classroom practice through more informed teacher preparation (Roblyer, 2005; Roblyer, 2003; Schrum, 1999). Students' increasing use of technologies outside the classroom is growing and will continue to do so, according to the Editorial Projects in Education recent *Education Week* report (Technology Counts 2007, 2007). Therefore, addressing barriers to the fullest effective use of educational technology is critical (Barron, 2003).

To determine how educational technologies are being utilized in K-12 classrooms, researchers have used instruments such as the Levels of Technology Implementation (LoTi) framework (Moersch, 1995), questionnaires (Littrell, 2005), and surveys (Hogarty, 2003) to collect data. The results of studies using these instruments reveal that despite the investment in technologies made by schools, not all teachers are able to use those technologies in the classroom across all subject areas and grade levels (Barron, 2003; Norris, et al., 2003). While significant resources have been devoted to professional development efforts and the incorporation of educational technology into teacher preparation programs, researchers still report wide variations in teachers' subsequent use of it in their classroom instruction (Bansavich, 2005; Bauer, 2002; Windschitl & Sahl, 2002).

Researchers seeking explanations for why educational technology has not produced expected improvements in student outcomes cite barriers such as lack of adequate teacher training (Glenn, 2000) and negative perceptions about using technology (Delacruz, 2004; Hu, 2003). A preliminary study of K-12 teachers conducted in 2006 by this researcher (Hall, 2008) suggested that those teachers who were confident that the time and effort required to use educational technology in the classroom would "pay off" in terms of student learning were more likely to utilize available technology resources and tools. That finding inspired this investigation of how teachers' computer self-efficacy, or the beliefs and attitudes about their ability to bring about a desired change or achieve a goal through the use of computers, may affect how they integrate technology into their classrooms.

Computer self-efficacy, which differs from other types of self-efficacy such as teacher self-efficacy or personal self-efficacy, has been the subject of a number of studies which provide some evidence that a correlation exists between a teacher's confidence in the use of computers and the integration of them in the classroom (Albion, 2001; Bansavich, 2005; Barbeite, 2004; Bayston, 2002; Callaway, 2004; Coleman, 2004; Czaja, 2006, Gaither, 2005, Green, 2006; Haney, Lumpe, Czerniak, & Egan, 2002; Holcombe, 2001; Kemp, 2002, Lorsbach & Jinks, 1999; Lynch, 2001; McNelly, 2005; Novick, 2003; Olivier & Shapiro, 1993; Pajares, 1997, 2002; Sam, Othman, & Nordin, 2005; Shiverdecker, 2002; Tschannen-Moran, Hoy, & Hoy, 1998; Varner, 2003; Wall, 2004; Whitehead, 2002). These studies laid the foundation for the researcher's belief that improving teacher computer self-efficacy would correspond to improved utilization of educational technology in the classroom. Such improvements, along with the modeling provided by teachers, could subsequently enhance student interest in the educational disciplines that underlie technology.

However, these studies do leave some gaps. For example, they frequently use instruments such as surveys and questionnaires that require self-reporting. While using surveys and questionnaires to collect data is valid and can permit a study to include larger sample sizes at a lower cost, they are not always supported by observations and follow-up interviews due to geographical and other limitations. Conversely, results obtained from small samples which can more easily include independent observations and follow-up interviews often yield findings that can be considered non-generalizable (Patton, 2002).

The studies sometimes suggest conflicting findings. For example, a high degree of computer self-efficacy in teachers has not always been found to be correlated with the highest degree of computer integration in the classroom (Norris, Sullivan & Poirot, 2003). Instead, teachers with more teaching experience have been reported by some researchers to demonstrate a greater degree of computer integration in their actual classroom instruction than teachers who were less experienced but who had higher computer self-efficacy (Coleman, 2004; Russell, Bebell, O’Dwyer, & O’Connor, 2003). Such anomalies highlight the importance of distinguishing between teachers’ use of computers in general and teachers’ use of computers in classroom instruction when designing studies that examine teachers’ computer self-efficacy.

Several causes for the lack of computer self-efficacy in many teachers have been identified in these studies. One is insufficient time to reach a level of mastery that enables ease of use (Albion, 2001). Another is insufficient scaffolding or professional development supports or support that is often provided only initially, such as when a given technology is first purchased and installed, but not on a continuing basis (Bansavich, 2005; Tschannen-Moran, Hoy, & Hoy, 1998). A third is insufficient free time in teacher schedules for receiving instruction and support (RameyGassert, Shroyer, & Shroyer, 1996). Teachers who were interviewed in this researcher's pilot study consistently emphasized limited professional development time, lesson preparation time, and personal time as barriers to more extensive use of educational technology in their classrooms.

Purpose of the Study

Using the findings of previous studies as a foundation, the purpose of this study was to examine whether a relationship exists among the perceived *computer* self-efficacy of teachers and their integration of educational technology in their classrooms, as well as other variables such as professional development and years of teaching experience.

The significance of determining whether these relationships exist could be far-reaching. Greater focus on assessing teachers' attitudes and beliefs during professional development could result in a higher transfer of skills and knowledge to classroom practice. Instruments assessing teacher computer self-efficacy could be incorporated into programs that prepare pre-service teachers and interns. Greater emphasis could be placed on modeling positive attitudes and beliefs with educational technology integration in professional development and teacher education programs. Finally, greater attention may be given to the affective attributes of future teachers that will enable them to become more effective facilitators of technical literacy, which may result in increasing the numbers of U.S. graduates who seek either careers or higher education in the science, technology, engineering, and mathematics (STEM) areas.

Using educational technology can increase the impact and effectiveness of learning activities in the classroom (Kulik, 2003). Technological literacy for all students as a means of equipping them to compete with an increasingly sophisticated global workforce is a founding principle of standards produced by, for example, the International Technology Education Association (ITEA) and the International Society for Technology in Education (ISTE). Being able to use technology is critical as society moves into the 21st century because low-wage positions will be the most common, with both domestic and global workforces competing for those jobs, and higher wage employers will be eager for science, math, and engineering majors from any country in the world. Students in the U.S. will need to be able to compete globally if they are to enjoy the standard of living realized by their parents (Committee on Prospering in the Global Economy of the 21st Century, 2007).

This investigation into the relationships among factors that influence teachers' use of educational technology can provide critical information that can benefit students and better equip them to compete in a global economy.

Theoretical Perspective

The theoretical perspectives or paradigms that dominate current research of teachers' use of educational technology in classrooms have shifted from a primarily behaviorist perspective to constructivist, social cognitivist and interpretivist views (Becker & Ravitz, 1999; Bull, 2002; Bullock, 2004; Burkett, 2002; Combs, 2003; DuBay, 2001; Kite, 2004; Lorsbach & Jinks, 1999; Lumpe & Chambers, 2001; Moersch, 1995;

Pajares, 1997; Rackley, 2004; Reimer, 2002; Schunk, 1981; Tschannen-Moran, et al., 1998; Willis, Thompson, & Sadera, 1999). This shift may have important implications for technology integration in the classroom, as some of these studies have suggested that the use of technology leads teachers to adopt more constructivist teaching philosophies or techniques (Becker & Ravitz, 1999; Bull, 2002), and others have suggested just the opposite (Windschitl & Sahl, 2002; Harris & Grandgenett, 1999).

Three perspectives are inherent in this research study; first, teachers' behaviors and beliefs affect their students; second, professional development for teachers can lead to changes in their attitudes toward educational technology and its integration into their classroom practices; and third, integrating educational technology into the curriculum can have a positive impact on the outcomes of students, especially in regard to the STEM areas. These ideas are drawn from the theories of social learning (Bandura, 1977) and constructivism (Vygotsky, 1978). Students—and teachers—construct their own knowledge in a collaborative manner and learn best when they can do so in culturally and contextually-relevant settings (Lave, 1988).

The theoretical perspective that learning should be student-centered rather than teacher-centered seems to dictate that every means of instruction—including the full utilization of available educational technology—be used to help teachers appeal to, engage, challenge, and assess students. However, technology is more than just a vehicle for delivering information or transporting knowledge from teacher to student. In the hands of knowledgeable teachers who are confident the use of technology will result in desired learning outcomes, technology can assist students in constructing their own knowledge, and can do so using a variety of approaches. Some of these are anchored instruction (Cognition and Technology Group at Vanderbilt, 1993), case-based learning (Kolodner, 1993), and problem-based learning (Forcier & Descy, 2005). Besides its ability to appeal to a variety of learners on multiple levels and with different learning needs, educational technology can be implemented into a variety of inquiry-based instructional strategies that encourage problem-solving skills and stimulate interest in an array of academic areas, including the critical areas of sciences and mathematics.

Self-Efficacy Overview

Self-efficacy refers to underlying beliefs about oneself, and specifically, a person's belief in their ability to produce desired results through their own efforts (Bandura, 1977). These self-beliefs give people the ability to control their thoughts, feelings, and actions. In this sense, behavior can be viewed as an external manifestation of internal beliefs. Thus, what people believe about their ability to perform a given task can be a predictor of their future performance of that task. This concept has been oversimplified as "self-fulfilling prophecy," but it extends beyond just making predictions about oneself. In his *Social Foundations of Thought and Action* (Bandura, 1986), Bandura situated self-efficacy within social cognitive theory, which provided a foundation for modeling and observational learning in education.

Self-efficacy is a dynamic construct, and can change—become stronger or weaker--as a person tackles new problems, learns new skills, and develops or inhibits abilities. The avenues of self-efficacy development and growth are through mastery, social modeling, social persuasion, and physical and emotional states. Mastery is related to whether one achieves or fails in attaining goals. Managing or explaining failure to oneself is an important aspect of mastery. People with high self-efficacy most often attribute failure to lack of effort, while people with low self-efficacy blame their failures on numerous problems. Vicarious experience or social modeling refers to the role others play in forming ideas about what one can or cannot do. Seeing someone like oneself do a task successfully can increase confidence about one's ability to perform the task. If the model is too different from oneself, however, self-efficacy may be decreased. Verbal or social persuasion refers to the influence other people have over a person's confidence that they can do a task successfully. People can be persuaded by others that they either can or cannot perform a task successfully. Others can also affect a person's self efficacy by offering him or her experiences that will build confidence and abilities and strengthen self-efficacy or by offering experiences that diminish confidence and decrease self-efficacy. Finally, people can learn to interpret their own physical and emotional arousal states and can learn the role these play in their success or failure in performing tasks or achieving goals (Bandura, 1995; Marakas, Yi, & Johnson, 1998). They can then practice self-regulation to minimize the impact of, for example, tension during an examination.

One of the more prolific academic writers on self-efficacy is Pajares (1996, 1997, 2002), who has done much to disseminate and extend the work of Bandura. Pajares explains the concept of self-efficacy as part of a "personal and collective agency" theory for explaining how people individually and in a group decide to behave or act. Rather than being merely reactive to the environment or engaging in involuntary behavior most of the time, people are self-regulating, able to internally reflect on their choices and learn from consequences of their behaviors. They are proactive in planning, and self-regulating in their ability to modify or adapt their behaviors.

Pajares (1997) reports the self-efficacy aspect of social cognitive theory has been tested in numerous domains, resulting in a large body of evidence that self-efficacy does impact human thought and actions, especially in the educational domain.

While Bandura first defined self-efficacy as previously described, the term "computer self-efficacy" was used to refer to attitudes of students toward computers as early as 1981 (Anderson, 1981). One of the instruments for its measurement that was tested for reliability and validity by its authors and by subsequent researchers was published in 1989 (Murphy, Coover, & Owen, 1989). The term was very likely a combination of computer anxiety, which was being widely studied at the time (Marcoulides, 1989), and self-efficacy. Pairing the term self-efficacy with the particular area under study is now common. In the literature search, care had to be taken to distinguish between *computer* self-efficacy and *teacher* self-efficacy. Teacher self-efficacy, which refers to the confidence teachers have that their efforts can affect student outcomes (Tschannen-Moran, Hoy, & Hoy, 1998), has its own body of literature that is separate and distinct from studies of teachers' computer self-efficacy, which is one of the factors under consideration in this study.

Computer Self-Efficacy Measurement and Assessment

A detailed and thorough explanation of computer self-efficacy as a construct and its measurement and study was provided by Marakas, Yi, and Johnson (1998) to explain some of the differences among research study findings, as well as to offer a conceptual model for future computer self-efficacy research. Because computer self-efficacy has proved significant to a variety of fields in its applications and implications, this study sought to provide a more thorough assessment of computer-self-efficacy that would allow for its improvement or enhancement. The two characteristics of self-efficacy they felt are most important are the ability of self-efficacy to predict future performance of a task, and its definition as the capabilities people perceive they have associated with a specific task.

Because self-efficacy is both situational and task specific, Marakas et al. (1998) argue that no “global” test can be used to evaluate it. Rather, instruments and research that reliably measure self-efficacy are task-specific. However, computer self-efficacy can be operationalized at both general and specific levels. Task-specific computer self-efficacy would thus refer to a person’s perception of his or her capabilities at specific computer-related tasks within the domain of general computing, while general computer self-efficacy would refer to someone’s skills across computer application domains, such as Microsoft Windows, UNIX, or other operating environments.

In a review of self-efficacy research, Pajares noted three areas of study that comprised research trends: the link between self-efficacy and career/college major choices, the relationship of self-efficacy and other motivational constructs and student performance, and most significantly to this work, the effect of efficacy beliefs of teachers on instructional practices and student outcomes (Pajares, 1997). A community of scholars Web site has been established at Emory University that lists current and past student research on self-efficacy: (http://www.des.emory.edu/mfp/Self-efficacyStudentResearch.html#computers).

Chapter 2. Literature Review

The relationship between teacher attitudes and beliefs toward technology and the effective use of technology in the classroom has been the subject of numerous studies in the past few years. A literature search was conducted of refereed journal papers and research articles, the bibliographies of these publications, conference proceedings, textbooks, state and Federal government documents, organizational reports, and doctoral dissertations published since 1977 across several domains. These domains included business, information technology, information systems, engineering, science and math education, as well as psychology and education in general. Search terms used were "computer self-efficacy," "computer self-efficacy scales," "teacher beliefs," "technology integration," "technology integration assessment," and "professional development." Variations of these terms ("teacher attitudes," for example) were also searched using a thesaurus. Databases searched included the Education Resources Information Center (ERIC), Academic Search Premier (EBSCO), PsycInfo, Dissertation Abstracts, and WilsonWeb OmniFile. Both qualitative and quantitative empirical studies were included in the search, and selections were made that represent a variety of theoretical perspectives, methodologies, populations, and purposes.

The doctoral dissertations completed in the past five years, in particular, have attempted to answer the question of whether teacher self-efficacy in regard to technology impacts their use of it in classrooms, and the answers are consistently affirmative. However, the evidence for such impact varies, and the kind of impact varies. Three main themes were detected in this literature—the uses of technology in classroom instruction by K-12 teachers, the evaluation of the effectiveness of such uses of technology, and the effects of teachers' self-efficacy in regard to technology on their integration of it in their classrooms.

Issues relating to technology integration have been reported in the *Journal of Computing in Teacher Education* (JCTE) since at least 1988, and yet the problem of fully integrating educational technology in teaching and learning in such a way that there are clear benefits to teachers and students has not been solved (Borthwick, 2007). Persistent problems require persistent research to find solutions. For example, both extrinsic and intrinsic barriers have been identified that prevent the kind of use of educational technology that is needed to impact student outcomes.

The research of interest to this study sought to determine the effects or relationships between academic motivation and self-regulation in general and in particular how the computer self-efficacy beliefs of teachers relate to their instructional practices and to various student outcomes. This review describes empirical studies and published journal articles, reports, and books that have contributed to the formulation of the research questions and background to this study of computer self-efficacy as it relates to teachers' integration of educational technology.

Extrinsic Barriers to Integrating Educational Technology

A frequently cited barrier to full educational technology integration in teaching and learning in U.S. classrooms is lack of access. This is a surprising finding since the latest National Center for Education Statistics report on Internet connectivity reports that nearly 100 percent of U.S. public schools had access to the Internet by 2005 (Wells & Lewis, 2006). However, access to technology and its presence in the classroom does not imply use.

A survey to which 3,665 K-12 teachers in four states responded was performed to examine how students used computers in the teachers' classrooms (Norris, Sullivan, Poirot, & Soloway, 2003). The survey (see the survey at www.snapshotsurvey.org) asked teachers to report the use of computers in terms of the number of minutes per week students would use a computer for curricular purposes in their classrooms. Of 3,625 teacher responses, 44.7 % reported less than 15 minutes per week of curricular use of computer technology by students. Another question on that survey asked teachers to report the curricular use by students of the Internet. Of 3,600 teacher responses, 67% reported less than 15 minutes per week of such use by students. Two other questions on the survey asked teachers to report the availability of Internet-connected computers for students in their classrooms or in shared computer laboratories. Either one or no Internet-connected computer for student use was reported to be present in the classrooms of 63.2% of the teachers. Of these, 38.6% reported seldom or no access to a shared computer laboratory with Internet access. Only 17.6% of the teachers reported curricular use of computer technology by students in their classrooms for more than 46 minutes per week, and 6.3% reported curricular use of the Internet by their students in their classrooms for more than 46 minutes per week. While these figures may not be representative of every state (the surveyed states were California, Florida, Nebraska, and New York), they reveal a need to more carefully examine what is meant by "access." If access means that only faculty or administrators have the ability to use the computers and Internet connectivity, there can be little impact on teaching and learning in terms of measurable student outcomes.

Lack of access has been echoed by other educational technology researchers. Borthwick (2007) reported that lack of access was fourth on a list of issues resulting from a brainstorming session with education graduate students who were integrating technology in K-12 classrooms. In the same *JCTE* issue, Schrum (2007) wrote: "It appears that there are large discrepancies between states and schools in the implementation of access and integration of technology" (p. 69). In a summary of a 1998 national survey of 4051 teachers in 1,100 schools, the Teaching, Learning, and Computing survey, Becker (2000) reported that a minority of teachers report frequent use of most computer applications. On the other hand, academic subject-matter teachers who had at least five computers in their classroom were among the top users of technology. This finding suggested that mere access to educational technology is insufficient; effective integration may require five or more computers per classroom.

Lack of access is one barrier. Even with access, however, educational technology must be used before it can have an effect on teaching and learning. Intrinsic barriers can inhibit use even when technology is available.

Intrinsic Barrier – Lack of Self-Efficacy

Educational technology may be present in a school, but it does not necessarily follow that teachers or students will have regular, reliable, durable, and dependable access to that technology for curricular use. Overcoming this barrier requires persistent effort. One effect of self-efficacy beliefs is that it is theorized to determine how much effort people will put forth to accomplish something, how long they will persist when confronting a barrier, and how much resilience they have in adversity (Bandura, 1977; Haney, Lumpe, Czerniak, & Egan, 2002). As Bandura (1997) wrote, "The acquisition of knowledge and competencies typically requires perseverant effort in the face of difficulties and setbacks. Therefore, it takes a resilient sense of personal efficacy to override the numerous dissuading impediments to significant accomplishments" (p. 72).

The Role of Computer Self-Efficacy in Technology Integration

In order for educational technology to be implemented in meaningful ways, teachers and students need access to that technology for curricular use. People with high computer self-efficacy may be more persistent in finding ways to incorporate educational technology in authentic learning experiences. An example of how high computer-self efficacy might be a factor in overcoming barriers to access arose during the pilot study conducted by the researcher (Hall, 2008). One of the teachers interviewed lacked regular, reliable access to educational technology, which she wanted to use with her students in project-based science lessons. She stated her solution to this problem was to collaborate with another teacher in the school to write a grant to obtain a laptop computer cart, with enough laptops for each student in a class to use. This is an example of someone who persisted when confronting a barrier, who felt strongly that having educational technology available for students would contribute to improved outcomes, and who believed the effort expended would yield desired results. It takes persistent effort to solve persistent problems. It may be necessary for teachers to have or to develop strong computer-self efficacy o overcome the access as well as other types of barriers to educational technology integration.

The Relationship Between Self-Efficacy and Other Teacher Attributes

The research studies reviewed provided varying degrees of evidence of a positive relationship between computer self-efficacy in teachers and the use of computers in daily classroom practice among K-12 teachers. However, other factors can affect technology integration. The levels technology integration can vary depending on the context in which it takes place (Coleman, 2004; Herman, 2002; Kite, 2004; Lorsbach & Jinks, 1999; Lumpe & Chambers, 2001; Pajares, 1997; Rackley, 2004; Whitehead, 2002). Levels of integration can also vary depending on whether technology is used primarily to deliver instruction (Bauer, 2002; Kite, 2004; Moersch, 1995), or whether it is integrated primarily to augment or improve instruction (Bansavich, 2005; Combs, 2003; DuBay, 2001; Kulik, 2003; Moersch, 1995; Ross, Hogaboam-Gray, & Hannay, 2001; Straker-Banks, 2002).

One study (Lam, 2000) examined why second-language teachers did or did not utilize technology in their classrooms, expecting to find that lack of self-efficacy would be a major factor. However, the study determined that such utilization might have been more related to teachers' beliefs about the effectiveness or efficiency of the technology than to their self-efficacy. The finding regarding the importance of teachers' beliefs about whether integrating technology in their instruction would be worth the effort was echoed in other studies (Atkins & Vasu, 2000; McNelly, 2004; Park, 2004; Windschitl & Sahl, 2002).

A need that was identified in the review was to distinguish between two uses of technology: as an instructional strategy to augment instruction that results in improved student outcomes, and as a strategy to deliver or transfer information (as in distance learning). In particular, more information is needed to determine whether the benefits of integrating technology in the classroom lies more in its capability of providing more or different (external) information than a teacher can provide without it (which may take us back to the delivery issue), or whether its value lies primarily in its ability to engage and excite students.

Impact of Self-Efficacy

Self-efficacy beliefs can have several results. These can be cognitive in that people can be optimistic or pessimistic when thinking about a problem or their future performance of a task. They can motivate people to accept challenges or to decline them. They can have emotional results, particularly in how people deal with depression and the stresses associated with their own and vicarious experiences. Finally, they can affect the decisions people make, such as whether to attempt a goal or task. Self-efficacy beliefs are asserted to be more predictive of future attainment than people's current knowledge, skills, or previous accomplishments (Zimmerman, 2000). This has important implications for any study of human development, but particularly for an endeavor in which one of the goals is to improve future performance.

The Impact of Other Variables

Does the grade level of the students, the content area being taught, the experience level of the teacher, or teacher age affect the relationship between teacher self-efficacy and integration of technology? Levels of self-efficacy and technology integration with elementary school teachers (Bauer, 2002; Chao, 2001; Coleman, 2004; DuBay, 2001; Kulik, 2003; Moersch, 1995); Nanjappa, 2003; Rackley, 2004; RameyGassert, et al., 1996; Ross, et al., 2001), middle school teachers (Atkins & Vasu, 2000; Bauer, 2002; Bull, 2002; Wetzel, 2002), and secondary or high school teachers (Bauer, 2002; Combs. 2003; Kemp, 2002; Straker-Banks, 2002; Varner, 2003) did seem to vary, but no study emerged that specifically addressed that issue beyond describing the levels of technology required at the various grades. For example, the level of technology integration needed and the extent of that integration mandated by national and state standards in grades 9 through 12 is much greater than that required at elementary levels. Only one doctoral dissertation research study (Bauer, 2002) of the reviewed literature included all three levels in a study of 30 teachers in two elementary schools, one middle school, and one high school. Additional and similar studies with attention to differences among the teaching levels may prove valuable in enabling teacher education programs to more appropriately target teachers' future classroom contexts.

The number of years of experience of teachers showed, somewhat surprisingly at first, an inverse relationship with self-efficacy, with "newer" teachers (whether that meant younger or more recently graduated from teacher education programs) reporting higher levels of self-efficacy in regards to technology (Kemp, 2002). However, improvements in technology integration into teacher education programs and the growing pervasiveness of technologies in recent graduates' classrooms in general may be a factor, and may be worth considering at length. A gap in the literature was found in addressing the differences between "digital immigrants" and "digital natives." Prensky (2001) defined digital natives as students who have "…spent their entire lives surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age" (p. 1), and digital immigrants as those who "were not born into the digital world but have…become fascinated by and adopted many or most aspects of the new technology (p. 1). The gap arises from the perspective, which in implied in Prensky's definition but not in later uses, that *digital* immigrants are not necessarily or even commonly *technology* immigrants. It may be useful to distinguish between these in determining technology self-efficacy, particularly when attempting to relate differences in the relationship between self-efficacy and technology integration to immutable but perhaps relevant attributes such as age (Coleman, 2004).

