Technology Integration in Education: An Examination of Technology Adoption in Teaching and Learning by Secondary Teachers in Minnesota

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Abstract

The purpose of this study was to explore possible causal factors for level of teachers' adoption of technology in teaching and learning. Furthering the understanding of the factors related to teachers' technology adoption may facilitate increased levels of technology integration in the teaching and learning process. Based on previous research and Rogers' (2003) diffusion of innovations theory, the ex post facto causal comparative research design examined relationships between teachers' technology adoption and age, gender, level of education, teaching experience, technology anxiety, perceived barriers to technology integration, technology available for use in teaching, training sources utilized, and the main predictor variable subject area. Utilizing online survey methods, the *Kotrlik-Redmann Technology Integration Survey* (2002) was utilized to collect data from 187 Minnesota teachers within the subject areas of business, English language arts, math, science, and social studies. Statistical analysis of the data, conducted via SPSS, included descriptive statistics, ANOVA and Gabriel's post hoc tests, Pearson's chi-square tests, and multiple regression techniques.

Findings suggest that technology adoption was significantly associated with the predictor variables technology anxiety, barriers to technology integration, technology available for teaching, and whether or not the teacher utilized college courses as a training source. Further, teachers' level of technology adoption differed by subject area. Business teachers adopted technology at significantly higher levels than other subject area teachers, especially math and science teachers.

The findings of the study revealed technology anxiety perceived by teachers was fairly low. No significant main effects were found for technology anxiety between subject area teachers. Technology anxiety was negatively correlated with technology adoption, as technology anxiety increased teachers' level of technology adoption decreased. Teachers in this study reported low-to-moderate barriers to integrating technology in teaching and learning, with business teachers experiencing significantly lower barriers than other teachers. The findings of this study revealed a negative relationship between technology integration barriers and technology adoption, as barriers decreased, technology adoption increased. Most teachers utilized a variety of training sources such as self-teaching, workshops/conferences, colleagues, and completing college courses. Business teachers were most likely and social studies teachers were least likely to use college courses as a training source. Whether or not a teacher utilized college courses or self-teaching as a technology training source were significantly related to technology adoption. Findings of the study revealed a positive relationship between technology available and technology adoption, as the technology available for teaching increased teachers' level of technology adoption increased. Further, relationships existed between subject area and the technologies teachers had available for their use in teaching. Business teachers had significantly more technology available for their use than math or science teachers.

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Chapter 1

Introduction

> "The single biggest problem facing education today is that our digital immigrant instructors, who speak an outdated language (that of the pre-digital age), are struggling to teach a population that speaks an entirely new language" (Prensky, 2001, p. 2).

The information revolution has changed the landscape for life and work. Not only has the work changed, but also the way people complete their work and operate in the world. The Information Age requires a different kind of worker and global citizen, one that can successfully navigate a technology-infused world. Unlike most teachers, today's twenty-first century students have grown up in a digital world (Prensky, 2001; Tapscott, 2009). Individuals now have access to more information than ever before through digital technologies. Teachers have been directed to develop technology-infused, student-centered teaching practices (International Society for Technology in Education, 2009) to meet the needs of today's students (U.S. Department of Education, 2010). Recent surveys by the National Center for Education Statistics have found that computer technologies are readily available in schools. One hundred percent of U.S public schools have computers with Internet technologies and 96 percent of classrooms have computers with Internet access. The ratio of 1:6 students to computers in classrooms indicates that computer technologies are readily available for teaching and learning. (Gray, Thomas, & Lewis, 2010). However, availability does not necessarily mean use of technological tools for teaching and learning (Redmann & Kotrlik, 2008a). Additional research is needed to understand how teachers are adopting digital technologies in their teaching and learning practices. This research study builds on previous research regarding the affordances and barriers to teachers' technology integration. Rogers' (2003) diffusion of innovations theory is used to frame this quantitative research study of the adoption of technology integration into teaching and learning practices by secondary teachers. Building on similar studies of career and technical education (CTE) teachers in Louisiana (Kotrlik & Redmann, 2009a), this study includes adoption of emerging technologies in teaching and learning practices to check trends over time. In addition, to set this survey study apart from previous research, secondary teachers from multiple subject areas, not just CTE, in Minnesota are sampled to check the validity of research findings across different populations.

Background of the Study

Technological innovations are quickly changing the world. The Information Age replaced the Industrial Age in the second half of the twentieth century, by which time the tape recorder, photocopier, transistor radio, calculator, credit