Instruments Used to Assess Self-Efficacy

A variety of instruments have been used to assess teacher self-efficacy, from surveys and questionnaires designed specifically for a given study, to validated instruments that are generally available to the research community. The Teachers' Attitudes Towards Information-Technology Scale (TAT) was used by four studies (Bull, 2002; Green, 2006; Herman, 2002; Kemp, 2002). The Computing Concerns Questionnaire (SoCC) and the Teaching with Technology Instrument (TTI) was used by one (Atkins & Vasu, 2000). The Level of Technology Integration (LoTI) instrument and the Computer Self-Efficacy Instrument (CUSE) were used by Johnson (2006) in his doctoral dissertation study of 133 Georgia teachers concluded that teacher training and personal computer use positively affected teacher self-efficacy, but did not affect their instructional practice to the same extent. A Computer Self Efficacy Scale and the Level of Technology Implementation questionnaire were also used in a comparison study of first- and second-year K-12 teachers (Helms, 2004) with the result that there was no statistically significant correlation between self-efficacy and technology implementation in first-year teachers; however, there were differences in the second-year teachers, with the researcher recommending a greater examination of the impact of mentoring on beginning teachers' self-efficacy and technology implementation. Another study used three instruments, Teachers' Computer Attitudes, developed specifically for the study, the Teacher's Sense of Efficacy Scale-Short Form from Tschannen-Moran, Woolfolk, &

Hoy's (1998) study and a demographic survey (Green, 2006). A statistical analysis of teachers in 19 teacher education programs used a 30-item Likert-like scale (Callaway, 2004). Beliefs About Teaching with Technology (BATT) and Microcomputer Utilization in Teaching Efficacy Belief Instrument (MUTEBI) were used by Lumpe & Chambers (2001). One study used five instruments: the Concerns-Based Adoption Model (CBAM) for measuring the levels of use of technology, a second CBAM for measuring the stages of adoption of technology, the Apple Classroom of Tomorrow (ACOT) instrument, the Teachers' Attitude Toward Computers (TAC), and the Technology Proficiency Self-Assessment Instrument (TPSA) (Swain, 2006). This study reported that student teachers' anticipated use of technology was heavily influenced by whether they believed that use would be efficient or worth the effort. Finally, one study that focused on a female teacher education population used three instruments, a Technology Self-Efficacy Scale, Intent to Use Technology Survey, and a Sources of Self-Efficacy in Computer Technology Use instrument and found that access to a computer at home the most important predictor of anticipated technology use (Novick, 2003). As a result of this review, the use of at least two instruments—one to measure or evaluate teacher self-efficacy with technology, and one to measure the integration of technology into that teachers' instruction—should be used to provide the most convincing and relevant results.

Need for Current Study

This literature review revealed that, although significant relationships between computer self-efficacy, the nature and extent of professional development provided to teachers, years of teaching experience, and the integration of technologies in the classroom have been shown to exist, they have not always been examined together in the same study. A study was needed that focused on these four aspects in particular.

One aspect of computer self-efficacy that emerged from this review as a possible area for future investigation was the belief of teachers as to whether the time and energy required to learn and implement a technology in the classroom would be justified in terms of successful outcomes. This aspect, along with both mutable and immutable attributes such as access, usage, availability of support, and age, have been suggested by previous studies as important determinants of the integration of education technologies in the daily classroom practice of teachers. This review provided the foundation for developing research questions around the beliefs of teachers of varying degrees of experience and the extent to which they integrated technology in their classrooms to identify whether those beliefs might have an impact on that usage.

Chapter 3. Research Design and Methods

The study was proposed in 2007 to examine factors that research had shown to influence the integration of technology by teachers, as shown in Figure 1. These factors include teacher beliefs regarding the use of technology in classrooms and their practices around the integration of technology as manifested by their classroom activities, lesson plans, and dialogue about technology.

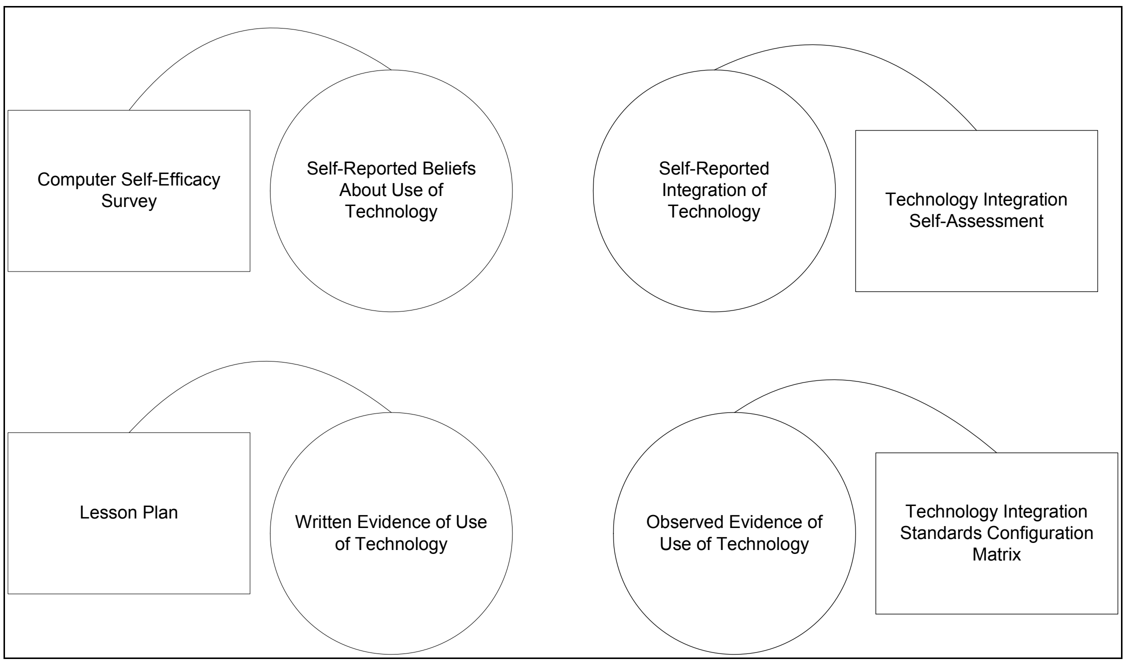

Figure 1. Study design for teachers' integration of technology in the classroom

The conceptual framework arising from the pilot study that laid the foundation for the current study is represented in Figure 2. As illustrated by the framework, the study examines technology from the perspective of who uses it, where it used, and when it is used. The inner circle targets the “what” (educational technology), the “who” (in-service teachers), the “where” (local school districts, and the “when” (during classroom teaching).

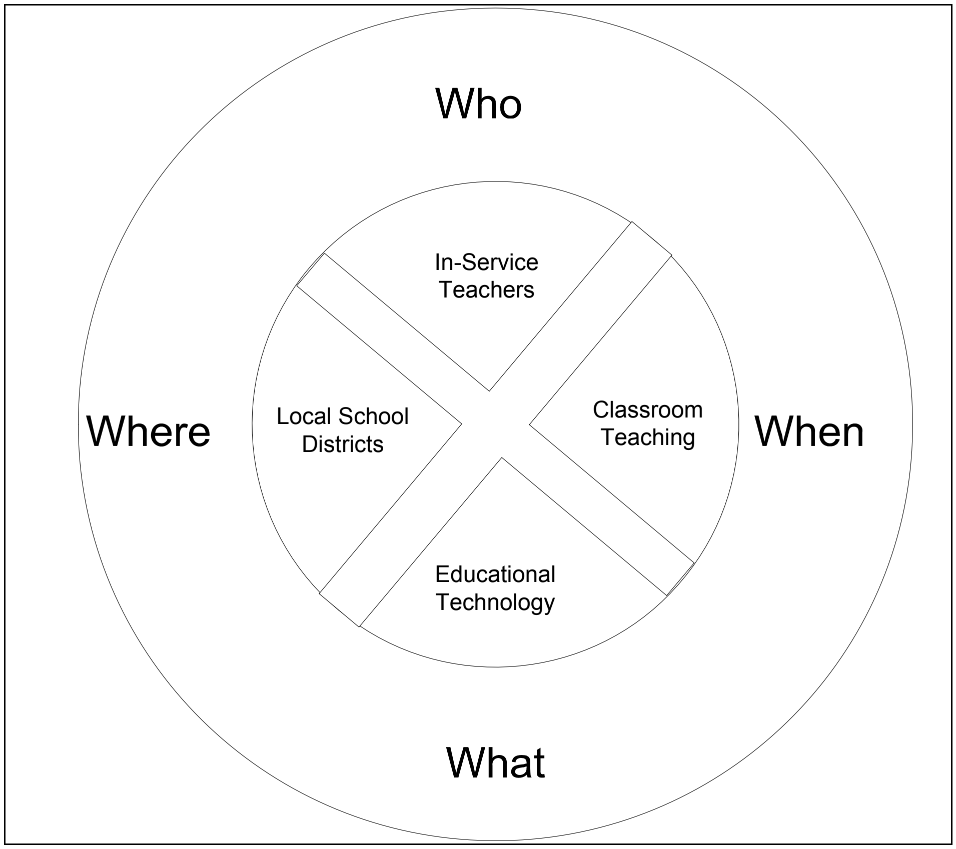

Figure 2. Conceptual framework for examining technology integration

The study took place over approximately three months with in-service secondary science, math, and technology teachers in schools in a large Midwestern metropolitan area. The research design included a qualitative approach, since several of the studies mentioned previously (Bitner & Bitner, 2002; Zhao & Frank, 2003) urged a greater emphasis on the teacher as an agent of change when studying the integration of technology into the classroom. Qualitative aspects were too often ignored by researchers using only quantitative analysis. Teachers' beliefs about their ability to effectively use educational technology or their computer-self efficacy and their current level of integration of such technology in their classroom instruction were measured. In addition to level of integration assessment, follow-up interviews and classroom observations were conducted to determine whether the self-assessments match observations and interview data. Field notes and interviews were utilized to minimize bias, as well as to detect patterns that might otherwise have been overlooked (Patton, 2002). Finally, information regarding teaching experience and professional development was captured for qualitative assessment and their expository support of quantitative findings.

Population

According to the Department of Education statistics for the region under study, there were 867 full time equivalent (FTE) teachers in the districts in which this investigation took place in the year 2006-2007, the latest year for which statistics were available (http://ilrc.ode.state.oh.us).

The school district to which this study assigned the pseudonym "Willow School District" listed on its published fact summary 130 high school teachers. The school district assigned the pseudonym "Pine School District" listed on its published fact summary 125 high school teachers. The comparable size of the faculty supported the comparisons of the use of these two school districts in examining the integration of educational technology in the classroom.

The study solicited participation from high school teachers in mathematics, science, and computer technology who taught in the two secondary schools in the greater metropolitan area. A minimum of three teachers was anticipated for a case study analysis that would provide thick descriptions of teachers' attributes, attitudes, and practices. A maximum of 30 teachers was anticipated for a quantitative analysis. The purposeful sampling from school districts within the same metropolitan area and in close proximity to each other ensured contextual relevance of teachers' experiences to pre-service teacher education and to professional development programs in the study area.

Sample

Of the 88 teachers of mathematics, science, and computer technology at the two schools who were invited to participate in the study, 20 teachers volunteered. Of these 20, 17 participants completed the study within the data collection period.

Each volunteer was assigned a study code number and pseudonym that was used to refer to them throughout their participation, and which was used to identify and correlate the instruments, interviews, and observations upon transcriptions and data entry. Examples of the codes and pseudonyms that were assigned to the participants are shown in Table 6.

Table 6

Examples of Codes and Pseudonyms

Participant Code	Pseudonym	Grade(s)	Subject(s)
P0402	Kelly	11, 12	Chemistry, Physics
P0403	Chris	11, 12	Science
P0404	Jamy	11, 12	Science
P0405	Alex	11, 12	Science
P0406	Lee	11, 12	Science
P0407	Lynn	11, 12	Science

Pine School District's Web site listed classes for seven foreign languages, a 90% college attendance rate, and a graduation rate of 97%. The site claimed 82% of its certified teachers had at least a master's degree, and 31 teachers held National Board certification. Two of the participants from this school subsequently identified themselves as holding doctorates. The district expenditure per pupil was listed at over $12,000 per year, with most of its budget derived from local sources such as residential taxes. The district listed 21 National Merit Scholars for the year reported, and, coincidentally, 21 Advanced Placement or Accelerated courses were listed. The high school Web site listed the 55 high school mathematics, science, and computer technology teachers with courses ranging from transitional mathematics to multivariable calculus, from transitional science to physics, and from basic computer applications to advanced techniques such as animation.

Willow School District listed on its Web site 1,850 high school students in grades 9 through 12. The site stated that the district was founded more than 120 years ago, making it one of the oldest schools of the metropolitan area. The district expenditure per pupil was listed at over $14,000 per year. The Web site stated more than 80% of its teachers had at least a master's degree, and fewer than 10 teachers held NBTC certification. The average years of teaching experience was 17. The high school had its own Web site with an online staff directory. Examination of this directory revealed 33 of the teachers listed taught science, mathematics, and computer technology courses. Courses were not identified as transitional or advanced on the Web site.

The quality and quantity of content on the Web sites varied greatly from basic contact and course information to multimedia insertions and accompaniments. The apparent recency of content posted on the Web sites varied from 2005 to 2007. All district teachers' Web sites were listed as links on a single Web page

Focus

Based on the pilot study (Hall, 2008) and the literature review, several variables were identified that appeared to contribute to the integration of technology. These are illustrated by Figure 3. The intent of the diagram is to show computer self-efficacy, teaching experience, and professional development related to technology have been studied and found to be associated with technology integration. The diagram does not intend to suggest that a cause-effect relationship has been found to exist among these variables and technology integration.

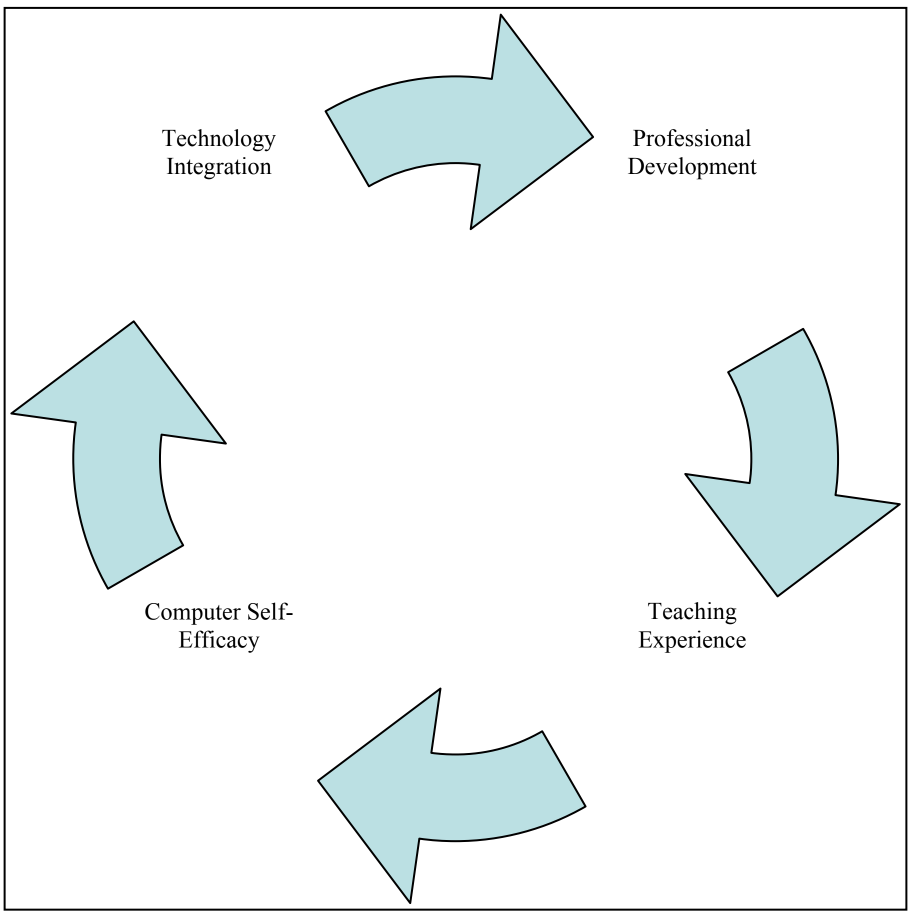

Figure 3. Variables associated with technology integration

The pilot study also resulted in the identification of numerous influences that arose as questions teachers asked that could affect decisions around how, when, and why to integrate technology. These questions are illustrated in Figure 4. As illustrated by the figure, these questions fell into a composite of beliefs about teachers' own uses of technology as well as beliefs about their access to and training on the technology. The questions guided the researcher to seek instruments to use in the current study that would address not only the self-efficacy beliefs of teachers in relation to educational technology skills, but also the beliefs of teachers in relation to their current uses of educational technology in their classrooms, their professional development, and their access.

Figure 4. Questions teachers asked

Recruitment

Teachers in the targeted area were invited via an E-mail to participate in the study. Those who indicated their willingness to participate were provided with a consent form, two surveys, and the semi-structured interview questions. They were asked to designate a time and place for meeting with the researcher. The recruitment E-mail used in this study is shown in Appendix E.

Informed Consent

Participants were asked to sign an informed consent form as soon as they indicated their willingness to participate in the study. Printed forms were provided to participants upon request to avoid placing additional time and cost demands on participants. Participants completed these forms and returned a signed copy of the signature page to the researcher before data collection began.

Anonymity/Confidentiality

All personal information about the volunteers and participants was kept confidential. Only the researcher had access to a key that paired the assigned code to the actual participant. Identifying information on surveys was removed before input and data were summarized so that specific individuals or their associated schools could not be identified. The digitally recorded interviews were transferred from the recorder to the researcher's computer and filed under the assigned code rather than actual name. Actual names were likewise replaced with assigned codes on printed copies of participants' lesson plans and other observation data. Handwritten field notes did not refer to actual teacher or school names but to pseudonyms and assigned codes.

Gender-free pseudonyms were assigned to volunteers to further protect their identities. These pseudonyms have been used in the descriptions throughout this study and in its reports and findings.

Participants received no incentive for participating in the study. They and their school district administrators could request and receive a copy of the final version of the dissertation in which their data were used.

Surveys

The evaluation plan included assessment of teacher perceptions of their computer self-efficacy beliefs and their conscious use of educational technology in their classrooms. The task-specific, computer self-efficacy self-assessment instrument, referred to as the CSE, is shown in Appendix A (Albion, 2001). The extent to which teachers believed they integrated technology into their instruction was also self-assessed using a technology integration self-assessment, referred to as the TISA, and is shown in Appendix B (Mills, 2003). The surveys included also collected demographic data such as age, gender, and years of teaching experience, and the number of weeks of technology-related professional development. Observation of teachers was performed using field notes and a technology integration instrument corresponding to the technology integration self-assessment described in Appendix C.

Interviews

Semi-structured interviews were conducted with the participants using a digital voice recorder and a five-question interview guide shown in Appendix D. Interviews were transferred from the recording device to the researcher's computer, then transcribed using a software application designed to transcribe the digitally captured voice data. The researcher then read through the software-generated transcriptions while listening to the digital audio and made corrections where necessary. All information that could identify the participant or particular school or school district was removed from the transcript at that time and a pseudonym and assigned code was used in analysis, description, and quotations. The researcher also wrote field notes before, during, and after the interviews. These field notes were analyzed and are reported in Chapter 4. They provide contextual relevance as well as establishing voice and perspective to the findings.

Observations and Lesson Plans

Participants were observed teaching a class in which they integrated technology. The participants were observed at the time, date, and class they selected. The researcher wrote field notes before, during, and after the approximately 50-minute class periods. The observations focused on the participants' integration of technology and were compared to lesson plans that were provided by the participants.

An instrument was used during observation that corresponded to the participants' self-reported assessment of their use of technology in the classroom using the TISA. This instrument, The Technology Integration Standards Configuration Matrix (TISCM), was also developed by Mills (2003). Using this instrument provided the researcher with a consistent, structured way to compare observations as well as to verify participants' perceptions of technology use in the classroom. This instrument is shown in Appendix C.

Research Plan

Previous studies suggested that teachers need to have from three to five years teaching experience to be able to effectively integrate technology (Byrom & Bingham, 1998). For this reason, the number of years of teaching experience for each participant was gathered as part of the self-assessment, along with the number of weeks of professional development related to technology that the teacher stated they had received.

Teachers' beliefs about their ability to effectively use educational technology (computer self-efficacy) and their levels of integration of such technology in their classrooms were measured using the self-assessments. The extent to which technology was being integrated into their instruction was also assessed by the researcher using a level of technology integration scale. A lesson plan from participants was collected as a triangulation strategy for the self-assessment and subsequent classroom observations.

Research Questions and Hypotheses

The primary research question addressed in this study was "What is the relationship among the integration of educational technology in the teaching of in-service, practicing teachers with computer self-efficacy, weeks of professional development, and years of teaching experience?"

Based on the literature review and pilot study, the focus of this research was on establishing first whether beliefs and practices as reported on the self-assessments would be correlated and, if such correlation existed, which areas of the beliefs showed the closest correlation to the integration of technology. These correlations would then be compared with the reported teaching experience and professional development to determine whether any one of these variables would be found to have the stronger relationship.

Independent and Dependent Variables

The independent variables in this study were the perceived computer self-efficacy, years of teaching experience, and weeks of professional development of the teacher participants. Based on previous studies, the participants of this study were anticipated to represent a range of experience. Therefore, years of teaching experience were collected at the beginning of the study as part of the computer self-efficacy self-assessment.

The dependent variable of perceived technology integration in the classroom was expressed in terms of the score received on the instrument used to capture the data (the TISA). Weeks of professional development training received by the participants were collected as part of the technology integration self-assessment.

Instruments

The following instruments were used with the permission of their authors (Albion, 2001; Mills, 2003) to collect data on the dependent measures for this research study and are printed with the permission of their authors in the indicated appendices:

1. Self-Efficacy for Computer Technologies scale (CSE) (Appendix A)
2. Technology Integration Self-Assessment (TISA) (Appendix B)
3. Technology Integration Standards Configuration Matrix (TISCM) (Appendix C)
4. Interview Guide (Appendix D)

A 53-item version of Delcourt & Kinzie's 46-item computer self-efficacy instrument was modified to add questions and was validated in a study by Albion (2000) of teacher education students. Based on a modified version of a previously validated instrument (Delcourt & Kinzie, 1993), Albion tested the Self-Efficacy for Computer Technologies (SCT) on 175 college students in primary or early childhood education. The SCT was administered twice in a pre- and posttest design. The statistical results were analyzed using SPSS with significance levels set at $p < .01$. The matched responses were analyzed using principal components analysis and Kaiser's criterion and Varimax rotation with pairwise exclusion for missing values. This type of analysis is appropriate for combining two correlated variables into a single factor and for identifying factors that show the least variance. The Kaiser criterion was used to determine which components to retain. Varimax rotation with pairwise exclusion for missing values was used to examine factor loading. The resulting six-factor solution accounted for 74.7% of the total variance. An alpha reliability estimate of .98 was obtained for the 53-item instrument, which Albion used to support the use of a single, composite score for the SCT. Reliability estimates for each of the scales were reported as follows: beliefs about using electronic mail, .96, beliefs about using the Internet, .95, beliefs about using word processing, .95, beliefs about using an operating system, .91, beliefs about using spreadsheets, .94, beliefs about using databases, .94, and beliefs about using CD-ROM databases, .92.

The scales were checked for external validity by examining the correlations between the values obtained in post-test and other variables. The results indicated that self-efficacy for computer technology was significantly correlated with the grades obtained on a training unit that provided basic computer skills, and which might be expected to increase confidence in the use of computers (Albion, 2001). The SCT instrument with its original scale is shown in Appendix A. It is referred to in this research study as the CSE (Computer Self-Efficacy), and was used by permission of the author in the form and format provided by the author. Indicators for participant identification, gender, age, years of teaching experience, and subjects and grade levels taught were added for the convenience of participants to aid in the collection of data regarding these variables, and thus did not affect the validity or reliability of the CSE instrument.

Two instruments were used for determining the extent to which teachers integrate technology. The Technology Integration Self-Assessment (TISA) which was validated and used by permission of the author without modification (Mills, 2000). The instrument lists statements designed to determine technology integration practices used in curricular activities. Each statement is accompanied by five subsequent statements that indicate the degree to which a technology has been integrated, in decreasing order of complexity, and including a final choice "None of the above." Participants could choose one or more of the subsequent statements to indicate the degree to which they integrated one of 18 practices, or they could choose the final item to indicate that they did not integrate that particular technology or practice in their curricular activities. This instrument was modified to include an item requesting the number of weeks of professional development and is shown as used in Appendix B.

The administration of the two self-assessment instruments was followed by observations of the teachers' technology integration practices in their classrooms. Observations were recorded as field notes, and teachers were rated to indicate the degree to which they were observed integrating technology in curricular activities using an instrument titled Technology Integration Standards Configuration Matrix (TISCM). This instrument, created by Mills (2003), corresponds to the TISA in every respect, except the practices are arranged into a grid that identifies those practices associated with international and national technology integration standards and ranging from Ideal to No Use. This TISCM instrument was used without modification by permission of its author (Mills, 2003) and is shown as used in Appendix C.

Two participants from each school were interviewed using the Interview Guide, which is provided as administered in Appendix D. This interview guide included five of the 10 questions used in the pilot study that focused directly on how teachers use technology in the classroom, how their experiences helped them to integrate technology, and why they thought technology helped students learn. Interview data were captured on a digital recording device that uses accompanying proprietary software to enable the digitized interview to be downloaded onto the researcher's computer and played back at varying speeds for transcription. The interviews were coded using the indexing capability of Microsoft Word to mark words and phrases throughout the interview transcripts. These marked entries were then listed in an index that was generated, which referenced the location of each entry. From these marked entries, themes were identified. A sample of the classes was observed and the technology integration practices of the teachers were recorded on the TISCM by the researcher.

Data Sources

The quantitative data collected are described in the discussions of independent variables and dependent measure. The data reported on instruments were triangulated with qualitative data obtained from field notes, observation notes, the TISCM, sample lesson plans, and interviews conducted with teachers using the Interview Guide.

Quantitative Analysis

Of the 18 participants who volunteered, 17 provided self-assessments by the date needed for inclusion in this analysis. The participant responses to the self-assessments resulted in 92 data points per participant. These were analyzed using descriptive statistics, parametric and nonparametric tests, and analysis of variance, the results of which are described in the results.

The information gathered included age group, length of teaching experience (in years), and length of time spent in technology-related professional development time (in weeks). These data were gathered as part of the CSE and TISA.

This study was designed to incorporate a triangulation strategy by combining more than one means of determining whether similar findings are achieved, as recommended by Patton (2002). In addition to this triangulation, layering of data provided deeper comprehension. The layers of qualitative data resulting from this study began with demographic information that included participant names, the schools at which they taught, and the courses and grades they taught. The next layer consisted of field notes to situate the contexts. The next layer consisted of transcribed interviews. The final layer consisted of the conclusions based on inductive and deductive reasoning as a result of examining the statistical results and the qualitative data.

Other Procedures and Research Schedule

As previously mentioned, field notes taken by the researcher included information about the learning environment of the participants, facilities, and community in which the schools are located. Recorded interviews with a sample of the teachers using an Interview Guide were transcribed and analyzed along with field notes, census data, and the TISCM ratings.

An automated indexing tool embedded in a current word processing package was used to capture and code references to educational technology, curricular use of technologies, and experiences with technologies that emerged from the interview transcriptions. Field notes were also analyzed for references to types and uses of technology.

The results of the quantitative analysis of the collected data from the administered instruments are triangulated with qualitative data to detect obvious patterns or discrepancies.

It was determined that schools within the same location and of similar size in terms of student population would provide greater insulation against confounding variables that might be otherwise be introduced. Four candidate schools were identified and census data collected in the fall and winter of 2007.

Entrée into the schools was initiated by the researcher in 2007 by contacting principals of four candidate schools in the greater metropolitan area while Institutional Review Board (IRB) review and approval was in process. Directories that included contact information for all science and math teachers in these schools were downloaded or obtained in print form from the candidate schools in preparation for the recruitment effort.

Approval for the study was obtained from the IRB in February, 2008. Upon approval, consenting principals were notified that the study could commence, and a recruiting E-mail was sent with their approval to teachers in two of the candidate schools. Principals were not told by the researcher which teachers volunteered to participate. They were notified only that the recruitment had been completed and that volunteers had participated.

The teachers from the two schools who volunteered to participate in the study were asked to complete a consent form, to complete the CSE, and to complete the TISA.

They were asked to provide a lesson plan incorporating technology and to provide a time and date for an interview and a classroom observation. Five classroom observations subsequently took place, four lesson plans were collected, and four interviews, two from each school, were recorded, within the constraints of the study time frame and participant schedules.

Field notes were taken by the researcher throughout the study. Observations of teachers' use of technology in their classrooms were conducted at times and during classes agreed upon by the teachers. The researcher evaluated the integration of technology using field notes and the TISCM. Participant interviews were conducted with teachers following these observations using the Interview Guide.

Chapter 4. Results

Naturalistic inquiry and open coding were used for transcription, field note, and observation note analyses (Strauss & Corbin, 1998; Patton, 2002). Questionnaire data were analyzed using descriptive statistics and analysis of variance (Gravetter & Wallnau, 2004). The results of these analyses are reported in this chapter.

Qualitative Analysis

The triangulation strategy employed by this mixed-methods study involved using field notes, transcribed participant interviews, lesson plans obtained from participants, and observation data obtained using the TISCM.

Themes Emerging from Interview Data

The indexed interview data from participants P0304 and P0304 with the pseudonyms Chris and Jamy from Pine High School, and from participants P0406 and P0407 with the pseudonyms Lee and Lynn from Willow High School were analyzed to determine emergent themes as recommended by Strauss & Corbin (1998). Summary data derived from the interviews are provided in Appendix F. The summary provides the dates and settings of the interviews, along with a table that lists each interview question and the summarized participant responses.

The Interview Guide questions were intended to elicit at least four categories of statements: those providing examples of how participants used technology in their classrooms, those providing evidence of beliefs about why participants used technology in their curricular activities, and those providing evidence of how participants were influenced by professional development and other types of experiences. A final question was posted to soliciting opinions or comments that were not targeted by the Interview

Guide. Using the two categories of technology use and technology beliefs as guides, a two-pass analysis took place. On the first pass, indexed statements specifying participants' use of technology were placed into a table and 24 themes were identified. On the second pass, indexed statements specifying participants' beliefs about technology were placed into a different table and 17 themes were identified.

The coding table used in the analysis is provided in Appendix G. In Table 28, the indexed statements related to technology use are listed. In Table 29, the indexed statements related to beliefs about technology are listed. From that data, themes were identified and indexed phrases classified as either supporting participant integration of technology, or statements supporting participant beliefs about technology.

Support of Technology Integration

There were 62 statements from the combined participant interviews that were classified into 24 themes providing evidence of the participants' integration of technology:

1. Computer Laboratory: 3 instances
2. Data Projector: 1 instance
3. Digital Microscope: 1 instance
4. Electronic Books: 2 instances
5. Electronic Laboratory Equipment: 1 instance
6. Electronic Whiteboard: 15 instances
7. E-mail: 1 instance
8. Extent: 1 instances
9. Instructor Desktop Computer: 1 instance

10. Internet: 7 instances

11. Laptop Carts: 1 instance

12. Laptops for Students: 1 instance

13. Learning Management System: 6 instances

14. Lesson Planning: 2 instances

15. Location : 1 instance

16. Personal Audio Device: 2 instances

17. Personal Response System: 2 instances

18. Professional Development: 1 instance

19. Simulation Software: 1 instance

20. Software: 3 instances

21. Student Use of Technology: 5 instances

22. Time of Use: 1 instance

23. Troubleshooting: 1 instance

24. Wireless Tablets: 1 instance

These 24 themes were collapsed into 13 categories of use as follows:

1. Classroom Hardware and Equipment

    a. Computer Laboratory: 3 references

    b. Data Projector: 1 reference

    c. Digital Microscope: 1 reference

    d. Electronic Laboratory Equipment: 1 reference

    e. Electronic Whiteboard: 15 references

    f. Instructor Desktop Computer: 1 reference

g. Personal Response System: 2 references

h. Wireless Tablets: 1 reference

2. Electronic Books: 2 references

3. E-mail: 1 reference

4. Extent of Use: 1 reference

5. Internet: 7 references

6. Student Use of Technology

    a. Laptop Carts: 1 reference

    b. Laptops for Students: 1 reference

    c. Student Use of Technology: 5 references

7. Administrative and Classroom Management Use

    a. Learning Management System: 6 references

    b. Lesson Planning: 2 references

8. Location of Use: 1 reference

9. Personal Audio Device Use: 2 references

10. Professional Development: 1 reference

11. Software Use

    a. Simulation Software: 1 reference

    b. Software: 3 references

12. Time of Use: 1 reference

13. Troubleshooting: 1 reference

The participants' indexed responses were counted to determine the number of times they uttered phrases that supported the integration of technology in their classroom or in their teaching activities, as follows:

- P0403: 17
- P0404: 10
- P0406: 15
- P0407: 20

Participant P0407 (Lynn) made the greatest number of references to technology use. Lynn taught a science course at Willow High School in a classroom with an instructor desktop computer, an electronic whiteboard, and personal response system devices. There were no computers available for use by the students in the classroom, but a shared computer laboratory was available for scheduled use by students.

Technology Integration Barriers

Barriers to the integration of technology were identified five times in a single participant interview and thus emerged as a theme. Participant P0406 (Lee) made the following references to barriers:

1. No regular access to individual computers in the classroom
2. Advance scheduling of shared computer laboratory for student use
3. No access to an electronic whiteboard
4. Lack of comfort using classroom equipment
5. Lack of knowledge using classroom equipment

Lee taught at Willow High School in a science classroom in which there was a single instructor workstation computer connected to a large-screen television. The computer had access to the Internet, but as in Lynn's classroom, there were no computers available for use by the students. A shared computer laboratory was available for scheduled use by students.

Evidence of Beliefs

There were 97 phrases indexed from the four participant interviews that were classified into themes providing evidence of the participants' beliefs surrounding the integration of technology. The themes emerging from this analysis follow:

1. Barriers: 21 references
2. Classroom Management: 2 references
3. Data Projector: 1 reference
4. Electronic Books: 2 references
5. Electronic Laboratory Equipment: 1 reference
6. Electronic Whiteboard: 11 references
7. Enablers: 6 references
8. Internet: 3 references
9. Laptop Carts: 3 references
10. Learning Management System: 5 references
11. Personal Response System: 1 reference
12. Professional Development: 1 reference
13. Software: 1 reference
14. Student Benefits: 17 references
15. Student Computers: 1 reference
16. Technology Integration: 19 references

17. Wireless Tablets: 1 reference

These 17 themes were collapsed into 8 categories of beliefs, as follows:

1. Classroom Hardware and Equipment
    a. Data Projector: 1 reference
    b. Electronic Laboratory Equipment: 1 reference
    c. Electronic Whiteboard: 11 references
    d. Laptop Carts: 3 references
    e. Personal Response System: 1 reference
    f. Student Computers: 1 reference
    g. Wireless Tablets: 1 reference
2. Electronic Books: 1 reference
3. Enablers: 6 references
4. Internet: 3 references
5. Administrative and Classroom Management
    a. Learning Management System: 5 reference
6. Software: 1 reference
7. Student Benefits: 17 references
8. Technology Integration: 19 references

The participants' indexed responses were counted to determine the number of times they uttered phrases that supported beliefs about technology in their classroom or in their teaching activities, as follows:

- P0403: 17
- P0404: 17

- P0406: 26
- P0407: 35

Participant P0407 (Lynn) made the greatest number of statements indicating beliefs about the integration of technology. As mentioned previously, Lynn taught a science course at Willow High School in a classroom with an instructor desktop computer, an electronic whiteboard, and personal response system devices. There were no computers available for use by the students.

Participants P0403 (Chris) and P0404 (Jamy) made the smaller number of beliefs about technology. These participants both taught at Pine High School. Jamy was observed teaching in a classroom with an electronic whiteboard, student computers, and electronic laboratory equipment. Chris was observed teaching in a classroom with an instructor desktop computer and with electronic laboratory equipment brought into the room on a portable cart.

Field Note Summaries

In order to set the stage for the descriptive statistics to follow, it is useful to give visuals and voices to the participants, their classrooms, technologies, settings, and communities. A comparison of the two schools using information derived from field notes is shown in Table 7. Excerpts from field notes and observation notes taken during visits to the schools are then presented. Naturalistic coding was used for analysis of the field notes (Patton, 2002).

Table 7

Participating School Characteristics

	Willow	Pine
Community	Historically manufacturing and	Historically residential with

	Willow	Pine
	residential, becoming large box retail.	small retail.
School	Draws students from entire urban region, diverse mix of upper and lower socio-economic status (SES) areas.	Draws students from primarily suburban region, homogenous student population and upper and middle income SES areas.
Entrée	Limited administrative support. Restricted access. Delayed visitor greeting. Close supervision outside the classroom. Visitor not invited to share common access area for teachers.	Strong administrative support. Open access. Prompt visitor greeting. No supervision once admitted. Visitor invited to share common access area for teachers.
Classroom	Large area classrooms, with laboratory stations and traditional classroom seating configurations. Locked doors during observations.	Mixed; some large area classrooms with laboratory stations behind traditional classroom seating configurations; some small classrooms without televisions or electronic whiteboards. No locked doors during observations.
Participants	Low levels of experience science teachers.	High and medium levels of experience science and mathematics teachers.
Technology	Traditional science laboratory equipment. Electronic whiteboard. Data projector. Retractable projection screen. Instructor desktop computers and printers. Large-screen televisions. Telephones. Intercom system used infrequently during observations. Bell periods marked by loud ringing. Student access cards with barcodes. Security sensors.	Traditional and electronic real-time science laboratory equipment. Scientific and graphic calculators. Electronic whiteboards. Data projectors. Retractable projection screens. Instructor desktop computers and printers. Wireless tablet. Wireless mouse. Student desktop computers. Large-screen televisions. Telephones. Intercom system used frequently throughout observations.

	Willow	Pine
		Bell periods marked by three-toned chimes. Student passbooks signed by teachers.

Summary of Field Notes from First Visit to Willow

Depending on the direction from which Willow High School was approached, one gained a different impression of the community in which it is located. From one direction, the streets were wide and large, older style homes with spacious and well-kept grounds were numerous. From another direction, large retail centers lined four- and six-lane streets. From another direction, manufacturing plants with partially filled parking lots were passed. From yet another direction, small residences pervaded narrow streets.

All entrances other than the main one to the school buildings were restricted. On the first visit, two unoccupied police vehicles were parked at the entry sidewalk. Approximately eight students stood talking to each other in a close circle by the entrance. Although police were obviously present, the observer saw nothing amiss inside the building. A podium facing the entrance was unmanned and teachers were standing and talking in a casual manner in the hallway by a library. Announcements for upcoming field trips, senior prom, and test dates were posted on the walls and the bulletin boards by the office. The floor was clean. The burgundy carpeting appeared worn.

The office receptionist did not immediately greet the observer during this first visit. The observer waited for approximately 15 minutes to be greeted; once initial introductions had taken place, the receptionist became more conversant.

Summary of Field Notes from First Visit to Pine

Regardless of the direction from which Pine School was approached, a uniformly residential environment was observed. One- and two-story homes were observed. Some of the one-story homes had strollers, tricycles, and playground equipment in the yards. Many had large trees with branches pruned around power lines. Some were observed to have ramped entries, and some of the late-model cars in the driveways had handicapped tags, indicating elderly residents. The two-storied houses had more than one automobile in driveways or featured three-door garages, fenced back yards, and appeared empty early in the day.

There were no service stations or fast food emporiums nearby, but there were a few European-style bistros, a major chain grocery store, and a variety of small retail shops, banks, and professional offices. The school was set on a hillside, visible in all directions. Signs posted at both entrances led to the visitor parking lot, which was close to the main entrance. Two police vehicles, one from each of the bordering communities, were parked alongside visitor cars. These cars were empty, and just as at Willow, no apparent reason for their presence was observed.

The double-wide entry of the main school building was unobstructed. An unoccupied bench sat to one side. Just inside the entry, a sign on a brochure stand advertised colleges. Facing the front doors and just to one side was a small desk with a receptionist and a visitor registration log book. A stack of sticky visitor tags and a pen lay by the log book. To the other side was an open, U-shaped office with four workstations, two of them occupied, and an open door that led to what appeared to be additional offices within.

The floor featured a green carpet with white flecks. It did not appear to be as worn as the carpet at Willow. The observer was immediately noticed and greeted by the receptionist, who supervised the sign-in process and used the telephone at the desk to call the participant being visited during this observation.

Summary of Field Notes from First Participant Observation at Willow

The teacher with the pseudonym Lee waited at the classroom with the door held open, and closed the door behind the observer. The chemistry classroom looked much like any other science classroom, with desks in the front of the room, and with laboratory stations in the back of the room. The room held 24 individual desks set up in six rows, and six laboratory stations were arranged longitudinally in three rows. The wood-and metal fixtures appeared to be in good condition. Rows of beakers and test tubes lined up on glass-fronted shelves mounted to the inside wall. Venetian-blinded windows on the opposite side offered a limited view of a mature tree and metal picnic tables outside.

A tan personal computer with a 15-inch, flat panel monitor sat on a small table placed next to the instructor's desk at the front of the room. Above it hung a ceiling-mounted television with an empty videocassette recorder rack. A closed projector screen dangled from a corner, but no projector was observed. A security sensor was mounted to the wall high above the instructor's desk. The floor was white tile with some dark flecks, while the students' seats were blue. The room walls had large, colorful posters taped at intervals. A flag draped one corner, just above a tan, wall-mounted telephone. A pencil sharpener and paper towel dispenser were mounted by the exit, along with a printed bell schedule taped to the wall.

Although ventilation chambers ran across on the ceiling, there was no audible exhaustion or ventilation taking place during the observation. A first aid cabinet was hung by the lab station cabinet, alongside a fire extinguisher. Two plants sat on a case by the window—one palm that appeared to be dormant and one large, green bamboo plant that appeared healthy. Posters were hung on the upper halves of the walls, one extolling “The Scientific Method,” another listing “The Science Process Skills.” The posters used different colors, in contrast to the bland tones of the floors and walls. The horizontal blinds were pulled up, and two of the bottom sections of the cantilevered windows were open. Drawers below the lab stations were neatly labeled, “gloves,” “aprons,” and “goggles.”

Throughout the observation of approximately 60 minutes, the classroom door was closed. It must have been locked, because Lee needed to open it for a student who arrived late. A class roster was pegged to the bulletin board by the door. Lee spoke quickly through the lesson on acid rain. Lee distributed a worksheet and presented a presentation software slide show that was projected onto the large TV monitor from the computer. The slides followed principles of good graphic design, using a variety of colors and short, bulleted lists. Rather than reading the slides, Lee glanced at the slides and seemed to use the bulleted lists as cues for the lecture. After the slide presentation ended, Lee asked the students to complete their worksheets. Lee worked with each student who raised his or her hand. Experience with classroom management issues was demonstrated as Lee monitored and checked students’ behavior.

After class, Lee sat down beside the observer at one of the laboratory stations and described the technology used in the classroom. Use was sporadic, but used whenever it could be arranged. “Students are already used to it,” Lee said when asked why students like to use technology in the classroom. Lee stated that students use the shared computer laboratory located in the school library to prepare for the state graduate testing. The courses Lee taught were 11^{th} and 12^{th} grade chemistry and a general science class. Lee stated that more technology would be used if it were available to the class, but added that it would be good if there were more assistance during classes. “I’d use even more of my technology; I’m just not always sure how to troubleshoot it when problems arise.”

Subsequent Visits to Willow

On subsequent visits to Willow High School, the police vehicles were parked in the visitor spaces. The podium in the entryway was manned by a man and a woman, both of whom were dressed as security guards. The observer was immediately greeted and asked to sign in, take a badge, identify who was being visited, and record the time of arrival before proceeding to the office. The receptionist greeted the observer promptly and the observer was then permitted to pass unobstructed through the hallways. Adults dressed as security guards were observed at hallway junctions. No one was observed to greet them or talk to them. The newspaper reported on one morning following an observation that a gun had been removed from a student at Willow earlier in the day of that visit.

Subsequent Participant Observations at Willow

During subsequent visits, a different science classroom was observed that was similar in size and configuration to the classroom in which the previous observation occurred. However, in this classroom, the student desks and chairs were configured to face each other from opposite sides of the room, leaving a large space in between the front rows. The instructor station was in the front of the room, and none of the student desks faced it. This room again had colorful posters taped to the walls, but this one also had an electronic whiteboard mounted on the wall at the front of the room. The instructor's computer sat on the instructor desk to one side of the front.

The teacher with the pseudonym Lynn sat at the instructor desk in the classroom with the electronic whiteboard, starting up a presentation software slide show. As the class began, Lynn started the presentation from the instructor's desktop computer that was displayed on the electronic whiteboard. Lynn was animated while speaking to the class, using frequent vocal shifts in tone, volume, and pacing while presenting. Gestures and body language were used in explaining concepts. Lynn walked slowly from one side of the classroom to the other while presenting, and could be clearly heard from the back of the classroom.

Lynn referred to technologies to be used by the students the following day to obtain bacteria samples, and announced that a movie to demonstrate the procedure would be shown toward the end of the class. Lynn used the electronic whiteboard "advance" tool to click through the presentation and occasionally picked up a stylus to circle a part of a slide drawing depicting, for example, an *e coli* cell. "This is the capsule, this is the cell wall, and this is the cell membrane," Lynn stated while using the stylus to draw arrows to the different layers. The slide presentation featured hyperlinks to documents outside the presentation, as well as to different parts of the presentation. When Lynn clicked on them, illustrations and definitions were displayed. The slides used a variety of text fonts and colors to emphasize key terms, and the font sizes were large enough to be viewed from the back of the room.

Lynn started the movie, which had been embedded as an object in the presentation, and displayed it on the electronic whiteboard. The sound system provided sufficient amplitude. The film demonstrated proper techniques for swabbing and culturing bacteria. As the end of the movie approached, the bell sounded.

Subsequent Visits to Pine

On the second and subsequent visits to collect data from participants at Pine High School, the prompt greeting and immediate attention to visitors from the receptionist did not vary. The sign-in process was static, except the receptionist recognized the observer and engaged in small talk. The observer was allowed to proceed directly to the office of the participant. On one subsequent visit, however, a different department was visited. There was a short delay while the head of the department was telephoned and came to the front to meet and talk to the observer before introducing the classrooms and teachers. This procedure may have indicated that a protocol was being followed of the department head having the first contact with observers.

Summary of Field Notes from First Participant Observation at Pine

A science teacher with the pseudonym Alex greeted the researcher at the front desk only a few minutes after sign-in, and conducted a tour of the section of the school building set aside for the science classrooms, laboratories, and storage rooms. The researcher learned that Alex was a department head, and that Alex's support seemed to authorize the open access to Pine classrooms and frank communications with its science teachers.

The science laboratories held electronic sensors, a spectrophotometer, and other equipment that appeared to be new or only slightly used. Alex cited when each piece of equipment was purchased and how it was used by various science classes. A classroom in which Alex stated physics was taught featured on its student workstations a variety of motion detectors, microphones, force probes, electricity sensors, and other real-time data probes. A laboratory was observed that Alex stated was set aside for biotechnology classes. Tables with light boxes for geminating seeds and growing plants lined one end of the room. Banks of planters and sacks of potting soil were stacked in a corner. Alex pointed out some weather stations used for environmental science classes and a special type of weather meter of which the Alex seemed especially proud.

The four classrooms observed in which chemistry and some other science classes were taught featured from nine to 15 laboratory stations, each equipped with a personal computer with a large screen monitor, a wraparound counter, and several stools. The colors were dark: the stools were backless, the computers were black. Various configurations were observed. In another classroom, laboratory stations form a semi-circle about a demonstration station. An interactive whiteboard was attached to the wall behind a desk that held a document camera. A data projector was mounted to the ceiling, pointing toward the whiteboard. A desktop computer and printer sat on a small table in a corner, just below a wall-mounted telephone, an item which was often missing from classrooms in other school districts that were observed by the researcher in previous years.

A different classroom, just around the corner from the one just described, featured a more traditional classroom setup, with a teacher station occupying the center of one side of the room, and rows of counters with chemistry workstations facing it. It had a television hanging from one corner of the ceiling, and a videocassette player sat on the instructor's desk. This was a familiar scenario; it had the appearance of being closed and private; the open configuration classroom seemed to invite observations.

"Here are the pH and pressure sensors, and here we have a light-intensity probe," Alex continued, proceeding to the science storage rooms. On a high shelf were a row of videocassettes, just above a row of chemistry teacher magazines, electronic balances, disassembled weather stations, and assorted sized beakers. Metal bins with open shelves held a variety of instruments. The teachers shared these instruments, according to Alex. "One of us usually helps set up the classrooms for whatever lab they're doing that week," Alex stated.

Later that morning, seven science teachers congregated in a shared office that offered individual desks and work areas, two central tables, and two desktop workstations, one of which had a printer underneath the desk, alongside stacks of telephone books. The door was not closed throughout all the observations. As the observer took notes, the teachers ate lunch and some played cards. One of them stated they had won a giant chocolate chip cookie prize, and this was shared with all from the center of a round table. A small stack of paper labeled "*Chapter 7 corrections*" shared a corner of one table with scissors, a game board, and a pepper mill. File cabinets cordoned off the various workspaces, which were not immediately recognizable as such. As the observation continued through the day, however, it became apparent to the researcher that each area had been personalized by a respective teacher. Shelves lined the walls such that the diners were surrounded by science textbooks for the various courses: biology, chemistry, physics, and geology.

The observer spent an entire school day at this office and in various classrooms, observing participants, collecting lesson plans, taking field notes, and recording interviews with participants, As the bells progressed, one teacher or another would come into the office to invite the observer to see an instrument, or a demonstration, or an experiment: "I just want to show you something quick" or "You've got to see this." The participants with the pseudonyms Pat, and Kelly, offered information throughout the day between their classes. Kelly spent a few minutes before one class to tell me how problems like the lost login are input into a central communication system that creates trouble tickets, a process similar to that used by corporate information systems departments. According to Kelly, the trouble tickets then get transmitted to wireless handheld devices carried by the school district technical staff who can respond as soon as they become available. Why is there such a rush? At this point, Pat, who joined us, stated, "There isn't the ratio of staff to computers that is recommended. Ours is more like one to one-hundred."

In requesting copies of lesson plans from each participant, it was learned that "most lesson plans are online," according to Pat. "How I do it [lesson planning] is that I look at the [standardized] tests first, then I do what I call a flight plan and put it on a poster that hangs in the classroom. I don't teach to the [standardized] test, so to speak, but the students do have to pass the test, so my lesson plans incorporate learning objectives that will help them do that."

Subsequent Participant Observations at Pine

On a subsequent Pine High School visit, the teacher with the pseudonym Jamy taught in a classroom that featured four aquariums. Jamy was holding a snake from one aquarium as the observer entered the room. Jamy described a partnership established with the metropolitan zoo. “They give me aquariums, and I give them lesson plans. What a deal!” Besides the four aquariums, the room held a video cassette recorder, a large-screen television, a document camera, a blackboard, an electronic whiteboard, and a data projector. Maps lined a bulletin board. The day’s class agenda was written on the blackboard in large, clear letters.

The lesson observed was on weather patterns and prediction. Jamy moved to the interactive whiteboard that faced the students and clicked on a link to bring up an interactive Web site that allowed viewers to see a variety of weather reports for the region, state, area, or nation. Jamy invited students to surmise how this site could be used in weather forecasting and prediction. Jamy asked a student to distribute worksheets and directed the class to use the computers at the work stations in groups to go to the indicated Web site to complete the worksheet by the end of class time.

The instructor desk sat at the back of the room behind the students. It held a desktop computer. Beside it was a small stand that held a laser disc player and a portable VCR. Beside the desk was a wall-mounted telephone. A wireless tablet and stylus sat atop the VCR. A bank of uncovered windows lined the top of all the outward-facing walls, and let in ambient natural light. Four students used the interactive whiteboard to provide information for their worksheets. The other groups used the computers at the different lab workstations.

The air coming through the ventilation system in the ceiling was noticeable. A tall rubber tree plant caught rays of sun coming through the vertical blinds covering the full length windows that described one corner of the room; butterfly decals were placed at eye levels. A large lily plant stood in front of the cords that ran down from the instructor's desktop computer that faced the door. The door was not closed.

One-inch, three-ring binders labeled "Unit Plans" lined a small bookcase that held a class printer that was assumed to be networked to all the computers in the classroom because a student came over to retrieve a piece of paper that emerged from it during the observation. Jamy called the class to a close a few minutes before the period ended with the sound of three-toned chimes.

The classroom in which Pat was observed teaching featured another electronic whiteboard, and the observer later learned from a participant that a large number of electronic whiteboards had been purchased by the district. During the observed lesson, Pat used the whiteboard to demonstrate calculations needed to find and record the answers to questions on a chemistry laboratory worksheet. Pat talked through the calculations of joule conversion and changes in the temperatures of metals and water. This was a more traditionally configured classroom in that the student desks occupied the center of the room, with the instructor's desk at the front. Laboratory stations hugged the walls and back. Science posters and handmade posters lined the upper halves of the walls. The lecture lasted approximately 10 minutes as Pat demonstrated how to perform the calculations on a worksheet projected onto the electronic whiteboard and explained how to do each one. Pat checked for understanding, then directed the students to perform their own calculations. Pat reminded the students that all the lesson plans were posted on the class Web site.

Jamy taught a biotechnology class in a classroom that was remote from the other science classrooms. As Jamy led the way to this class by going down the stairs of the building, a small pond was spotted that featured large, orange fish. “That was a senior class gift to the school,” Jamy explained. This class is for 11th grade students. A document camera sits on the instructor desk, along with a desktop computer and flat panel, 15-inch monitor. An aquarium with numerous, active fish sat on one of the tables by the door. The room did not seem as open as the previously observed classrooms. The door was closed throughout the class. The room had a freestanding electronic whiteboard sitting across from the entrance to the classroom, but no data projector was evident. “I used it until someone pulled out the lamp and cut the wires,” Jamy explained. “They had to remove screws to do that.”

Light racks lined the back of the classroom. Lab coats, with students’ names embroidered on them, hung neatly in a closet in the front of the classroom, along with gloves, goggles, and other laboratory equipment.

Jamy started the class with a lecture on the transformation of bacteria, using a Microsoft PowerPoint slide show running on the instructor’s desktop computer and displayed on the large screen television monitor mounted to the ceiling in the front of the room. Jamy used the blackboard and chalk to record student hypotheses and options. “One of the constraints of using this classroom is that there is a class right before this one, so labs can’t be set up in advance,” Jamy stated. After students donned lab coats, goggles, and gloves, Jamy described the procedures being used as each culture plate was streaked. Jamy supervised the use of small, glass burners and specific scientific terms were employed in descriptions and explanations. After the streaking procedure was completed, Jamy explained that a movie would be shown to demonstrate procedures for an upcoming laboratory exercise. The observed noted that the movie, which Jamy stated was from 1984, was a VHS format cassette played on a VCR and projected onto a large screen television mounted to the ceiling.

Technology Integration Barriers Observed or Recorded

There were some barriers to technology use in both schools. Vandalism and lack of pre-class set up time was mentioned by Jamy at Pine High School. Lee at Willow High School stated that the students shared a computer laboratory that had to be scheduled in advance. Pat at Pine High School talked about a recent upgrade to a piece of new hardware and its accompanying software, detailing how much time software updates took and what errors and difficulties seem to have resulted, as follows:

> "Vendors need to understand the importance of product stability to a teacher. Is the time it takes to install an update and the time it takes to learn the new feature going to be worth the additional capability they offer? I always ask myself if the time it takes to learn or use the technology going to be worth it in terms of student outcomes and is it going to save time. Because of course technology is worth spending the time to learn when it then saves time, like the grading heuristic we use."

Kelly stated that there was the occasional "pebble in the shopping cart" when it came to problems with equipment. It could arise, Kelly stated, from "piecemeal work, with no one thinking all the pieces through. There are little barriers. The teachers here are smart, but like the electronic whiteboards were delivered without splitter cables for sound."

Kelly stated that not all the teachers at Pine were positive about technology. "Not everyone likes to use computers," Kelly said. "You have to believe it [technology] will work.” Kelly also stated that “…the credibility of the person talking about the technology is important.” When asked about whether technology training enhanced use, Kelly responded, “It’s one thing to gain the skill, and another to use it.”

Technology Integration Enablers Observed or Recorded

At Pine, the observer noted that teachers spent time between bells to demonstrate technologies that they used in their classes. Pat showed a digital video of a cloud chamber; another showed a video created by a student using a camcorder. The teachers shared their technology findings with each other. One mentioned that Alex had earned graduate credit for participating in an online science inquiry program offered by a local college for science teachers, and that others were thinking of doing the same the next year. Pat demonstrated an application developed by one of the teachers that allowed an instructor to electronically submit student work submitted to the learning management system drop box to copy and paste it into an electronic file containing the solution set. The program compared the student’s calculations and answers to the correct ones and automatically provided a score. “This application lets me say to the student, ‘Tell me what you learned.’ I couldn’t do that before, because I didn’t have the time. It would have taken me two days to grade the assignment. Now I do it in two minutes,” said Pat. Lynn at Willow High School had led interactive whiteboard training for other teachers at Willow, and Lee mentioned that the troubleshooting training received had helped increase confidence in using equipment.

Researcher Summary of Field Notes

The summaries presented in the previous sections situate the schools and clarify the contexts in which data were collected and inferences drawn. The impressions gained by the observer were as follows:

- Priorities may have differed between the schools based on the observation that Willow High School featured in its entry hallway a long row of glass-fronted cases with more athletic trophies than could be easily counted. Pine High School also featured in its entry hallway a smaller case of athletic trophies, but directly across from that case was a case of photographs labeled “National Merit Finalists.”
- The atmospheres conveyed by the visitor protocols, sign in procedures, hallway monitors, and security measures were markedly different. Willow High School’s security felt threatening from the outside and just inside the entrance. Pine High School’s security felt unthreatening and more inquisitive than oppressive. The closed and locked doors and police and guard presences at Willow inferred that there might be something to fear, while the open doors and less obvious police presence at Pine inferred that there was nothing to fear.
- Once inside classrooms and with teachers, the differences between Willow and Pine became much less marked. Observations noted that similar teaching styles and pedagogical techniques were employed between the two schools. Observations also noted that instructors had similar technologies for managing classroom administrative tasks and to present

curricular materials. Variations among the use of these technologies by teachers were marked in both schools.

Capturing the contexts, voices, visuals, and environments can help situate a study. By describing the settings in which these participants were using and talking about educational technology, a deeper understanding of both the barriers and enablers to that use can be obtained that lend support and insight around the quantitative data that was collected during this study. By capturing and reporting the conversations and observations that were not necessarily part of the study, details may emerge that aid in comprehending the implications of statistics.

Quantitative Analysis

Participant responses to the CSE and TISA were analyzed using descriptive statistics, parametric and nonparametric tests, and analysis of variance as recommended by Gravetter & Wallnau (2004). Responses to the CSE and TISA instruments were collected from participants and input directly into SPSS Version 15.0 for Windows. Participants were assigned case numbers and pseudonyms from the key previously described. The key was designed by the investigators that projected up to 30 possible cases. The pseudonyms were deliberately selected to be as free from gender bias as possible.

Data collected from participants as part of the self-assessments included grades and subjects currently being taught, number of years of teaching experience, and estimated number of weeks of professional development. While 18 participants volunteered, 17 of them provided responses to the instruments within the constraints of the study. While all 17 participants whose data were included in this analysis provided information regarding identification, subjects, and grades, one participant did not provide the number of years of teaching experience on the CSE instrument and three participants did not provide the number of weeks of professional development in their responses on the TISA instrument.

The participant characteristics derived from participant data are shown in Table 8. They show the total number of participants, subjects taught (summarized into science, math, or technology), grades taught, number of years of teaching experience, and estimated number of weeks of professional development. One participant responded to the professional development weeks in terms of weeks per year over all years of teaching experience; this value was normalized by those years. Dots in the table indicate the participant provided no response.

Table 8

Participant Characteristics and Variables

Participant ID	Subject (Science or Math)	Grade Level	Teaching Experience in Years	Professional Development in Weeks per Year
P0402	Science	10, 11	30	2
P0403	Science	11, 12	7	1
P0404	Science	10, 11	5	4
P0405	Science	11, 12	27	2
P0406	Science	10	3	2
P0407	Science	10, 11	1	.
P0408	Math	9, 10, 12	.	0
P0409	Math	9, 10, 11, 12	7	10
P0410	Math	9, 10, 11, 12	7	3
P0411	Math	9, 10, 11, 12	11	1
P0412	Math	9, 11, 12	29	0
P0413	Math	9, 11, 12	17	5
P0414	Math	9, 10, 11, 12	20	1
P0415	Math	10, 11, 12	18	2
P0416	Math	9, 12	.	0
P0418	Math	11, 12	34	.
P0419	Math	11	18	.

As can be seen from Table 8, more than half (11) of the 17 participations were mathematics teachers. Fourteen of the teachers taught at the 11th and/or 12th grade levels. Only one of the science teachers included in the sample taught at the 9th grade level, while eight of the mathematics teachers taught at the 9th grade level. This may indicate that more mathematics courses are required at the 9th grade level or that the courses taught by the participants who taught sciences such as chemistry and biotechnology were not offered at the 9th grade level. Another possibility is that participants did not report the grade levels at which they were qualified to teach, but only those grade levels they were teaching at the time of the survey.

Responses to Self-Assessments

The participant responses to the TISA and CSE were input into tables for analysis using SPSS 15.0 for Windows Student Version. Participant responses to the TISA are shown in a single table; however, the responses to the CSE were partitioned by specific dimension of the CSE. This partitioning allowed for different skills to be analyzed separately, since self-efficacy is task-specific (Bandura, 1997). That is, an individual may report strong self-efficacy in one skill related to computer use, but not another. This was confirmed by the samples included in this study.

The 17 participant responses to the technology integration survey (the TISA) are shown in Table 9. The raw TISA data were converted from the original “a”, “b”, “c”, “d”, or “e” responses to numbers. Since participants could choose one or more of the “a” through “d” responses, or “e” alone, a binary table was employed to preserve the scalar nature of these responses such that “15” represents the highest possible combined score on an item, and “0” the lowest. The TISA raw score data and the binary table used to convert the responses to numeric scores are given in Appendix H. Blanks in **Table 9** indicate values that were missing from the instrument because participants did not provide a response.

Table 9

TISA Converted Scores

Paticipant ID	Common Technology Device Operation	Basic File Management Tasks	Troubleshooting Strategies	Software Productivity Use	Communication and Collaboration Technology Use	Internet Research Use	Responsible Technology Use	Equitable Technology Access Facilitation	Learning Management Technology Use	Evaluating Technology Resources	Assessment of Technology-Derived Data	Multiple Technology Contexts and Tools Use	Student Technology Use for Authentic Learning	Technology for Higher Order Learning Use	Technology for Diverse Learning Needs Use	Student Technology Use Assessment and Evaluation	Student Documentation of Technology Experiences	Technology for Instructional Analysis and Improvement Use
P0402	15	15	15	15	15	15	15	15	15	15	15	15	14	14	5	7	2	3
P0403	15	15	15	15	15	7	9	15	15	7	4	15	7	7	7	2	0	3
P0404	15	15	15	15	15	11	15	15	15	15	15	15	15	15	7	12	2	3
P0405	15	15	15	15	15	15	15	3	3	15	15	15	15	15	15	4		15
P0406	15	7	15	7	15	3	1	4	0	1	0	15	3	3	0	0	0	3
P0407	15	15	7	15	15	3	0	11	2	2	0	10	7	3	2	8	0	3
P0408	15	15	15	15	15	3	1	0	3	3	0	3	0	0	0	0	0	15
P0409	15	15	15	15	15	15	1	0	2	15	1	12	1	0	3	4	0	15
P0410	13	15	15	15	15	15	13	3	7	3		15	7	7	1		3	15
P0411	15	15	15	15	15	7	3	3	15	5	0	15	3	3	5	4	0	15
P0412	3	15	15	11	7	7	1	1	0	0	0	3	0	0	1	0	0	3
P0413	15	15	15	11	15	3	1	0	14	3	0	15	0	0	0	0	0	15
P0414	15	15	15	15	15	3	1	0	1	0	0	3	0	0	0	0	0	7
P0415	1	9	7	14	15	1	1	5	3	4	0	7	4	2	3	3	0	3
P0416	15	15	15	15	7	7	5	0	4	1	0	3	0	0	0	0	0	15
P0418	11	7	15	3	15	7	3	3	3	0	0	1	3	3	0	1	0	3
P0419	7	15	7	15	5	5	15	4	2	2	1	3	4	0	9	0	2	3

Participant responses to the CSE are shown in the next series of tables. The seven dimensions of the CSE (one attitude dimension and six skill dimensions) were examined separately to determine whether a separate analysis should be performed on each. In Table 10, the participant responses to the first 19 items of the instrument, statements which indicate general attitude toward using computers, are shown. The participants are listed in the leftmost column; the CSE item number is listed across the top row. The scores are the actual values entered by the participants. The values were represented by a Likert-like scale from 1 to 4, where 4 represented “Strongly Agree,” and 1 represented “Strongly Disagree.” Statements were either negatively worded or positively worded. In scoring negatively worded statements, the inverse was used such that “4,” for example, indicated a participant “strongly agreed” with all of the positive attitude statements, or “strongly disagreed” with all of the negative attitude statements. Dots in the tables indicate that no response was given by the participant for that particular item.

Table 10

CSE Raw Scores for Items 1-19, Attitude

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
P0402	4	4	4	4	4	4	4	4	4	.	4	4	4	4	4	4	4	4	4
P0403	4	4	4	4	4	4	7	4	4	1	4	3	4	4	4	4	4	4	4
P0404	3	4	4	3	4	4	4	4	4	2	4	3	4	4	4	3	4	4	4
P0405	4	4	4	4	4	4	3	3	3	2	4	4	4	4	4	4	4	4	1
P0406	4	4	3	4	4	4	4	3	4	2	3	3	4	4	3	3	3	3	4
P0407	4	4	4	4	4	4	4	4	3	2	4	4	4	4	4	4	4	4	4
P0408	4	4	4	4	4	3	4	3	4	1	3	3	3	3	4	3	3	3	2
P0409	4	4	4	3	4	4	4	4	3	1	4	4	4	4	3	4	4	4	4
P0410	4	4	4	3	4	3	3	4	2	1	4	3	3	3	4	4	4	3	4
P0411	4	4	4	3	4	4	4	4	4	1	4	4	3	4	4	4	4	4	4
P0412	4	1	2	2	3	2	3	3	3	2	3	2	3	1	1	3	3	1	3
P0413	4	4	4	4	4	3	4	4	4	1	4	4	4	3	2	4	4	4	4
P0414	4	4	3	4	4	3	4	4	1	2	4	4	3	4	4	4	4	4	4
P0415	4	3	3	4	4	2	3	3	4	1	4	2	3	3	1	4	2	3	3
P0416	4	4	4	3	4	3	4	4	3	2	4	4	4	4	3	4	4	4	4
P0418	4	4	3	4	4	3	3	3	2	1	4	3	3	3	2	4	3	3	4
P0419	4	4	2	2	4	2	3	3	4	1	4	4	3	3	2	3	3	2	4

Participant responses to Items 20-29 of the CSE, which measured self-efficacy toward word processing operations, are shown in Table 11. For this and the other skill dimensions, statements about performing specific operations were preceded by “I feel confident.” Participants then rated their self-efficacy for that skill using the same, Likert-like scale from 1 to 4, where 4 represented “Strongly Agree,” and 1 represented “Strongly

Disagree." Participants' actual responses are provided in the table. A row of "4's," for example, indicates the participant "strongly agreed" with all statements about their confidence performing word processing operations.

Table 11

CSE Raw Scores for Items 20-29, Word Processing

	20	21	22	23	24	25	26	27	28	29
P0402	4	4	4	4	4	4	4	4	4	4
P0403	4	4	4	4	4	4	4	4	4	4
P0404	4	4	4	4	4	4	4	4	4	4
P0405	4	4	4	4	4	4	4	4	4	4
P0406	4	4	4	4	4	4	4	4	4	4
P0407	4	4	4	4	4	4	4	4	4	4
P0408	4	4	4	4	4	4	4	4	4	4
P0409	4	4	4	4	4	4	4	4	4	4
P0410	4	4	4	4	4	4	4	4	4	4
P0411	4	4	4	4	4	4	4	4	4	4
P0412	4	4	4	4	4	4	3	4	4	4
P0413	4	4	4	4	4	4	4	4	4	4
P0414	4	4	4	4	4	4	4	4	4	4
P0415	4	4	4	4	4	2	1	3	3	4
P0416	4	4	4	4	4	4	4	4	4	4
P0418	3	3	3	2	3	3	3	3	3	3
P0419	4	4	4	4	4	4	4	4	4	4

Participant responses to Items 30-38 of the CSE, which measured self-efficacy toward E-mail operations, are shown in Table 12.

Table 12

CSE Raw Scores for Items 30-38, E-mail

	30	31	32	33	34	35	36	37	38
P0402	4	4	4	4	4	4	4	4	4
P0403	4	4	4	4	4	4	4	4	4
P0404	4	4	4	4	4	4	4	4	4
P0405	4	4	4	4	4	4	4	4	4
P0406	4	4	4	4	4	4	4	4	4
P0407	4	4	4	4	4	4	4	4	4
P0408	4	4	4	4	4	4	4	4	4
P0409	4	4	4	4	4	4	4	4	4
P0410	4	4	4	4	4	4	4	4	4
P0411	4	4	4	4	4	4	4	4	4
P0412	4	4	4	4	4	4	4	4	4
P0413	4	4	4	4	4	4	4	4	4
P0414	4	4	4	4	4	4	4	4	4
P0415	4	4	4	4	4	4	4	4	4
P0416	4	4	4	4	4	4	4	4	4
P0418	4	4	4	4	4	4	4	4	4

P0419	4	4	4	4	4	4	4	4	4

Participant responses to Items 39-45 of the CSE, which measured self-efficacy toward spreadsheet operations, are shown in Table 13.

Table 13

CSE Raw Scores for Items 39-45, Spreadsheets

	39	40	41	42	43	44	45
P0402	4	4	4	4	4	4	4
P0403	4	4	4	4	4	4	4
P0404	4	4	4	4	4	4	4
P0405	4	4	4	4	4	4	4
P0406	2	2	3	4	4	4	4
P0407	4	4	4	4	4	4	4
P0408	2	3	2	3	3	3	3
P0409	4	4	4	4	4	4	4
P0410	4	4	4	4	4	4	4
P0411	4	3	3	4	4	4	4
P0412	3	2	2	3	2	3	3
P0413	4	4	1	4	4	4	4
P0414	4	4	4	4	4	4	4
P0415	4	4	4	4	4	4	4
P0416	4	4	2	4	4	4	4
P0418	2	2	2	2	2	2	2
P0419	4	4	4	4	4	4	4

Participant responses to Items 46-58 of the CSE, which measured self-efficacy toward database operations, are shown in Table 14. Dots indicate that the participant did not provide a response for that item.

Table 14

CSE Raw Scores for Items 46-58, Databases

	46	47	48	49	50	51	52	53	54	55	56	57	58
P0402	4	4	4	4	4	4	4	3	4	4	4	4	4
P0403	3	3	3	3	3	3	3	4	3	4	4	4	4
P0404	3	3	4	4	4	4	4	3	3	4	4	4	4
P0405	4	4	4	4	4	4	4	2	2	2	2	2	2
P0406	1	1	3	2	2	3	3	4	2	3	3	3	4
P0407	4	4	4	4	4	4	4	3	2	3	2	2	3
P0408	2	2	2	2	2	2	2	2	2	2	2	2	2
P0409	4	4	4	4	4	4	4	2	2	2	2	3	2
P0410	4	4	4	4	4	4	4	4	4	4	4	.	.
P0411	2	2	4	2	2	4	4	2	2	4	2	2	4
P0412	3	2	2	2	2	2	2	1	1	1	1	1	1
P0413	1	1	1	1	1	1	1	1	1	1	1	1	1

P0414	3	3	3	3	3	3	4	3	3	3	3	2	2
P0415	2	3	3	3	1	2	2	1	1	1	1	1	1
P0416	2	4	4	4	4	4	4	4	4	4	4	4	4
P0418	2	2	2	2	2	2	2	2	2	2	2	2	2
P0419	1	1	1	1	1	1	1	1	1	1	1	1	1

Participant responses to Items 59-65 of the CSE, which measured self-efficacy toward operating system (OS) and file management operations, are shown in Table 15. Dots indicate that the participant did not provide a response for that item.

Table 15

CSE Raw Scores for Items 59-65, OS/File Management

	59	60	61	62	63	64	65
P0402	4	4	4	4	4	4	4
P0403	4	4	4	4	4	4	4
P0404	4	4	4	4	4	4	4
P0405	4	4	4	4	4	4	4
P0406	3	4	4	3	3	4	4
P0407	3	4	4	4	4	4	4
P0408	3	3	3	3	3	3	3
P0409	3	2	3	3	3	3	3
P0410	.	.	.	.	.	.	.
P0411	4	4	4	4	4	4	4
P0412	2	3	3	3	3	3	3
P0413	4	4	4	4	4	4	4
P0414	3	4	4	3	4	4	4
P0415	1	4	3	2	4	4	4
P0416	4	4	4	4	4	4	4
P0418	3	3	3	3	3	3	3
P0419	4	4	4	3	4	4	3

Finally, the participant responses to CSE items 66-72, self-efficacy for Internet use or operations, are shown in Table 16. The dots shown for participant P0410 indicate missing responses to that section of the CSE. Since responses were provided for the first seven items of this section of the CSE, the survey was not excluded from analysis.

Table 16

CSE Raw Scores for Items 66-72, Internet

	66	67	68	69	70	71	72
P0402	4	4	4	4	4	4	4
P0403	4	4	4	4	4	4	4

P0404	4	4	4	4	4	4	4
P0405	4	4	4	4	4	4	4
P0406	4	4	4	4	4	4	2
P0407	4	4	4	4	4	4	3
P0408	3	3	3	3	3	3	2
P0409	3	3	4	4	4	4	4
P0410	.	.	.	.	.	.	.
P0411	4	4	4	4	4	4	4
P0412	3	3	1	1	2	2	2
P0413	4	4	4	4	4	4	4
P0414	4	4	4	4	4	4	3
P0415	4	3	1	4	1	1	1
P0416	4	4	4	4	4	4	1
P0418	4	4	4	4	4	3	2
P0419	4	4	4	4	4	4	1

To determine whether a relationship between the TISA and CSE existed, the means of the participant scores on the two instruments were computed, and are shown in Table 17. The CSE values were computed summing the scores in all dimensions and dividing by the number of questions. The mean values of the TISA responses ranged from 0 to 15. To make these categorical variables comparable to the continuous CSE values, which ranged from 1 to 4, the mean values of each TISA response were scaled by dividing the 16 possible values by 4, resulting in the values shown in Table 17. Values are rounded to the nearest 0.1 and the computations are reported for each dimension of the CSE.

Table 17
Mean Computed Values of CSE and TISA Responses

Participant	CSE Averaged Means	TISA Scaled Means
P0402	4.0	3.3
P0403	3.9	2.5
P0404	3.9	3.4
P0405	3.8	3.2
P0406	3.5	1.4
P0407	3.8	1.7
P0408	3.1	1.5
P0409	3.6	2.1
P0410	2.7	2.4

Participant	CSE Averaged Means	TISA Scaled Means
P0411	3.8	2.3
P0412	2.8	1.0
P0413	3.5	1.8
P0414	3.7	1.3
P0415	3.0	1.2
P0416	3.8	1.5
P0418	3.0	1.2
P0419	3.33	1.46

To determine if a specific dimension of the CSE contributed the most strongly to overall correlation, CSE values were computed by summing the scores in each dimension and dividing by the number of questions in the respective dimensions. The results are given in shown in Table 18. Values are rounded to the nearest 0.1 and the computations are reported for each dimension of the CSE.

Table 18

Mean Computed Values of CSE by Dimension and TISA Responses

	CSE Attitude	CSE Word Process.	CSE E-mail	CSE Spread-sheets	CSE Data-bases	CSE File Mgmt.	CSE Internet	TISA (Scaled)
P0402	3.8	4.0	4.0	4.0	3.9	4.0	4.0	3.3
P0403	4.0	4.0	4.0	4.0	3.4	4.0	4.0	2.5
P0404	3.9	4.0	4.0	4.0	3.7	4.0	4.0	3.4
P0405	3.9	4.0	4.0	4.0	3.1	4.0	4.0	3.2
P0406	3.5	4.0	4.0	3.3	2.6	3.6	3.7	1.4
P0407	3.8	4.0	4.0	4.0	3.3	3.9	3.9	1.7
P0408	3.3	4.0	4.0	2.7	2.0	3.0	2.9	1.5
P0409	3.7	4.0	4.0	4.0	3.2	2.9	3.7	2.1
P0410	3.4	4.0	4.0	4.0	3.4	.0	.0	2.4
P0411	3.7	4.0	4.0	3.7	2.8	4.0	4.0	2.3
P0412	2.4	3.9	4.0	2.6	1.6	2.9	2.0	1.0
P0413	3.6	4.0	4.0	3.6	1.0	4.0	4.0	1.8
P0414	3.6	4.0	4.0	4.0	2.9	3.7	3.9	1.3
P0415	3.0	3.3	4.0	4.0	1.7	3.1	2.1	1.2
P0416	3.7	4.0	4.0	3.7	3.9	4.0	3.6	1.5
P0418	3.2	2.9	4.0	2.0	2.0	3.0	3.6	1.2
P0419	3.0	4.0	4.0	4.0	1.0	3.7	3.6	1.5

After examining the mean computed values, it was determined that a variety of statistical procedures could be used to look for relationships as recommended by Gravetter & Wallnau (2004). Histograms generated for both the dimensional statistics of the CSE and the TISA indicated neither were normally distributed. Within the CSE instrument, numerous variations occurred among the seven different dimensions and the TISA responses were multi-modal. This posed the dilemma of whether parametric or nonparametric tests should be used to analyze relationships. Parametric analysis assumes normal distributions; nonparametric analysis does not. At the same time, due to the small sample size (n = 17) and because the sample of participants was drawn from a larger population that could be assumed to exhibit a Gaussian distribution, parametric tests could be used to make inferences about the means. To resolve the dilemma, both types of tests were performed.

Parametric correlation was used to examine the relationship between the cumulative CSE means and the TISA scaled means. A null hypothesis was formed that no relationship between the TISA and the averaged sum of all dimensions of the CSE would be found. The dependent variable for this analysis was the TISA scores, and the independent variable was the averaged means of the CSE scores across all seven dimensions.

The results of the correlation are shown in Table 20. The Pearson correlation value obtained was .559, or $r = 0.6$, with significance at the 0.05 level in a two-tailed test. Because Pearson correlations range from very weak (.00) to very strong (1.00), a finding of $r = 0.6$ with $p = .05$ provides moderate evidence that a correlation between the cumulative CSE and TISA scores in the sample was found. Therefore, the null hypothesis was rejected.

Table 19

Correlation Table for TISA Scaled Means and CSE Averaged Means

		TISA Scaled	CSE Averaged
TISA Scaled	Pearson Correlation	1	.559(*)
	Sig. (2-tailed)		.020
	n	17	17
CSE Averaged	Pearson Correlation	.559(*)	1
	Sig. (2-tailed)	.020	
	n	17	17

* Correlation is significant at the 0.05 level (2-tailed).

Next, a nonparametric test was performed. The Kendall tau test was selected over the Spearman rho based on the number of samples ($n < 20$). Using the TISA scaled means and the CSE cumulative averaged scores resulted in a computed value of .529 (r = 0.51), with significance at the 0.01 level in a two-tailed test ($p = .01$). Again, the null hypothesis was rejected.

The mean computed values for the TISA and for each of the sections of the CSE vary from 2.4 on the TISA to 4.0 for that portion of the CSE surrounding self-efficacy beliefs regarding E-mail skills, as shown in Table 20.

Table 20

Descriptive Statistics for the TISA and CSE Variables

Scores	Means	Std. Deviations
TISA Scaled	2.0	.78
CSE Attitude	3.5	.40
CSE Word Proc.	3.9	.31
CSE E-mail	4.0	.00
CSE Spreadsheets	3.6	.62
CSE Databases	2.7	.95

Scores	Means	Std. Deviations
CSE File Mgmt.	3.4	.98
CSE Internet	3.3	1.07

The correlation matrix is shown in Table 21. The matrix was used to determine the strength of the relationships among the CSE dimensions and the TISA. As shown in the table, the strength of relationships among the various sections of the CSE and the TISA varied from a correlation value of *r* = .1 for the Operating System/File Management dimension of the CSE to *r* = .6 for the Databases dimension of the CSE.

Table 21

Correlation Matrix for TISA and CSE Dimensions

		CSE Attitude	CSE Word Proc.	CSE Spread-sheets	CSE Data-bases	CSE OS/File Mgmt.	CSE Internet
TISA Scaled	Pearson Correlation	.594(*)	.393	.531(*)	.621(**)	.140	.234
	Sig. (2-tailed)	.012	.119	.028	.008	.592	.365
	n = 17						

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

In order to determine whether CSE had greater correlation with the TISA than years of teaching experience, a Pearson correlation analysis was performed using years of teaching experience, weeks of professional development, the combined CSE, and the TISA. The results are shown in Figure 5. It should be noted that one participant provided 52 on the item requesting weeks of professional development related to technology due to inadequate specification of the period of time over which the training was received. This outlier value was averaged over the number of years of teaching experience, or two (2) weeks, which was similar to the number of weeks reported by other participants.

Correlations

		TISAScaled	CSEAveraged	Years of Teaching Experience	Weeks of Prof. Development
TISAScaled	Pearson Correlation	1	.559*	-.059	.250
	Sig. (2-tailed)		.020	.828	.388
	N	17	17	16	14
CSEAveraged	Pearson Correlation	.559*	1	-.333	.107
	Sig. (2-tailed)	.020		.207	.716
	N	17	17	16	14
Years of Teaching Experience	Pearson Correlation	-.059	-.333	1	-.212
	Sig. (2-tailed)	.828	.207		.488
	N	16	16	16	13
Weeks of Prof. Development	Pearson Correlation	.250	.107	-.212	1
	Sig. (2-tailed)	.388	.716	.488	
	N	14	14	13	14

*. Correlation is significant at the 0.05 level (2-tailed).

Figure 5. Correlation matrix comparing TISA, CSE, Years of Teaching Experience, and Weeks of Professional Development

As illustrated, a statistically significant Pearson correlation at $p = .05$ was obtained only for the CSE; neither years of teaching experience nor weeks of professional development reported resulted in a significant correlation.

Printed lesson plans were collected from a sample of participants as a means of collecting written evidence to be used in making a determination whether technology was integrated into the lesson plan. Participants' planned use of educational technology for classroom or administrative functions, to deliver or augment instruction, to engage students in the performance of authentic or problem-solving tasks, and to assist students in the completion of tasks are reported in Table 22.

Table 22

Lesson Plan Analysis Showing Teacher and Student Use of Technology

Participant	Teacher Use: Administrative	Teacher Use: Curricular	Student Use

Participant	Teacher Use: Administrative	Teacher Use: Curricular	Student Use
P0403	• Learning management system	• Word processor for laboratory worksheet	• Student use of electronic laboratory equipment to fill out worksheet
P0404		• Presentation software presentation • Presentation showed evidence of Internet research • Word processor for worksheet	• Student use of PC workstations • Use of interactive Web site to complete worksheet
P0406		• Presentation software presentation • Presentation showed evidence of Internet research • Word processor for worksheet	
P0407		• Presentation software presentation • Presentation showed evidence of use of Internet • Word processor for worksheet	

The lesson plan collected from participant P0403 was the only plan that exhibited planned use in all three areas of administrative, teacher, and student use. The lesson plan collected from participant P0404 was the only plan that planned more than a single instance of student use. All four participant plans exhibited planned instructional use of technology by the teacher.

Chapter 5. Conclusions and Other Generalizations

"Don't be afraid of the technology; embrace it."

Participant P0404 (Jamy)

The results presented in the previous chapter were examined and conclusions drawn. These conclusions, acknowledgements of limitations, and recommendations for further research are based on the evidence collected.

Study Summary

This mixed methods, empirical study of 17 mathematics and science teachers from two large suburban schools in the greater metropolitan area of a Midwestern city was conducted during the spring, 2008. Data were collected in the form of responses to two self-assessment instruments. One instrument included 19 items that assessed the participants' perceptions of their integration of technology in the classroom based on international technology standards (TISA). The other instrument (CSE) included 72 items that assessed the participants' attitudes toward computers in general, and their self-efficacy beliefs around 6 skill areas or dimensions: E-mail, word processing, spreadsheets, databases, file management, and Internet use. Responses to these instruments provided a set of 90 data points per participant, in addition to demographic and other data collected as part of the self-assessments, such as weeks of professional development and years of teaching experience.

Responses to the self-assessments were consistent across 17 of the 18 participants, and the quantitative and subsequent statistical analysis included all 17 cases. The results obtained suggest that a small but statistically significant relationship does exist between teachers' perceptions of their computer self-efficacy and their integration of technology in their teaching and learning activities. The relationship was derived from participants' responses to the CSE and to the TISA.

In addition to the data were collected using these two instruments, data were also collected by digitally audio recorded interviews, observations, and field notes. The additional data were collected to support the self-reported instrument data, as well as to offer fresh insights into the current attitudes, behaviors, and perspectives of practicing teachers toward technology in high school math and science classes. These data were summarized and provide authentic voices to augment and support the quantitative results.

The results were that a statistically significant correlation between overall computer self-efficacy and technology integration as reported by the teachers in this sample was found to exist ($r = 0.6$, $p = .05$).

In Table 17, the averaged cumulative scores for the participants' technology integration and computer self-efficacy were listed that showed the participants who scored the highest on the TISA were P0404, P0402, and P0405, with 3.4, 3.3, and 3.2, respectively. On the CSE, two of these three participants, P0402 and P0404 scored the highest with 4.0 and 3.9 respectively. Participant P0405 scored among the highest (3.8), exceeded only by the score for P0403 (3.9). This finding suggests that the teachers in this sample who rated their integration of technology highest also considered themselves the most confident overall in computer self-efficacy beliefs. It may be significant that all three of these participants taught science classes at Pine High School.

This distribution of highest scores on the comparisons of TISA totals to CSE averages suggests that teachers bring a variety of strengths to technology integration, and that scoring high on one instrument was indicative of a high score in the other.

A comparison of TISA self-reported scores was performed against TISCM scores assigned by the researcher during classroom teaching observation. A close relationship was found between the perceptions of the participants about their practices, and the perceptions of the observer, suggesting that the participants accurately reported their use of technology in the classrooms. This relationship is illustrated in Table 23.

Table 23

Comparison of Self-Reported, Observed, and Interview References to Technology Integration

Participant	TISA Score (Sum)	TISCM Score (Sum)	Interview References to Technology Integration
P0403	173	45	17 references
P0404	230	44	10 references
P0406	92	31	15 references
P0407	118	48	20 references

When the quantitative results were triangulated with qualitative data from the interviews, additional evidence of relationships among the variables was identified. Some of these relationships were counter-intuitive. For example, participant P0404, who scored the highest (241) on the self-reported technology integration assessment, made the least number of references (10) during the interview to technology integration, and scored second lowest on observed technology integration (44). On the other hand, participant P0407, who scored the highest (48) on the observed technology integration, did make the most references (20) to technology integration in the classroom during the interview, yet rated second lowest on self-reported technology integration.

A number of explanations might be offered for these variations. For example, teachers who integrate technology to a great extent in their classrooms may perceive that they are not doing as much as they could with improved access or availability of technology. Another explanation may arise from the nature of the instrument used to assess technology integration. For example, when the surveys were completed in the presence of the researcher, three of the participants commented on the instrument. One participant commented during the completion of the TISA survey that the instrument was taking more time to complete than the CSE survey because they had to think harder about their answers. Another said that it caused them to think about ways they could be, but are not, implementing technology in their classrooms. Finally, one participant stopped completing the instrument during the meeting and stated that they would take it home overnight and return it later. Some responses on the TISA were marked out or corrected, which may indicate that the first response had been reconsidered during completion.

A comparison of the computer self-efficacy CSE scores to participant interview data also yielded some interesting results. For example, participant P0407 had one of the lowest scores of the four interviewees, yet the transcript contained the largest number of belief statements around technology. The participant who scored the highest on the strongest predictor variable of CSE for databases, P0404 made among the fewest number of belief statements. The participant scores and the number of references made to beliefs drawn from the interview transcripts are shown in Table 24.

Table 24

Comparison of CSE to Interview References to Beliefs

Participant	CSE Databases	CSE Attitude	CSE Spreadsheets	Interview References to Beliefs
P0403	3.4	4.0	4.0	17

P0404	3.7	3.7	4.0	17
P0406	2.6	3.5	3.3	26
P0407	3.3	3.8	4.0	35

Relationships

While these results are not generalizable because of sample size and other limitations of the study, and while statistics do not "prove" anything, they do suggest that the research question of whether a relationship between perceived computer self-efficacy and perceived levels of technology integration among teachers of science and mathematics in two suburban schools can be answered with a yes.

The researcher expected the results to show that higher perceptions of technology integration practices would not necessarily have a strong relationship with years of teaching experience, or weeks of professional development, but that they would have a relationship with the perceived computer self efficacy. As shown in Table 25, the variable years of teaching experience did not exhibit a close relationship with TISA scores.

It should be noted that TISA scores were converted using a binary table as reported earlier. The highest possible value was 270. Both the two highest and two lowest scores were achieved by participants, all four of whom reported more than 30 years of teaching experience. Professional development did exhibit a possible relationship with TISA score; however, confusion of the participants surrounding this parameter may have affected results as described in the limitations.

Table 25

TISA Totals, Teaching Experience, and Professional Development by Participant

Participant	Years of Teaching Experience	Professional Development	TISA Sum

Participant	Years of Teaching Experience	Professional Development	TISA Sum
P0402	30	52	232
P0403	7	1	215
P0404	5	4	241
P0405	27	2	236
P0406	3	2	154
P0407	1		155
P0408		0	146
P0409	7	10	165
P0410	7	3	202
P0411	11	1	204
P0412	29	0	131
P0413	17	5	141
P0414	20	1	129
P0415	18	2	148
P0416		0	135
P0418	34		171
P0419	18		150

It was anticipated that there would not be a close relationship among the number of years of teaching experience, and weeks of professional development on the CSE scores of the participants. As shown in Table 26, this was also the case with the CSE items 1 through 19 regarding attitude toward computers, where a score of 76 was possible.

Table 26

CSE Items 1-19 Totals, Experience, and Professional Development by Participant

Participant	Years of Teaching Experience	Professional Development	CSE Attitude Score
P0402	30	52	72
P0403	7	1	68
P0404	5	4	70
P0405	27	2	68
P0406	3	2	66
P0407	1		73
P0408		0	62
P0409	7	10	70
P0410	7	3	64

P0411	11	1	71
P0412	29	0	45
P0413	17	5	69
P0414	20	1	68
P0415	18	2	54
P0416		0	70
P0418	34		60
P0419	18		57

A strong relationship was not found among the variables and the CSE score on items 1-19. Additional analysis was conducted of other sections of the CSE with similar results.

A surprising finding was the relationship between the participant scores on the database area of the CSE and the TISA scores. When compared to all other skill areas assessed by the CSE, this skill showed the greatest correlation with TISA, as shown by the correlation matrix given in Table 21.

Support of Theoretical Perspectives

The thrust of this study was to answer the research question of whether teacher computer self-efficacy is more closely related to their use of technology than their professional development training or years of teaching experience. Professional development has been established as an important enabler in the use of technology by the literature and by other studies (Atkins & Vasu, 2000; Banilower, Heck, & Weiss, 2006; Callaway, 2004). Likewise, the number of years of teaching experience had been studied as an important factor influencing technology integration, whether it was examining whether fewer years of experience was associated with greater integration of technology (Coleman, 2004), or whether more years of experience was associated with such integration (Delcourt & Kinzie, 1993).

The very nature of this question exhibits the underlying position of the researcher based on past studies and a review of the literature that external actions are subject to intrinsic states which are in turn subject to numerous influences (Bandura, 1997; Ertmer, Ottenbreit-Leftwich, & York, 2007; Haney et al., 2002). One of these is the influence of vicarious experience. An example of this struck as the participant Chris said, "Sometimes it's seeing somebody else use a piece of technology and me thinking, 'Oh, man, that would have been great. I should do that.'" Vicarious experience also played a role in one of the high users of technology in this study, the participant called Lynn. Lynn listed one year of teaching experience on the survey, and had provided professional development rather than receiving it, yet Lynn scored highest on use of technology in both self-reported and observed instruments. Lynn attributed advanced technological skill to working under a mentor teacher who provided professional development to other teachers and allowed Lynn to assist in that training.

The idea that behavior--the act of using technology--might be more influenced by beliefs than by any other influence was reinforced by the extent of the observed technology use by the participant Lynn. Even though Lynn had just a few technological tools available, the utilization of those resources took place before, during, and after the class, extending beyond the classroom setting. The technology integration appeared especially in Lynn's case to be the external manifestation of an internal state, such as a belief or attitude. This was illustrated by Lynn's description of what experiences contributed to the ability to integrate technology into the classroom, *"Basically, I'm a big dork."* The influence of close associates and friends for learning how to use technology was reinforced by statements made by the participants during the interviews. For example, in talking about family influence, Lynn stated that "…we don't care about fine china, we care about our electronics… ." Jamy stated that "I have kids of my own. They teach me things all the time."

The approach taken in this study was to use more, rather than fewer, available means of capturing, examining, analyzing, and reporting data. Therefore, a number of qualitative and quantitative methods were employed throughout the study; some were abandoned early in the analysis process, others were adopted when the existing methods failed to yield sufficient information to determine whether or not relationships existed. For example, the capture of field notes yielded thick descriptions of the school settings that provided support for the researcher's perspective that learning is situated, and that this applies to teachers (as learners) as well as to students. This was emphasized by the participant Kelly, who referred to the high school's technology-rich classrooms as a "Promised Land." The open, collegial office setting provided at Pine for the teachers permitted the observation that might otherwise have escaped notice was the transfer of knowledge that took place among the teachers during their planning bells, lunch times, and before and after school. The lack of such a setting at Willow High School might have contributed to isolation of teachers who make less use of technology because they are unacquainted with school policies, resources, and district personnel who might otherwise be able to help. This was illustrated when the Willow teacher Lee observed that "I'm new to the district so I'm not sure what's available to me. Sometimes my equipment doesn't work and I don't know how to get it fixed." At Pine, the participant called Alex stated at our first meeting that the teachers worked together to set up laboratory experiments, and one of the observed classes involved combining two classes and two teachers working together on demonstrations.

A second perspective going into this research study was that formal technology training such as professional development for teachers can lead to changes in their attitudes toward educational technology and its integration into their classroom practices. However, the findings did not lend a great deal of support to that perspective. The participant interviews revealed that professional development offered basics (Chris), troubleshooting (Lee), or, as offered by Jamy, "…I have learned a fair amount without professional development."

The third perspective concerning technology integration going into this study was that curricular use of educational technology can have a positive impact on the outcomes of students, especially in regard to the STEM areas, that such use should be student-centered rather than teacher-centered and the full utilization of available educational technologies can help teachers appeal to, engage, challenge, and assess students. However, this question was beyond the scope of this study, and could be addressed in future research.

Further Discussion of the Study and Recommendations for Future Research

The study that was proposed in 2007 was modified in accordance to requests from the governing Institutional Review Board to condense the procedure for collecting data from teachers. This was requested with the stated intention of minimizing the impact of the research on teacher time and of simplifying the data collection. The procedures were changed to send out a single recruitment E-mail to candidates that included all the necessary forms, rather than first requesting volunteers to set up a time for face-to-face meetings, and then following up with the consent forms and data collection.

The entrée plan of contacting school principals before recruiting teachers removed barriers that might otherwise have excluded participation. For example, the principal of Pine school requested two meetings with the researcher to discuss the requirements of the study and the possible benefit and significance of any findings. When the IRB approval was obtained and the E-mail recruitment was ready to be sent, the principal somewhat unexpectedly recommended that it not be sent until the state testing for graduates was completed. This advice was heeded with the result that most of the teachers recruited did participate.

The principal of Willow conveyed support of the research project via E-mail. A greater number of teachers at Willow were recruited, but did not comprise the majority of participants, even though subsequent recruitment efforts were made. This suggests that entrées made after face-to-face meeting with the administrator of the school district can lead to productive efforts to recruit and conduct studies. Establishing relationships with administration to assure them that teacher time contributed to research can result in benefits that affect the local and greater community may be one of the more important unanticipated benefits of such meetings.

It was envisioned that the data collection process would proceed in an orderly fashion as follows:

1. The researcher would send out an E-mail recruitment, and that more than 30 enthusiastic teachers would respond. The researcher would select only 30

volunteers to equally and proportionately represent two schools and each STEM area of science, mathematics, and computer technology teachers.

2. Each volunteer would arrange a meeting separately with the researcher. At this meeting, the participant would hand the researcher completed self assessments, allow the classroom observation, record a 15-minute interview, and provide a lesson plan of the observed class all at one time.

When the study was conducted, candidates did not volunteer for participation in numbers that proportionately represented the two schools, and no teachers of computer technologies at either school responded to the recruitment. This affected the scope of the research in that it was limited to the participation of science and mathematics teachers.

The participants often requested that meetings be broken into several smaller bits of time at several times throughout the day. This required the researcher to be available throughout the day to accommodate the teacher schedules. This could not have been accomplished had the researcher not been available from 7:00 a.m. to 3:30 p.m. on the days requested by the participants.

More than one participant wanted to be observed on the same day, but at different times during the day, at different schools, and in different classrooms. This placed further emphasis on the need of the researcher to be available for an entire school day, to be able to gain familiarity with the staff, to become familiar with the locations of the classrooms within the schools, and to be able to cover the distances between schools in a timely fashion. A future study design could include more than one observer to serve on the research team to accommodate these situations.

Observations of three of the participants occurred in sequential bell periods of a day. Two of the participants held a combined class and offered it for observation, a situation that was unanticipated in the study design and thus affected the use of the TISCM as a rating instrument to triangulate participant responses to the TISA.

It was anticipated that all of the volunteers would provide responses to the instruments first, and then all of them would permit observation and interview on the same day. However, some teachers participated in one part of the study without participating in another. For example, one participant permitted classroom observation but had no opportunity for an interview or to provide responses to the self-assessments due to unexpected family demands. This affected the original intent of the researcher to use artifacts, interview transcripts, TISCMs, and lesson plans collected from a participant to triangulate statistical results. This placed heavier than expected focus on the statistical aspect of the study, since 17 of the 18 participants did provide responses to the self-assessments.

The factors that the literature review had indicated might act as independent variables on technology integration included age, teaching experience, professional development, and gender. During the administration of the instruments that collected this data, it was found that participants had questions as to what responses were expected. For example, the CSE instrument collected age ranges that were not representative of the population in this study, resulting in a non-normal distribution of ages. Reflecting on this, the age parameters should have been modified to provide for the participants to simply state their ages or, if age ranges were retained, they should be expanded to include ranges up to and including 65. The study design could also allow for the researcher to provide an estimated observed age range.

The data collection item that caused the greatest confusion among participants was the amount of professional development relating to technology that they had received. The following possible causes of confusion were captured from the participants based on the following assumptions that they shared with the researcher:

- This value covered all professional development received throughout a teaching career.
- This value covered all professional development received from all school districts where the participant had been employed.
- This value covered only the training received by the current employer over all the years employed.
- This value covered training received outside the school district only during the current school year.
- This value included online courses and informal help.

The researcher provided guidance in a single instance to indicate that this item was intended to capture the number of weeks of professional development training over the past year at the current institution. The purpose of capturing this information was to help in making inferences about the perceived value of school-provided professional development and its possible relationship with the degree to which they integrated technology. This was not explicitly stated on the data collection instrument. In future uses of the instrument, this item should be clarified to specify whether the participant should provide the number of hours, days, weeks, or years, the source of that training, and perhaps the term "professional development" better described.

Subjects and grade levels taught were another area where possible confusion occurred, since participants did not list all of the grades and subjects they taught, but only the ones they were teaching at the time, or in some cases only the grade and subject that was observed. This was discovered during data input. In some cases the more complete information could be obtained from the teacher schedule or Web page, but data collection of these variables could have been improved perhaps by stating the desired information in a more explicit manner.

The distribution of the instruments via E-mail, while permitting consistent communication with a large number of teachers at one time, was limited in at least two respects. In two verified cases, the E-mail attachments, which included the consent form and self-assessments, were affected by the school's firewall, which stripped attachments from the communication. In another case, the E-mail was directed into the recipient's "junk" mail filter because it was distributed as a mass E-mail. The E-mail was re-distributed to individuals singly in a subsequent recruitment effort without success.

Sending a single recruitment E-mail could have contributed to the low response rate from Willow school, even though a subsequent recruitment E-mail was sent after waiting for two weeks. Future efforts could be modified to include a face-to-face meeting of the research team with the solicited population to describe the study, its time requirements, and then to distribute printed forms to only those who indicate interest. This would eliminate the need to send E-mails with large file size attachments. This was performed at Pine school during initial contact with one group of teachers, which resulted in a participation rate of 5 out of 8 who attended the meeting.

Interview data that was collected from four of the participants is reported in Appendix F. It confirms the finding from the pilot study that the teachers who use technology terms the most frequently in their responses to interview questions also were observed to be using technology to the greatest extent in their classrooms. One teacher who did not use a relatively large number of terms was observed to use a variety of technologies in the class, and this use was integrated into the lesson plan. The lack of an operational definition of what instrumentation could be included in the term "technology" might have affected both the participants' responses to the interview questions and the researchers' observation. Technology can be perceived, after all, to include a blackboard and chalk. It could be assumed to include electronic probes and instruments such as voltmeters; however, this robustness of terminology diluted the original focus on computer technologies. Future research should make greater distinction on what is meant when the term is used, and clarification offered to study participants from the start.

The analysis was performed using a student version of SPSS, which prohibited the analysis of more than 50 variables at any one time. Future work could utilize the full version of SPSS.

All 17 participants ranked themselves very confident on their abilities to use E-mail. This suggests that the use of E-mail on a computer is no longer useful as an indicator of general computer skill. It may further indicate that E-mail use has become so commonplace that it might be replaced on surveys of overall computer self-efficacy. There was no distribution of scores across the sample for this area; rather, responses resulted in a constant. Further investigation might be performed into E-mail skills to determine whether and to what extent using E-mail is a demonstration of computer competence. It may be more effective, for example, to use Web programming as an indicator in future surveys.

The field notes summarized into the data narrative illustrate the need to gain entrée and to be able to spend entire school days with teachers in an open atmosphere of professional exchange in order to obtain in-depth observations. For example, the Willow school technical coordinator met with the researcher early in the study, resulting in expectations of numerous instances and uses of technology which were not subsequently observed. This may have been the result of the short time spans spent during visits, or it may have been a result of the restrictions placed around visitors. Additional investigation with the assistance and support of the school administrators at the district level might yield .a more balanced view of the technology available and used by the mathematics and science teachers.

Other researchers have evaluated the relationship between computer self-efficacy and professional development. Gallagher (2007) studied teachers enrolled in an online professional development course and found that pre- and post-assessments of computer self-efficacy showed a significant increase that may have been attributable to online professional development. However, that study employed the CUSE (Cassidy and Eachus, 2002) rather than the CSE.

Likewise, Becker's (2007) study of elementary school teachers used effect size to obtain results that suggested that teachers with less teaching experience reported themselves as having greater technical skill, but that teachers with both high and low years of experience reported infrequent use of technology with students and frequent use for themselves. As Becker's study suggests, there may be a disconnect between how to use technology, and how to use them to teach.

In his study of teacher professional development, Sharma (2004) recommended a model for teacher technology integration that included access, training, and outside resource support to help teachers; however, a different instrument, the Technology Skills Assessment, was used in that study to measure such integration, and a Teacher Technology Questionnaire was used. Sharma reported that the teachers in the study found professional development to increase their knowledge of technology and their use of it in their classrooms. Like Sharma, this research found that teachers benefitted from professional development when there was open sharing and professional camaraderie in sharing of technology integration knowledge.

As Park (2004) found in the study of factors affecting intention to use technology, teacher beliefs did have a significant indirect effect, with computer self-efficacy, facilitating conditions, and professional development having a significant direct effect.

As Vanatta & Fordham (2004) found in their study of teacher dispositions and teacher self-efficacy, teacher attitudes are likely predictors of technology integration in the classroom; future studies could combine the teacher self-efficacy and computer self-efficacy to determine whether these two constructs are related.

Whitehead's (2002) study used regression analysis to suggest that, as separate variables, self-efficacy and context beliefs of teachers regarding computer use for instruction did predict computer use of teachers. In his study, using the MUTEBI and

BATT instruments to measure self-efficacy beliefs and context beliefs yielded a statistically significantly correlation as well.

The finding of similar results obtained by different researchers using a variety of instruments suggests that the instruments used to measure self-efficacy and technology integration do not seem to produce significant differences as long as the instruments used are validated and have been found reliable, and as long as the methodologies employed are also valid.

The results of this dissertation are significant by themselves, because they provide a foundation for answering the question of whether computer self-efficacy and technology integration in the classrooms of secondary math and science teachers are related. They are also significant in their implications that perhaps needs analyses should look beyond just skill sets and also examine beliefs around those skills to help determine which teachers need more or less assistance in utilizing the technologies available to them. Beyond the immediate needs, however, the results also lay the foundation for looking beyond whether computer self-efficacy affects technology integration to examining whether a causal relationship exists between the two. Additional studies could examine whether increasing the computer self-efficacy of teachers causes a measurable increase, decrease, or no change in levels of technology integration in the classroom. Additionally, further investigation based on the current study's results could examine whether increasing the use of technology in curricular activities causes a measurable increase, decrease, or no change in the computer self-efficacy of teachers.

The conclusions drawn by examination of the results of this study support the perspective that technology is far more than just a vehicle for delivering information or transporting knowledge from teacher to student. Drawing on the Clark-Kozma debate as a metaphor, the researcher concludes that the truck used to transport the bread does matter. Putting the bread in a frozen truck has one impact; putting it in a heated one has another. Putting it in a clean, attractive truck has one effect, and placing it in a soiled, damaged one has quite another. Putting it in an accessible, open truck has one effect, and locking it away behind guarded doors has another. Indeed, in the hands of knowledgeable teachers who are confident that the use of technology will result in benefits for their students and benefits to them, educational technology can excite students and teachers in the critical disciplines of sciences and mathematics.

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APPENDIX A. SELF-EFFICACY FOR COMPUTER TECHNOLOGIES INSTRUMENT[1]

Computer Self-Efficacy Survey

This questionnaire forms part of an investigation of ways to improve the preparation of teachers for teaching with
computers. Data collected on the questionnaire will be used for research purposes only. They will form part of a doctoral dissertation and may be reported in conference and journal papers. Strict confidentiality will be maintained for individual responses. Your name will be removed from the data when it is analyzed and only summary data will be reported.

Instructions

These questions require you to indicate the strength of your agreement with a statement by ticking a box. Please answer all questions by checking boxes as appropriate. There are no right or wrong answers. Your initial response is probably the most accurate reflection of your thinking so move quickly from each statement to the next.

Name: ____

Sex: □ Male □ Female   Age: □ less than 21 □ 21 – 25 □ 26 – 30 □ more than 30

Subject(s) and Grade Level(s)
Taught:____

Years of Teaching Experience ______.

The statements in this block concern how you might feel about computers. For each statement, indicate the strength of your agreement or disagreement by a tick in the appropriate box.		
1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree	Strongly Disagree	Strongly Agree
	1 2	3 4
1. I don't have any use for computer technologies on a day-to-day basis.	❑ ❑	❑ ❑
2. Using computer technologies to communicate with others over a network can help me to be more effective in my job.	❑ ❑	❑ ❑
3. I am confident about my ability to do well in a course that requires me to use computer technologies.	❑ ❑	❑ ❑
4. Using computer technologies in my job will only mean more work for me.	❑ ❑	❑ ❑
5. I do not think that computer technologies will be useful to me in my profession.	❑ ❑	❑ ❑
6. I feel at ease learning about computer technologies.	❑ ❑	❑ ❑
7. With the use of computer technologies, I can create materials to enhance my performance on the job.	❑ ❑	❑ ❑
8. I am not the type to do well with computer technologies.	❑ ❑	❑ ❑
9. If I can use word-processing software, I will be more productive.	❑ ❑	❑ ❑
10. Anything that computer technologies can be used for, I can do just as well some other way.	❑ ❑	❑ ❑

[1] Instrument used by permission of Peter R. Albion, © 2001, University of Southern Queensland

11. The thought of using computer technologies frightens me.	❑ ❑	❑ ❑
12. Computer technologies are confusing to me.	❑ ❑	❑ ❑
13. I could use computer technologies to access many types of information for my work.	❑ ❑	❑ ❑
14. I do not feel threatened by the impact of computer technologies.	❑ ❑	❑ ❑
15. I am anxious about computers because I don't know what to do if something goes wrong.	❑ ❑	❑ ❑
16. Computer technologies can be used to assist me in organizing my work.	❑ ❑	❑ ❑
17. I don't see how I can use computer technologies to learn new skills.	❑ ❑	❑ ❑
18. I feel comfortable about my ability to work with computer technologies.	❑ ❑	❑ ❑
19. Knowing how to use computer technologies will not be helpful in my future work.	❑ ❑	❑ ❑
The statements in this block concern your level of confidence for performing certain tasks with a computer. For each statement, indicate the strength of your agreement or disagreement by a tick in the appropriate box		
1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree	Strongly Disagree	Strongly Agree
	1 2	3 4
20. I feel confident using a word-processing program to write a letter or a report.	❑ ❑	❑ ❑
21. I feel confident accessing previous files with a word processing program.	❑ ❑	❑ ❑
22. I feel confident making corrections while word processing.	❑ ❑	❑ ❑
23. I feel confident formatting text (e.g., bold, underlining) while word processing.	❑ ❑	❑ ❑
24. I feel confident moving blocks of text while word processing.	❑ ❑	❑ ❑
25. I feel confident using the spell checker while word processing.	❑ ❑	❑ ❑
26. I feel confident using the searching feature in a word processing program.	❑ ❑	❑ ❑
27. I feel confident printing out files I've written while word processing.	❑ ❑	❑ ❑
28. I feel confident saving documents I've written with a word-processing program.	❑ ❑	❑ ❑
29. I feel confident renaming a word-processing file to make a back-up copy.	❑ ❑	❑ ❑
30. I feel confident logging on to e-mail.	❑ ❑	❑ ❑
31. I feel confident reading messages on e-mail.	❑ ❑	❑ ❑
32. I feel confident responding to mail messages on e-mail.	❑ ❑	❑ ❑
33. I feel confident deleting messages received on e-mail.	❑ ❑	❑ ❑
34. I feel confident sending mail messages on e-mail.	❑ ❑	❑ ❑
35. I feel confident sending the same mail message to more than one person on e-mail.	❑ ❑	❑ ❑
36. I feel confident responding privately to messages sent to more than one person on e-mail.	❑ ❑	❑ ❑
37. I feel confident forwarding messages received on e-mail.	❑ ❑	❑ ❑
38. I feel confident logging off from e-mail.	❑ ❑	❑ ❑
39. I feel confident formatting the columns and rows in a spreadsheet.	❑ ❑	❑ ❑
40. I feel confident naming the columns and rows in a spreadsheet.	❑ ❑	❑ ❑
41. I feel confident entering appropriate formulas for calculation in a spreadsheet.	❑ ❑	❑ ❑
42. I feel confident entering data in a spreadsheet.	❑ ❑	❑ ❑
43. I feel confident editing previous spreadsheet files.	❑ ❑	❑ ❑
44. I feel confident printing out the spreadsheet.	❑ ❑	❑ ❑
45. I feel confident saving a spreadsheet file.	❑ ❑	❑ ❑

46. I feel confident formatting data fields in a database.	❑ ❑	❑ ❑
47. I feel confident naming data fields in a database.	❑ ❑	❑ ❑
48. I feel confident entering records in a database.	❑ ❑	❑ ❑
49. I feel confident searching records in a database with specific terms.	❑ ❑	❑ ❑
50. I feel confident sorting records in a database.	❑ ❑	❑ ❑
51. I feel confident printing out records in a database.	❑ ❑	❑ ❑
52. I feel confident saving database files.	❑ ❑	❑ ❑
53. I feel confident using a database on compact disc, such as ERIC, AEI, GPO, SSO, etc.	❑ ❑	❑ ❑
54. I feel confident selecting the right database on compact disc for a specific topic.	❑ ❑	❑ ❑
55. I feel confident selecting search terms for a database literature search.	❑ ❑	❑ ❑
56. I feel confident getting into a database on compact disc and starting a literature search.	❑ ❑	❑ ❑
57. I feel confident using descriptors from a database literature search to obtain new search terms.	❑ ❑	❑ ❑
58. I feel confident using the print function in a database search on compact disc.	❑ ❑	❑ ❑
59. I feel confident getting software up and running.	❑ ❑	❑ ❑
60. I feel confident handling a floppy disk correctly.	❑ ❑	❑ ❑
61. I feel confident finding a file that I need.	❑ ❑	❑ ❑
62. I feel confident installing a new program.	❑ ❑	❑ ❑
63. I feel confident copying an individual file.	❑ ❑	❑ ❑
64. I feel confident getting rid of files when they are no longer needed.	❑ ❑	❑ ❑
65. I feel confident organizing and managing files.	❑ ❑	❑ ❑
66. I feel confident using a browser to view sites on the Internet.	❑ ❑	❑ ❑
67. I feel confident making a printed copy of a web page.	❑ ❑	❑ ❑
68. I feel confident recording an Internet site so that I can find it again.	❑ ❑	❑ ❑
69. I feel confident using a printed address to locate an Internet site.	❑ ❑	❑ ❑
70. I feel confident conducting a search for Internet resources.	❑ ❑	❑ ❑
71. I feel confident downloading a file from the Internet.	❑ ❑	❑ ❑
72. I feel confident decoding a file which has been downloaded from the Internet.	❑ ❑	❑ ❑

APPENDIX B. TECHNOLOGY INTEGRATION SELF-ASSESSMENT[2]

Technology Integration Self-Assessment

Name:____

Technology-Related Professional Development Received (in weeks):____________

The purpose of this survey is to determine the existing level of technology integration among classroom teachers. Please complete the following survey by marking all skills you can ACTUALLY perform or have performed for each of the 18 items on the questionnaire. On survey items for which you have no experience, mark as "None of the above."(Approximate time to complete the survey is 8-12 minutes).

1. Operate common technology devices including computer keyboard, mouse, monitor, printer, video camera, digital camera, VCR, scanner, or projection device.

____a. Use mouse and/or keyboard function keys to select a screen icon.
____b. Connect keyboard, mouse, monitor, and printer to computer.
____c. Connect a projection device to computer and project monitor image to a screen.
____d. Create a picture with a digital or video camera OR scan an image with a scanner and transfer to a computer file.
____None of the above

2. Perform basic file management tasks using a Windows and the Novell network.

____a. Save an application file (word processing, spreadsheet, database) to a location on a local drive.
____b. Search for a file by name, type, or date.
____c. Create a folder on a local drive and copy/save files in the folder.
____d. Locate, copy, or move files from a local computer drive to a network drive or folder.
____None of the above

3. Apply trouble-shooting strategies for solving routine hardware and software problems that occur in the classroom.

____a. Properly shut down and restart computer when computer hangs or locks up.
____b. Determine if a computer is logged-on to a computer network.
____c. Remove a paper jam from a printer; install paper and ink cartridge in a printer.
____d. Download and install software updates or install software updates from a local or network drive.
____None of the above

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4. Use software productivity tools to prepare publications, analyze and interpret data, perform classroom management tasks, report results to students, parents, and/or other audiences, and/or produce other creative works.

____a. Load application software (word processing, spreadsheet, database) and enter information.

____b. Create a word processing document and format for printing.

____c. Create a spreadsheet using calculations and computation functions and format for printing.

____d. Prepare a report in a word processing document that includes a table that is imported or pasted from a spreadsheet or database file.

____None of the above

5. Use technology to communicate and collaborate with peers, parents, and the larger community to nurture student learning.

____a. Send an email message to an existing name on the school network address book.

____b. Add a name and address to an email address book OR set email program to use signatures and apply a signature to all email messages.

____c. Add and retrieve an attachment to/from and email message.

____d. Prepare an email distribution list and send an email message to every contact on the list.

____None of the above

6. Use technology to locate, evaluate, and collect educational research/best practices information from a variety of sources.

____a. Browse the Internet to locate useful information using specific URLs.

____b. Perform a search using an Internet search engine or perform a search of an academic database, on-line library catalog, or CD-ROM reference materials.

____c. Subscribe to and read electronic newsletters or journals related to an area of education.

____d. Subscribe to and participate in discussion groups or chat rooms of practitioners or subject-matter experts.

____None of the above

7. Practice and model responsible use of technology systems, information, and software.

____a. Be familiar with school district acceptable use policy (have read it).

____b. Read and discuss school district acceptable use policy with students at least once each semester.

____c. Develop classroom guidelines and procedures for students for computer and network use based on school district acceptable use policy and copyright and licensing restrictions.

____d. Develop classroom guidelines and procedures for students for computer and network use based on school district acceptable use policy and copyright and licensing restrictions. Provide orientation on proper use of equipment and software.

____None of the above

8. Facilitate equitable access to technology resources for all students.

____a. Some students use a classroom computer or go to computer lab after completion of classroom learning activities.

____b. Some students use a classroom computer or go to computer lab to reinforce or supplement learning objectives.

____c. All students use one or more educational software packages to reinforce or supplement learning objectives.

____d. All students regularly use a classroom computer or go to computer lab to perform learning activities related to specific learning objectives.

____None of the above

9. Manage student learning activities in a technology-enhanced learning environment.

____a. Students use a classroom computer or computer lab on their own to perform activities unrelated to classroom learning activities.

____b. Students use a classroom computer or computer lab on their own as an instructional supplement.

____c. Conduct and facilitate student learning activities using educational software on a classroom computer or in the computer lab occasionally (monthly).

____d. Conduct and facilitate student learning activities using educational software on a classroom computer or in the computer lab or on a regular (weekly) basis.

____None of the above

10. Evaluate and select informational and educational resources based on the appropriateness to learning objectives, hardware requirements, and software features.

____a. Describe one technology resource that teacher would like to use for instruction or classroom learning activities.

____b. Describe two or more technology resources and how they relate to learning objectives that teacher would like to use for instruction or classroom learning activities.

____c. Develop a technology plan for classroom or lab including hardware requirements and software features.

____d. Develop a plan with a budget to purchase technology for classroom or lab including hardware requirements, software features, and relation to learning objectives.

____None of the above

11. Demonstrate strategies to assess the validity and reliability of data gathered with technology.

____a. Describe two or more criteria or strategies students should use for critically evaluating the quality, reliability, and validity of web page content.

____b. Establish and communicate criteria and strategies to students for determining the quality, reliability, and validity of web page content.

____c. Establish and communicate criteria and strategies to students for determining the quality, reliability, and validity of web page content. Develop a printed list of appropriate web sites and search engines for use with related classroom learning activities.
____d. Establish and communicate criteria and strategies to students for determining the quality, reliability, and validity of web page content. Develop an electronic list or database (word processing document, spreadsheet, database, or HTML) of appropriate web sites and search engines for use with related classroom learning activities.
____None of the above

12. Use multiple technology contexts and a variety of productivity tools to provide classroom instruction.
____a. Use supplemental materials in teacher's manual to reinforce or supplement classroom instruction.
____b. Use word processing to create worksheets, handouts, and tests or use videotapes and/or CD-ROMs to reinforce or supplement classroom instruction.
____c. Use a multimedia presentation application or web pages to create and present instruction on a single topic.
____d. Use a multimedia presentation application or web pages to create and present instruction on multiple topics.
____None of the above

13. Employ technology in classroom learning activities in which students use technology resources to solve authentic problems in various content areas.
____a. Students use a classroom computer or go to computer lab after completion of classroom learning activities.
____b. Students use a classroom computer or go to computer lab to reinforce or supplement learning objectives.
____c. Integrate at least one project per semester that is a technology-based, authentic learning experience (application) established for targeted curriculum themes or learning objectives into classroom instruction.
____d. Integrate two or more technology-based projects per semester that are authentic learning experiences (applications) established for targeted curriculum themes or learning objectives into classroom instruction.
____None of the above

14. Use technology resources to provide learning contexts requiring the use of problem solving, critical thinking, informed decision-making, knowledge construction, and creativity by learners.
____a. Students use a classroom computer or go to computer lab after completion of classroom learning activities.
____b. Students use a classroom computer or go to computer lab to reinforce or supplement learning objectives.
____c. Integrate at least one technology-based project per semester that requires students to solve problems or formulate decisions into classroom instruction.

____d. Integrate two or more technology-based projects per semester that require students to solve problems or formulate decisions into classroom instruction.
____None of the above

15. Implement technology-based learning experiences that utilize a variety of grouping strategies to address the diverse learning needs of students (e.g. cooperative learning, project-based, collaborative, individualized, learner-centered).
____a. Allow students to work in pairs or small groups on the computer to learn or use educational software.
____b. Occasionally use a team-learning (small group) strategy to complete a technology-based learning activity.
____c. Routinely (quarterly or more) use individual and cooperative learning strategies (may include collaborations with external sources) that result in the completion of technology-based products of learning.
____d. Create an individualized learning plan for each student and track accomplishment of learning goals in the plan using a computerized productivity tool.
____None of the above

16. Apply multiple methods of evaluation and assessment to determine learners' use of technology for learning, communication, and productivity.
____a. Evaluate student technology skills using objective tests only.
____b. Evaluate student technology skills using objective tests and subjective evaluation of student-produced materials.
____c. Evaluate demonstrations of student technology skills using checklists, rubrics, and benchmarks to facilitate student in assessing his/her own performance.
____d. Use action research methods to determine whether technology and classroom teaching methods are impacting student learning.
____None of the above

17. Engage learners in the development of electronic portfolios that document their technology-based educational experiences.
____a. Maintain a cumulative folder of various student technology-based products of learning.
____b. Maintain an electronic file of various student technology-based products of learning.
____c. Students are required to maintain an electronic portfolio of technology-based products of learning using a word processing document.
____d. Students are required to maintain an electronic portfolio of technology-based products of learning using web pages or a multimedia presentation application and demonstrate technology skills and experiences.
____None of the above

18. Use technology resources and productivity tools to collect, analyze, interpret, and communicate learner performance data and other information to improve instructional planning, management, and implementation of instructional/learning strategies.

____a. Write evaluations of student work or progress and notes to parents using word processing and/or email.
____b. Use an electronic gradebook (or spreadsheet or database) to keep track of student grades.
____c. Use an electronic gradebook (or spreadsheet or database) to keep track of student grades and track student mastery of learning objectives.
____d. Maintain and aggregate performance data for students in electronic files. Modify classroom and individual instruction based on analyses of student performance data.
____None of the above

APPENDIX C. TECHNOLOGY INTEGRATION STANDARDS CONFIGURATION MATRIX[3]

Technology Integration Standards Configuration Matrix

TECHNOLOGY IMPLEMENTATION COMPONENT	**4 IDEAL USE**	**3 MODERATE USE**	**2 MINIMAL USE**	**1 UNACCEPTABLE USE**	**0 NO USE**
1. Operate common technology devices including computer keyboard, mouse, monitor, printer, video camera, digital camera, VCR, scanner, or projection device.	Create a picture with a digital or video camera OR scan an image with a scanner and transfer to a computer file.	Connect a projection device to computer and project monitor image to a screen.	Connect keyboard, mouse, monitor, and printer to computer.	Use mouse and/or keyboard function keys to select a screen icon.	None of these
2. Perform basic file management tasks on a computer and local area network.	Locate, copy, or move files from a local computer drive to a network drive or folder.	Create a folder on a local drive and copy/save files in the folder.	Search for a file by name, type, or date.	Save an application file (word processing, spreadsheet, database) to a location on a local drive.	None of these
3. Apply trouble-shooting strategies for solving routine hardware and software problems that occur in the classroom.	Download and install software updates or install software updates from a local or network drive.	Remove a paper jam from a printer; install paper and ink cartridge in a printer.	Determine if a computer is logged-on to a computer network.	Properly shut down and restart computer when computer hangs or locks up.	None of these
4. Use software productivity tools to prepare publications, analyze and interpret data, perform classroom management tasks, report results to students, parents, or other audiences, and produce other creative works.	Prepare a report in a word processing document that includes a table that is imported or pasted from a spreadsheet or database file.	Create a spreadsheet using calculations and computation functions and format for printing.	Create a word processing document and format for printing.	Load application software (word processing, spreadsheet, database) and enter information.	None of these
5. Use technology to communicate and collaborate with peers, parents, and the larger community to nurture student learning.	Prepare an email distribution list and send an email message to every contact on the list.	Add and retrieve an attachment to/from and email message.	Add a name and address to an email address book OR set email program to apply a signature to all email messages.	Send an email message to an existing name on the school network address book.	None of these
6. Use technology to locate, evaluate, and collect educational research/best practices information from a variety of sources.	Subscribe to and participate in discussion groups or chat rooms of practitioners or subject-matter experts.	Subscribe to and read electronic newsletters or journals related to an area of education.	Perform a search using an Internet search engine OR perform a search of CD-ROM reference materials or on-line library catalog.	Browse the Internet to locate useful information using specific URLs.	None of these
7. Practice and model responsible use of technology systems, information, and software.	Develop classroom guidelines and procedures for students for computer and network use based on school district acceptable use policy and provide orientation on proper use of equipment and software.	Develop classroom guidelines and procedures for students for computer and network use based on school district acceptable use.	Read and discuss school district acceptable use policy with students at least once each semester.	Be familiar with school district acceptable use policy (have read it).	None of these
8. Facilitate equitable access to technology resources for all students.	All students regularly use classroom computer or go to computer lab to	All students use one or more educational software packages	Some students use classroom computer or go to computer lab	Some students use classroom computer or go	None of these

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	perform learning activities related to specific learning objectives.	to reinforce or supplement learning objectives.	to reinforce or supplement learning objectives.	to computer lab after completion of classroom learning activities.	
9. Manage student learning activities in a technology-enhanced learning environment.	Conduct and facilitate student learning activities using educational software on a classroom computer or in the computer lab or on a regular basis.	Conduct and facilitate student learning activities using educational software on a classroom computer or in the computer lab occasionally.	Students use a classroom computer or computer lab on their own as an instructional supplement.	Students use a classroom computer or computer lab on their own for activities unrelated to classroom learning objectives.	None of these
10. Evaluate and select informational and educational resources based on the appropriateness to learning objectives, hardware requirements, and software features.	Develop a plan with a budget to purchase technology for classroom or lab including hardware requirements, software features, and relation to learning objectives.	Develop a technology plan for classroom or lab including hardware requirements and software features.	Describe two or more technology resources that teacher would like to use for instruction or classroom learning activities.	Describe one technology resource that teacher would like to use for instruction or classroom learning activities.	None of these
TECHNOLOGY IMPLEMENTATION COMPONENT	**4 IDEAL USE**	**3 MODERATE USE**	**2 MINIMAL USE**	**1 UNACCEPTABLE USE**	**0 NO USE**
11. Demonstrate strategies to assess the validity and reliability of data gathered with technology.	Communicate criteria and strategies to students for determining the quality of web page content; develop an electronic list or database (text or HTML document) of appropriate web sites and search engines for use with classroom learning activities.	Communicate criteria and strategies to students for determining the quality of web page content. Develop a list of appropriate web sites and search engines for use with classroom learning activities.	Establish and communicate criteria and strategies to students for determining the quality, reliability, and validity of web page content.	Describe two or more criteria or strategies students should use for critically evaluating the quality, reliability, and validity of web page content.	None of these
12. Use multiple technology contexts and a variety of productivity tools to provide classroom instruction.	Use a multimedia presentation application or web pages to create and present instruction on multiple topics.	Use a multimedia presentation application or web pages to create and present instruction on a single topic.	Use word processing to create worksheets, handouts, and tests OR use videotapes and CD-ROMs to reinforce/supplement classroom instruction.	Use supplemental materials in teacher's manual to reinforce or supplement classroom instruction.	None of these
13. Employ technology in classroom learning activities in which students use technology resources to solve authentic problems in various content areas.	Integrate two or more technology-based learning experiences per semester into classroom instruction that are established for targeted curriculum themes or learning objectives.	Integrate one technology-based learning experiences per semester into classroom instruction that is established for targeted curriculum themes or learning objectives.	Students use a classroom computer or go to computer lab to reinforce or supplement learning objectives.	Students use a classroom computer or go to computer lab after completion of classroom learning activities.	None of these
14. Use technology resources to provide learning contexts requiring the use of problem solving, critical thinking, informed decision-making, knowledge construction, and creativity by learners.	Integrate two or more technology-based projects per semester into classroom instruction. requiring students to solve problems or formulate decisions.	Integrate one technology-based project per semester into classroom instruction requiring students to solve problems or formulate decisions.	Students use a classroom computer or go to computer lab to reinforce or supplement learning objectives.	Students use a classroom computer or go to computer lab after completion of classroom learning activities.	None of these
15. Implement technology-based learning experiences that utilize a variety of grouping strategies to address the diverse learning needs of students (e.g. cooperative, project-based, collaborative, individualized, teams).	Create an individualized learning plan for each student and track accomplishment of learning goals in the plan using a computerized productivity tool.	Routinely use individual and cooperative learning strategies that result in the completion of technology-based products of learning.	Occasionally use a team-learning (small group) strategy to complete a technology-based learning activity.	Allow students to work in pairs or small groups on the computer to learn or use educational software.	None of these
16. Apply multiple methods of evaluation and assessment to determine learners' use of	Use action research methods to determine whether technology and	Evaluate demonstrations of student technology skills using	Evaluate student technology skills using objective tests and	Evaluate student technology skills using	None of these

technology for learning, communication, and productivity.	classroom teaching methods are impacting student learning.	checklists, rubrics, and benchmarks to assist students in assessing their performance.	subjective evaluation of student-produced materials.	objective tests only.	
17. Engage learners in the development of electronic portfolios that document their technology-based educational experiences.	Students are required to maintain an electronic portfolio of technology-based products of learning using web pages or a multimedia presentation application and demonstrate technology skills and experiences.	Students are required to maintain an electronic portfolio of technology-based products of learning using a word processing document.	Maintain an electronic file of various student technology-based products of learning.	Maintain a cumulative folder of various student technology-based products of learning.	None of these
18. Use technology resources and productivity tools to collect, analyze, interpret, and communicate learner performance data and other information to improve instructional planning, management, and implementation of instructional/learning strategies.	Maintain and aggregate performance data for students in electronic files. Modify classroom and individual instruction based on analyses of student performance data.	Use an electronic gradebook (or spreadsheet or database) to keep track of student grades and track student mastery of learning objectives.	Use an electronic gradebook (or spreadsheet or database) to keep track of student grades.	Write evaluations of student work or progress and notes to parents using word processing and/or email.	None of these

APPENDIX D. INTERVIEW GUIDE

This questionnaire forms part of an investigation of how teacher use technology in their classrooms. Data collected on the questionnaire will be used for research purposes only. They will form part of a doctoral dissertation and may be reported in conference and journal papers. Strict confidentiality will be maintained for individual responses. Your name will be removed from the data when it is analyzed and only summary data will be reported.

Teacher Name____

Questions for Teacher Interview

How do you like to integrate technology in your classroom?

Why do you think technology helps students to learn?

Do you think your participation in professional development helped you to integrate technology in your classrooms? If so, what particular experiences helped you most, and how did they help you?

What other experiences have contributed to your ability to integrate technology into your classrooms?

Do you have any other observations that you would like to share about using technology to teach your subject(s) and grade(s)?

APPENDIX E. RECRUITMENT E-MAIL

Date:

From: Bettie C. Hall, M.Ed.
Division of Teacher Education
University of Cincinnati

RE: Participation in research project titled: How teachers in the greater [Metropolitan] area are using technology for instruction

Hello,

I am E-mailing you to ask you to be a participant in my research to examine how teachers in K-12 classrooms in the greater [Metropolitan] area are thinking about and using technology. I would like to invite you to contact me if you are interested in participating. I am writing a dissertation at the University of Cincinnati and I want to use the information I collect from you and other teachers in the [targeted] area

If you choose to participate, please send me your preferred contact information that includes a daytime telephone number, preferred mailing address, and preferred E-mail address. I will send you two self-assessment surveys. I will also ask you to let me know a convenient time and date when I could come interview you for about one-half hour about what you do with technology in your classes. I will also ask you for a sample of a lesson plan that uses technology that you have used in your classroom. I will also ask you to let me know a convenient time and date when I could come and observe you teaching in your classroom for one class period. No student made materials will be collected.

If you would like to talk with me, please reply to this email with the requested contact information. I will send you two copies of a consent form, the self-assessments and contact you to finalize a date, time and place for us to meet. At the interview meeting, I will ask you to sign the consent forms and collect the completed surveys and the sample lesson plan. You will keep one of the consent forms for your records.

All identifying school and personal information will be removed from data I collect. I will be glad to explain the consent form and everything I am asking you to do. If you have questions about data collection and confidentiality before the interview, please email me and I will answer promptly.

My E-mail is hallbe@email.uc.edu. My telephone number is [xxx-xxx-xxxx]. I look forward to hearing from you.

Bettie C. Hall, M.Ed.
Doctoral Candidate in Curriculum and Instruction
Dept. of Teacher Education
College of Education, Criminal Justice, and Human Services

University of Cincinnati
Cincinnati, OH 45221

APPENDIX F. TEACHER INTERVIEW SUMMARY

Seventeen teachers in a large, Midwestern urban area were interviewed to determine how they integrated technology in their classrooms and what contributed to that integration. Samples from the teachers who participated were selected for analysis. Their responses are summarized in Table 27.

Interview Dates

P0403 - April 10, 2008

P0404 – April 7, 2008

P0406 – April 8, 2008

P0407 – April 10, 2008

Settings

- P0403 is a physics teacher for grades 11 and 12 in a large, technology-rich, suburban high school that has been rated "Excellent." One computer is available to the instructor in the classroom in which this teacher is observed.

- P0404 teaches science and biotechnology for grades 10 and 11 in the same high school as P0403. Six computers are available for student use in the classroom in which this teacher is observed, along with one computer that is available to the instructor. An electronic whiteboard is also available in this classroom, as well as a videocassette recorder, a laser disc player, and a wireless tablet.

- P0406 teaches chemistry and another science course for grades 11 and 12 in a large suburban high school that has been rated "Effective." The high school has 600 computers, according to its Web site, but only one is available to the instructor in the classroom in which this teacher is observed. None are provided for the students in the room. A large television monitor is available for students to view the instructor's computer.

- P0407 teaches environmental science and biology for grades 10 and 11 in the same large suburban high school as P0406. Again, only one instructor computer is available in the classroom in which this teacher is observed. There is an electronic whiteboard and projector in this classroom.

Table 27

Participant Responses to Interview Questions

Interview Question	P0403 Responses	P0404 Responses	P0406 Responses	P0407 Responses
How do you like to integrate technology in the classroom?	1. Learning management system for automated attendance, grade recording, posting, and archiving assignments and lesson plans. 2. Overhead projector for showing [Internet] videos.	As much technology as possible.	1. As much technology as I can. 2. Presentation software slide shows. 3. Online multimedia videos. 4. Textbook CDROM video clips. 5. Computer laboratory in the library for test	1. Electronic whiteboard to project computer applications, presentations, and online animations. 2. Electronic whiteboard tools to mark up and save lessons for classes. 3. Wireless

	3. Vernier® probes and software for data collection and analysis. 4. Electronic laboratory equipment for experimenting.		preparation.	tablets for polling.
Why do you think technology helps students to learn?	1. Lets kids actually see a theoretical idea. 2. Provides an actual representa-tion of an idea. 3. I can communi-cate better.	1. Because they are so techno-oriented. 2. Every student has an [portable media player] and every student has a cell phone. 3. I let them play music from their [portable media players] ... because…fine arts help incorporate or improve learning.	1. Because they're so used to [portable media players] and cell phones and the students are familiar with electronics. 2. It gives them a visual. 3. It gives them something to focus on. 4. They know their electronics. 5. This is the technology age. 6. It makes [the content] more familiar to them so they're not as afraid of it.	1. Because of the society we live in today. 2. Kids know technology. 3. We have to meet their needs by staying up with their technologies 4. Students need it. 5. It keeps them excited. 6. They love it. 7. It makes things simpler and more fun for me. 8. If it's more interesting for me, hopefully it's interesting for them, too.

			7. Makes it [the content] more interesting because it's something they can relate to.	
Do you think participation in professional development has helped you integrate technology in the classroom? If so, what particular experiences helped you most, and how did they help you?	1. The professional development on the learning management system provided the basics, gradebook, weighting tests.	2. I've had a lot of training outside the classroom, through masters programs, outside activities. 3. Each teacher is required to have a learning management system site. 4. Each teacher is supposed to have all their lesson plans on the learning management system Web site. 5. We take attendance electronically. 6. We communicate electronically.	Troubleshooting has made me less fearful of using technology.	Yes, at a previous school.

What other experiences have contributed to your ability to integrate technology into your classroom?	1. Seeing somebody else use a piece of technology. 2. College experience. 3. I think back to a lab experiment that I saw in the past.	1. I have kids of my own. They teach me things all the time. 2. Let [students] show me how to do stuff. 3. I learned about books on tape from one of the other teachers.	1. Family uses technology. 2. E-mail. 3. Had laptop carts during internship. 4. Used chemistry virtual laboratory demonstrations and simulations. 5. Online biology software for virtual dissections.	1. Mentor teacher taught electronic whiteboard professional development. 2. Family uses technology and thought it was important. 3. Spouse uses technology. 4. Took course in programming at college.
Do you have any other observations that you would like to share about using technology to teach your subject(s) and grade(s)?	1. I can't imagine doing teaching without technology. 2. There's so much space for me to learn more and use it more often. 3. I expect that'll expand the older I get and the better I get at teaching.	1. I'm in a master's program and we post a lot of stuff and make our own Web pages, and I find there are a lot of people out there that are afraid of the technology. 2. I'm kinesthetic; I have to mess with it. 3. Don't be afraid of the technology; embrace it.	1. I'm new to the district so I'm not sure what's available to me. 2. Sometimes my equipment doesn't work and I don't know how to get it fixed. 3. I always develop [lesson plans] first and then go back and put the technology in.	1. Would like to take using electronic white boards to a higher level.

APPENDIX G. CODING TABLE

Index of Interviews

Table 28. *Statements Showing Evidence of Technology Integration*

Integration Theme	Statement	Interview Transcript Page
Use: Barrier	*I don't have individual computers for the kids*	INP0406-2
Use: Barrier	*I'm kind of hesitant at even scheduling time in the computer lab*	INP0406-2
Use: Barrier	*sometimes my equipment doesn't always work and I don't always know how to get it fixed*	INP0406-6
Use: Barrier	*The teacher across the hall from me has a [electronic whiteboard]*	INP0406-2
Use: Barrier	*whenever I want to do a [presentation software presentataion] or a streaming video or something I know I have to go in and change some settings because it always changes itself back*	INP0406-3
Use: Computer Laboratory	*I do go to the computer lab here when we do [State Standardized Testing] prep*	INP0406-5
Use: Computer Laboratory	*we have computer labs*	INP0406-2
Use: Computer Laboratory	*when you don't have computers in your classroom for your kids, you can demonstrate and then schedule the lab*	INP0406-4
Use: Data Projector	*I've started using one of the rooms I in we have one of those overhead projectors*	INP0403-2
Use: Digital Microscopes	*used digital microscopes*	INP0407-2
Use: Electronic Books	*I can listen to it in my car and because I was listening to it, I found another resource to use*	INP0404-3

Integration Theme	Statement	Interview Transcript Page
	in a classroom	
Use: Electronic Books	*I take excepts and have the kids listen to stuff from books on tape*	INP0404-3
Use: Electronic Laboratory Equipment	*we get to use lab equipment for you know, for circuits, for sound, we use a lot with microphones that are online, voltage probes, um, force sensors, all that stuff for all those things too*	INP0403-2
Use: Electronic Whiteboard	*do a lot more with [electronic whiteboards], like, I ultimately like to take it to a higher level,*	INP0407-5
Use: Electronic Whiteboard	*I figure out more things to use it for*	INP0407-2
Use: Electronic Whiteboard	*I had them come up and we did stations and one of the stations was at the [electronic whiteboard] and they had to manipulate a DNA structure*	INP0407-3
Use: Electronic Whiteboard	*I have lots of online like animations, so I'll put up an animation and I can just click through it and pause or click and drag things*	INP0407-1
Use: Electronic Whiteboard	*I like to be really interactive with it*	INP0407-1
Use: Electronic Whiteboard	*I like to integrate my [electronic whiteboard] in the classroom a lot*	INP0407-1
Use: Electronic Whiteboard	*I like to use it for sometimes lab data*	INP0403-2
Use: Electronic Whiteboard	*I mean used it for microscopes*	INP0407-2
Use: Electronic Whiteboard	*I only have to write the questions once then, and then I can save kids' solution*	INP0403-2
Use: Electronic Whiteboard	*I pop them on, they can answer, they can come up and fill in the answers, we can erase that document, and it's ready to go for the next class again*	INP0403-2

Integration Theme	Statement	Interview Transcript Page
Use: Electronic Whiteboard	*I use it for notes*	INP0407-1
Use: Electronic Whiteboard	*I use my [electronic whiteboard] for everything*	INP0407-2
Use: Electronic Whiteboard	*if I'm doing, showing how nucleotide-based pairs line up, then I can just hand write it in there*	INP0407-1
Use: Electronic Whiteboard	*movies*	INP0407-2
Use: Electronic Whiteboard	*the [electronic whiteboard] gallery*	INP0407-1
Use: E-mail	*we communicate electronically*	INP0404-2
Use: Extent	*as much technology as possible*	INP0404-1
Use: Extent	*I try to use technologies as I can bring in*	INP0404-1
Use: Instructor Computer	*I have my one computer*	INP0406-2
Use: Internet	*I can pull up anything from Utube from Teachertube*	INP0403-2
Use: Internet	*I download a video*	INP0406-6
Use: Internet	*I find some really cool demos*	INP0407-1
Use: Internet	*I found some online frog dissections that I'll use when I do my dissections*	INP0407-1
Use: Internet	*I like using it for videos*	INP0403-2
Use: Internet	*there's resources that I do use but it also has Web sites to go to*	INP0406-3
Use: Internet	*we have [online multimedia video] available to us*	INP0406-6
Use: Laptop Carts	*we did have laptop carts*	INP0406-4
Use: Laptops	*We had the laptops and I did much more projects and things like that*	INP0406-5
Use: Learning Management System	*archive too of all the work they've done over a long time*	INP0403-1
Use: Learning Management System	*I can also post all of my work,*	INP0403-1
Use: Learning	*I can post all their*	INP0403-1

Integration Theme	Statement	Interview Transcript Page
Management System	*assignments on there*	
Use: Learning Management System	*I can scan in all my solutions with explanations*	INP0403-1
Use: Learning Management System	*I use [a learning management system] often*	INP0403-1
Use: Learning Management System	*we post a lot of stuff and upload a lot of stuff and we make our own Web pages*	INP0404-3
Use: Lesson Planning	*I always develop first and then go back and put the technology in*	INP0406-6
Use: Lesson Planning	*I don't plan too many lessons around technology*	INP0406-2
Use: Location	*how I use it in the different rooms varies significantly*	INP0403-1
Use: Personal Audio Device	*I have an [portable media device], I know how to use it a little bit to listen to it*	INP0404-3
Use: Personal Audio Device	*I let them play music from their [portable media devices]*	INP0404-1
Use: Personal Response System	*they're called [an audience response system] and it's kind of like [a televised game show]*	INP0407-2
Use: Personal Response System Devices	*I haven't gotten to use them yet*	INP0407-2
Use: Professional Development	*they videotaped me*	INP0407-5
Use: Simulation Software	*So I found this wonderful software and … I put it on the laptops and it was awesome and you click on the equipment that you need and you drag and click the chemicals and put it in and then it would show it mixing. It was a chemical laboratory simulation.*	INP0406-5
Use: Software	*we use a lot of [data collection technology] software*	INP0403-2
Use: Software	*when I taught biology, I found online biology software and*	INP0406-5

Integration Theme	Statement	Interview Transcript Page
	found virtual dissection … .	
Use: Student Use	*I want some of my students to make podcasts for me,*	INP0404-3
Use: Student Use	*I'll give them problems they've had a long time in the past*	INP0403-1
Use: Student Use	*one of my projects was here's a topic, you guys can choose what type of product you want to make, it can be a video, it can be a [presentation software], it can be a public presentation, it can be a storybook, it can be a photo essay*	INP0404-3
Use: Student Use	*they each had their individual laptops and got to analyze it on their laptops*	INP0407- 2
Use: Student Use	*they use it for warm-up questions*	INP0403-2
Use: Time	*During the day, not as much as in the evening*	INP0403-1
Use: Troubleshooting	*I can start something up like my TV is hooked to the computer*	INP0406-3
Use: Wireless Tablets	*We have wireless tablets that we can use in the back*	INP0407-2
Use: Software	*we go and they do … software that has questions for [State Standardized Testing]and they do the [State Standardized Testing] prep there*	INP0406-5

Table 29

Statements Showing Evidence of Beliefs About Technology

Belief Theme	Statement	Interview Transcript Page
Belief: Barrier	*I don't have time to bring these up in every class, unfortunately*	INP0406-4
Belief: Barrier	*I find that there are a lot of people out there that are afraid of the technology*	INP0404-4
Belief: Barrier	*even if I know what's available to me sometimes my equipment doesn't always work and I don't always know how to get it fixed.*	INP0406-6
Belief: Barrier	*I always develop first and then go back and put the technology in, so that's one of my problems,*	INP0406-6
Belief: Barrier	*I can get in here and I can start something up like my TV is hooked to the computer but it never works right, but now I know how to get it working right*	INP0406-3
Belief: Barrier	*I don't think in terms of developing them in a technology way*	INP0406-6
Belief: Barrier	*I don't think we focus enough on technology*	INP0407-4
Belief: Barrier	*I feel that as much as I've been into it, that I'm so behind the times because things change so fast*	INP0406-4
Belief: Barrier	*I haven't had the time to figure out … how to do that and that's one of the problems … when you're so stressed for time and you're trying to get something to work right … if I can't get it in 10 minutes, I've got to move on to the next thing*	INP0406-7
Belief: Barrier	*I think would be a good tool*	INP0406-7

Belief Theme	Statement	Interview Transcript Page
	but it seems like every time I download a video, it seems like the sound never works right	
Belief: Barrier	*I'm kind of hesitant at even scheduling time in the computer lab because I never know exactly what we're going to be doing or when we're going to be doing it.*	INP0406-2
Belief: Barrier	*I'm new to the district I'm not sure what's available to me*	INP0406-6
Belief: Barrier	*I'm still in the email phase where everybody else is into instant messaging and that kind of thing*	INP0406-4
Belief: Barrier	*I've got only so much time*	INP0406-2
Belief: Barrier	*I'm not in the mindset of starting to think about a lesson in terms of how can I make this technical*	INP0406-3
Belief: Barrier	*part of the problem with going to the lab was you know the classroom management aspect*	INP0406-6
Belief: Barrier	*some of the reasons that I don't plan too many lessons around technology is because I don't have that much in here to use*	INP0406-2
Belief: Barrier	*they're afraid they're going to screw it up*	INP0404-4
Belief: Barrier	*things change so much you know*	INP0406-2
Belief: Barrier	*you have so little time to develop lessons and a lot of times you don't think in terms of how can I develop them with technology*	INP0406-3
Belief: Barrier	*You've got to go around and look at the bottom of the*	INP0406-6

Belief Theme	Statement	Interview Transcript Page
	screen and see how many windows they have up cause you know they only need to have one window up and if you're not behind them looking at them, they're looking at other Web sites, so that's one problem with the Internet.	
Belief: Classroom Management	*it's a hassle for me to tell the kids to put their cell phones away, put their iPods away, they're always bringing them out*	INP0407-2
Belief: Classroom Management	*So that's kind of my how I feel about it, because if they're interested, my best days are days when they're interactive*	INP0407-5
Belief: Data Projector	*I've started using one of the rooms I in we have one of those overhead projectors, so that's nice for a whole bunch of stuff*	INP0403-1
Belief: Electronic Books	*Because in every, well not every but in a lot of lessons, it's … you can show the video or … a CDROM … and it has … slides and video clips that goes along with the reading which is wonderful because …very few of these kids read*	INP0406-4
Belief: Electronic Books	*One really nice thing about the [chemistry] course I'm teaching … the book and stuff … have a video that goes along with it*	INP0406-3
Belief: Electronic Laboratory Equipment	*you have to be able to actually picture what's going to happen in that circuit,*	INP0403-2
Belief: Electronic Whiteboard	*every day I figure out more things to use it for*	INP0407- 2

Belief Theme	Statement	Interview Transcript Page
Belief: Electronic Whiteboard	*I had them come up and we did stations and one of the stations was at the [electronic whiteboard] and they had to manipulate a DNA structure*	INP0407-3
Belief: Electronic Whiteboard	*I haven't used it as much as I'd like to*	INP0407-1
Belief: Electronic Whiteboard	*I like to integrate my [electronic whiteboard] in the classroom a lot because it's an interactive multimedia tool*	INP0407-1
Belief: Electronic Whiteboard	*I like to use it*	INP0403-2
Belief: Electronic Whiteboard	*I like to use, I have lots of online like animations*	INP0407-1
Belief: Electronic Whiteboard	*I love it*	INP0407-3
Belief: Electronic Whiteboard	*I mean, students never want to sit at the front of the room, but when they got to use the [electronic whiteboard], it was great.*	INP0407-3
Belief: Electronic Whiteboard	*I ultimately like to take it to a higher level*	INP0407-6
Belief: Electronic Whiteboard	*science is really great for it*	INP0407-1
Belief: Electronic Whiteboard	*They love it.*	INP0407-3
Belief: Electronic Whiteboards	*Like the kids, I hadn't realized how great it was at the beginning but at the end I taught them what everything was and they were like, "Oh yeah, the [electronic whiteboard's] great.*	INP0407-7
Belief: Enablers to Technology Integration	*My mentor teacher was a, and again this is where I student taught, she was my coop teacher and she was the head*	INP0407-4

Belief Theme	Statement	Interview Transcript Page
	of the [electronic whiteboard] coordinators, so that was really pretty cool for me	
Belief: Enablers to Technology Integration	*Oh man that would have been great, I should do that*	INP0403-4
Belief: Enablers to Technology Integration	*we don't care about fine china, we care about our electronics, so it's helped that I've learned a lot through [my spouse] because [my spouse] is really into it and [my spouse] does Internet programming,[my spouse] has built [my spouse's] own Web site*	INP0407-5
Belief: Enablers to Technology Integration	*We're just like big on technology; we're big geeks like that*	INP0407-5
Belief: Enablers to Technology Integration	*it's kind of been cool that I've come in even as a first year teacher and just been kind of like teaching teachers how to do this, and that's probably one of the biggest things*	INP0407-6
Belief: Enablers to Technology Integration	*My family also really incorporated technology and thought it was really important*	INP0407-6
Belief: Internet	*I find some really cool demos*	INP0407-1
Belief: Internet	*I like using it for videos which is really quick*	INP0403-2
Belief: Internet	*I was just totally blown away by some of the stuff that's out there*	INP0404-3
Belief: Laptop Carts	*it actually saved me*	INP0406-5
Belief: Laptop Carts	*it was awesome*	INP0406-5

Belief Theme	Statement	Interview Transcript Page
Belief: Laptop Carts	*they were great*	INP0406-5
Belief: Learning Management System	*I can post all their assignments on there, which is good*	INP0403-1
Belief: Learning Management System	*I can't imagine using a paper and pencil grade book any more*	INP0403-3
Belief: Learning Management System	*it makes it so I can communicate better*	INP0403-3
Belief: Learning Management System	*It's way way easier*	INP0403-3
Belief: Learning Management System	*So like if I give a homework assignment and I know the kids are going to be confused, I can scan in all my solutions with explanations to kind of help them think things through, and then they can check that work all the time, so that's really valuable for me*	INP0403-1
Belief: Personal Response System	*I love I haven't gotten to use them yet but the idea of using them for something like [State Standards Testing] prep would be awesome*	INP0407-2
Belief: Professional Development	*it's made me less fearful of using technology and I think that's the biggest thing.*	INP0406-3
Belief: Software	*I found this wonderful software*	INP0406-5
Belief: Student Benefits	*Because they are so techno-oriented at this point in time.*	INP0404-1
Belief: Student Benefits	*even with me there's been a gap so I'm trying to like stay up to date with them, because they're, the old textbook worksheet method is like well yeah it works, it works, but it's not as engaging I think for them as technology is concerned.*	INP0407-3

Belief Theme	Statement	Interview Transcript Page
Belief: Student Benefits	*every student has an [portable media device] and every student has a cell phone and while the school rules say they're not supposed to be using them in the classroom I find I can use them as fabulous teaching tools*	INP0404-1
Belief: Student Benefits	*I think like this morning as an example with that the lab activity we were doing, technology there lets the kids actually see a theoretical idea*	INP0403-2
Belief: Student Benefits	*I want it to be interesting for me, and if it's interesting for me hopefully it's interesting for them too.*	INP0407-4
Belief: Student Benefits	*I'll teach more of a general college prep level, and I think they tend to love it more,*	INP0407-7
Belief: Student Benefits	*if we're trying to meet the needs of the students, we have to do like, we have to meet their needs by staying up with their technologies so, and I don't feel too awfully disconnected from them since I went here, I graduated from here so I kind of know where they're coming from*	INP0407-2
Belief: Student Benefits	*If you can have students show you how to do or use something electronically, you will see them beam, so I fake or feign ignorance a lot of times to let them show me how to do stuff*	INP0404-2
Belief: Student Benefits	*if you can't build it and you can't watch it and you can't use technology to do it, it's, you know, it's just somebody talking about it. I think it's the same with videos and things*	INP0403-3

Belief Theme	Statement	Interview Transcript Page
	like that; you're introducing those so it's not just a theoretical idea but an actual representation of what you've got going on	
Belief: Student Benefits	*It keeps them excited*	INP0407-3
Belief: Student Benefits	*My students are techno-oriented*	INP0404-1
Belief: Student Benefits	*Students need it*	INP0407-3
Belief: Student Benefits	*The biggest things about why I think technology helps students learn is because the society we live in today*	INP0407-2
Belief: Student Benefits	*the more I can make it authentic for them in the classrooms, the more they're going to be willing to learn and give me their attention, so I try to use technologies as I can bring in*	INP0404-1
Belief: Student Benefits	*They know technology better than probably 75% of the teachers in this building*	INP0407-2
Belief: Student Benefits	*what I got as a result was fantastic.*	INP0404-3
Belief: Student Benefits	*I have kids that are fantastic at making videos*	INP0404-3
Belief: Student Computers	*my wish would be to have computers and laptops in every room,*	INP0407-3
Belief: Technology Integration	*And my advice is don't be afraid, just go out and play with it*	INP0404-4
Belief: Technology Integration	*because I look at, and maybe it's just me being coming from a school where it's all technology and I was really spoiled there so it was, I don't think we do it enough*	INP0407-4

Belief Theme	Statement	Interview Transcript Page
Belief: Technology Integration	*I am the biggest supporter of it*	INP0407-3
Belief: Technology Integration	*I can do whatever*	INP0403-2
Belief: Technology Integration	*I can't imagine doing teaching without technology*	INP0403-4
Belief: Technology Integration	*I just expect that that'll expand the older I get and the better I get at teaching*	INP0403-4
Belief: Technology Integration	*I like to use as much technology as possible*	INP0404-1
Belief: Technology Integration	*I think we tend to spend more time on assessment and behavior which is all very very important but I think we tend to forget the technology aspect because I think if we could tweaked the technology aspect a little bit, we could tweak the assessment and behavior as well*	INP0407-5
Belief: Technology Integration	*I try to make it a little bit different*	INP0407-4
Belief: Technology Integration	*I'm fascinated with things, not necessarily the mechanics behind things, but, "Ah I can use this for this, and I can use that for this."*	INP0404-3
Belief: Technology Integration	*I've always found it to be important and plus I find it fascinating, so it's personally something I've always been interested in from day one.*	INP0407-6
Belief: Technology Integration	*If you mess it up, just start over again*	INP0404-4
Belief: Technology Integration	*it makes it a lot simpler and more fun for me. I don't really like, I'm not a big, "Here's the notes, here's the review", even though that's kind of what I did today*	INP0407-3

Belief Theme	Statement	Interview Transcript Page
Belief: Technology Integration	*So don't be afraid of the technology; embrace it.*	INP0404-4
Belief: Technology Integration	*technology just makes life a whole lot easier, I mean every time, it makes my life smoother*	INP0403-3
Belief: Technology Integration	*that's easy*	INP0403- 3
Belief: Technology Integration	*There are sometimes when you don't need technology but if I can use it I will try to*	INP0404-1
Belief: Technology Integration	*when you don't have computers in your classroom for your kids, you can demonstrate and then schedule the lab*	INP0406-5
Belief: Technology Integration	*You have your stuff backed up hopefully so just go out and fiddle with it and make it to the point where you like it, cause that's for me that's the only way I learn.*	INP0404-4
Belief: Wireless Tablets	*We have wireless tablets that we can use in the back which is just great*	INP0407-2

APPENDIX H. TISA SCORING TABLES

Table 30

TISA Unconverted Raw Scores

Participant ID	Common Technology Device Operation	Basic File Management Tasks	Troubleshooting Strategies	Software Productivity Use	Communication and Collaboration Technology Use	Internet Research Use	Responsible Technology Use	Equitable Technology Access Facilitation	Learning Management Technology Use	Evaluating Technology Resources	Assessment of Technology-Derived Data	Multiple Technology Contexts and Tools Use	Student Technology Use for Authentic Learning	Technology for Higher Order Learning Use	Technology for Diverse Learning Needs Use	Student Technology Use Assessment and Evaluation	of Technology Experiences	Technology for Instructional Analysis and Improvement Use
P0404	abcd	abcd	abcd	abcd	abcd	Abd	abcd	abcd	abcd	abcd	abcd	abcd	abcd	abcd	abc	dc	b	ab
P0406	abcd	abc	abcd	abc	abcd	Ab	a	c	e	a	e	abcd	ab	ab	e	e	e	ab
P0405	abcd	abcd	abcd	abcd	abcd	Abcd	abcd	ab	ab	abcd	abcd	abcd	abcd	abcd	abcd	c		abcd
P0403	abcd	abcd	abcd	abcd	abcd	Abc	ad	abcd	abcd	abc	c	abcd	abc	abc	abc	b	e	ab
P0407	abcd	abcd	abc	abcd	abcd	Ab	e	abd	b	b	e	bd	abc	ab	b	d	e	ab
P0402	abcd	abcd	abcd	abcd	abcd	Abcd	abcd	abcd	abcd	abcd	abcd	abcd	bcd	bcd	ac	abc	b	ab
P0408	abcd	abcd	abcd	abcd	abcd	Ab	a	e	ab	ab	e	ab	e	e	e	e	e	abcd
P0409	abcd	abcd	abcd	abcd	abcd	Abcd	a	e	b	abcd	a	cd	a	e	ab	c	e	abcd
P0410	acd	abcd	abcd	abcd	abcd	Abcd	acd	ab	abc	ab		abcd	abc	abc	a		ab	abcd
P0411	abcd	abcd	abcd	abcd	abcd	Abc	ab	ab	abcd	ac	e	abcd	ab	ab	ac	c	e	abcd
P0412	ab	abcd	abcd	abd	abc	Abc	a	a	e	e	e	ab	e	e	a	e	e	ab
P0413	abcd	abcd	abcd	abd	abcd	Ab	a	e	bcd	ab	e	abcd	e	e	e	e	e	abcd
P0414	abcd	abcd	abcd	abcd	abcd	Ab	a	e	a	e	e	ab	e	e	e	e	e	abc
P0415	a	ad	abc	bcd	abcd	A	a	ac	ab	c	e	abc	c	b	ab	ab	e	ab
P0416	abcd	abcd	abcd	abcd	abc	Abc	ac	e	c	a	e	ab	e	e	e	e	e	abcd
P0418	abd	abc	abcd	ab	abcd	Abc	ab	ab	ab	e	e	a	ab	ab	e	a	e	ab
P0419	abc	abcd	abc	abcd	ac	Ac	abcd	c	b	b	a	ab	c	e	ad	e	b	ab

The TISA values were first originally recorded exactly as the instrument provides, as a, b, c, and/or d, or just e, responses as shown in Table 30. Participants could choose one or more values a, b, c, and d, or they could choose e alone. These participant responses were coded into a binary number using the conversion table shown in Table 31. In the converted table shown in Table 9, the responses that included a, b, c, and d are represented by the number 15, while e is represented by 0, as shown in Table 31. This binary coding permitted the retention of the scalar nature of the a, b, c, d, e responses on the instrument.

Table 31

Binary Coding Table Used to Convert TISA Responses

A	B	C	D	Number	Code
0	0	0	0	0	e
0	0	0	1	1	a
0	0	1	0	2	b
0	0	1	1	3	ba
0	1	0	0	4	c
0	1	0	1	5	ca
0	1	1	0	6	cb
0	1	1	1	7	cba
1	0	0	0	8	d
1	0	0	1	9	da
1	0	1	0	10	db
1	0	1	1	11	dba
1	1	0	0	12	dc
1	1	0	1	13	dca
1	1	1	0	14	dcb
1	1	1	1	15	dcba

[redacted]

[redacted]

Date: Wed 23 May 07:40:02 EDT 2007
From: Peter Albion [redacted]
Subject: Re: Permission to use instrument
To: Bettie Hall <hallbe@email.uc.edu>

Bettie

You are welcome to use the instrument as published in JTATE
Albion, P. R. (2001). Some factors in the development of self-efficacy beliefs for computer use among teacher education students. *Journal of Technology and Teacher Education*, 9(3), 321-347.
or as it appears in my dissertation which is available from
<http://adt.usq.edu.au/adt-QUSQ/public/adt-QUSQ20030806.164001/index.html> or
<http://www.usq.edu.au/users/albion/papers/thesis.pdf>. The versions in the dissertation are copies of the forms I used and may be more complete.

There is no cost or condition other than the regular acknowledgement of sources.

Best wishes for your study. I'll be interested to know of the results.

Regards

Peter Albion

On 23/5/07 3:35 PM, "Bettie Hall" <hallbe@email.uc.edu> wrote:

> Dear Dr. Albion,
>
> I am a doctoral student at the University of Cincinnati in Cincinnati, Ohio. I am writing to ask if I could obtain and use the Self-Efficacy for Computing Technologies instrument that was developed by you for my dissertation which is entitled "An Investigation of the Relationship Among Computer Self-Efficacy, Professional Development, and Technology Integration in Teachers of Varying Years of Experience." I am interested in evaluating the computer self-efficacy of teachers in a professional development program.
>
> I would like to start collecting data in July, 2007. Please let me know if there are any costs or other requirements for using the instrument. Thank you in advance for your consideration.
>
> Best Regards,
> Bettie Hall, Doctoral Candidate
> Curriculum and Instruction
> Teacher Education
> hallbe@email.uc.edu <mailto:hallbe@email.uc.edu> - university e-mail
> [redacted]

~~~~~~

Peter Albion PhD [redacted]
Associate Professor [redacted]
University of Southern Queensland [redacted]

[redacted]
This message represents my views which may not be those of USQ.

[redacted]

[redacted]
~~~~~~

[redacted]

[redacted]

Re: Permission to print instruments

1 message

Peter Albion [redacted] **Tue, Apr 29, 2008 at 6:54 PM**
To: Bettie Hall <hallbe@email.uc.edu>
Cc: KENNETH E MARTIN [redacted]

Bettie

Congratulations on completing your dissertation.

I have no restrictions on the instrument. It is readily available through my dissertation and publications so restrictions beyond simple acknowledgement serve no obvious purpose.

I look forward to seeing your results when they are available.

Regards

Peter Albion

On 30/04/08 12:25 AM, "Bettie Hall" <hallbe@email.uc.edu> wrote:

> Hi Dr. Albion:
>
> It was a great pleasure meeting you at the SITE conference in Las Vegas in February. As you may recall, I am a doctoral candidate in Curriculum and Instruction at the University of Cincinnati. Last May of 2007, you graciously granted permission for me to use the Computer Self-Efficacy for Computer Technologies (SCT) which you described in your 2001 publication and dissertation to collect data for my dissertation study.
>
> As I will be submitting a copy of my dissertation [redacted] for publication through [redacted] in the next week or two, I would like to know if you have restrictions around the publication of the instrument, which I have referred to in my dissertation as the "CSE" (Computer Self-Efficacy). If so, please let me know and I will include only summary descriptions of the instrument. If not, please let me know if you prefer me to acknowledge you (if beyond referring to your publication), or how your copyright should be placed.
>
> Thank you so much for letting me use the instruments! I have some very interesting results and look forward to being able to share them with you.
>
> Best Regards,
>
> Bettie Hall
>
> Bettie Hall
> Adjunct/Doctoral Candidate

[redacted]

[redacted]

Date: Wed 23 May 14:52:26 EDT 2007
From: "Mills, Steve" [redacted]
Subject: RE: Permission to use instrument
To: "Bettie Hall" <hallbe@email.uc.edu>

Hi Bettie,

Yes, you have my permission to the instrument. There is no charge…the only thing I would ask is that you cite it, which I'm sure you will do. Plus I would be interested in your findings and any adaptations you make to the instrumentation as you get further along in your study.

I have attached several documents that we used for data collection for the TISCM. There were 18 components and for the school district study we divided them into 3 phases. We later added a 4th phase (technology mentoring) and 5th phase (technology leadership). We used several approaches to data collection: interviews, self-report assessment, or criterion-based scenario assessment. Examples of all of these are attached.

Here's the citation you can use for the actual instrument (we first started using "Integration" and "Matrix" and later changed those to "Implementation" and "Map." So you may see both usages but for our purposes they are the same thing):

Mills, S. C. (2000). *Technology Implementation Standards Configuration Map*. Lawrence, KS: University of Kansas, Life Span Institute.

We later refined this model for a project in another school district and enhanced to include a student ICM and so I have attached it also. We focused on integrating learning projects using technology and so there was a lesson template that I have also included. The same template is used in my texts (Mills & Roblyer, 2003, 2006; Mills, 2006):

Mills, S. C. (2003). *Technology Integration Configuration Map—What Teachers and Students Do in Technology-Rich Classrooms* . Lawrence, KS: University of Kansas, Life Span Institute.

There may be some adaptations that you make to account for newer/emerging technologies that might be in wider use than when we developed the instrumentation. I would also suggest that you take a look at CBAM (Concerns Based Adoption Model, Fuller (1969), Hall, Wallace, & Dossett (1973), Hall & Loucks (1977), Hord, Rutherford, Huling-Austin, & Hall, (1987), and Hall & Hord (2001)←I would especially recommend you get this book—it sums up all the others). CBAM is a change model for measuring organizational change, specifically as related to the implementation of an innovation. The TISCM is based on Innovation Configuration Maps (or

[redacted]

[redacted]

[redacted]

RE: TISA and TISCM

1 message

Mills, Steve [redacted] **Tue, Apr 29, 2008 at 11:02 AM**
To: Bettie Hall <hallbe@email.uc.edu>

Hi Bettie,

My desire would be that you publish it in your dissertation in the form that you used it to conduct your research, if that is what you would like to do. In my opinion, complete disclosure in a dissertation is the best approach. So you have my permission to publish the whole instrument in your dissertation and just include the copyright as © 2003, Steven C. Mills (or whatever I may have told you previously) and no restrictions, royalties, or fees apply to your usage and publication in your dissertation. I would like for it to be available for other researchers to use/adapt, so I would encourage the whole instrument being presented in the dissertation if that is what you and your doctoral committee prefer.

Congratulations, Bettie, on completion of your degree program and I look forward to reading about your research and findings.

Steve M

Steven C. Mills, Ph.D.

Director/CEO * smills@ahec.osrhe.edu

Ardmore Higher Education Center

The University Center of Southern Oklahoma

611 Veterans Boulevard * Ardmore, OK 73401

[redacted]

[redacted]

UNIVERSITY OF Cincinnati **Institutional Review Board**

February 27, 2008

Bettie C. Hall, M ED
Curriculum & Instruction
0022
[redacted]

RE: IRB #: 07-10-26-07-E How Teachers in the Greater Cincinnati Area are Using Technology for Instruction

Dear Bettie Hall,

The University of Cincinnati Institutional Review Board - Social and Behavioral Sciences (IRB-S) has reviewed and approved your new research project.

Approval is effective 2/27/2008 and expires 2/27/2009.

If your research requires signed consent, the approved consent version (with the IRB approval date and expiration date in the footer) is attached to this approval. This is the version that MUST be used with your participants.

The research MUST be conducted EXACTLY as approved. ANY modifications to the approved project must be reviewed and approved by the IRB-S BEFORE being implemented.

To continue your research beyond the expiration date shown above, you MUST submit a Progress Report to the IRB-S **at least one month before the expiration date shown above**.
At the completion of your research, you MUST submit a final Progress Report to the IRB-S marked "completed."

Also attached to this approval are Investigator Responsibilities, which are expected of all human subjects researchers at the University of Cincinnati.

Sincerely,
[redacted]
Julie W. Gerlach, B.S.N., M.P.H., C.I.P.
Chair, UC IRB-S

JWG:cn
Cc: Kenneth Martin, PhD (ML 0022)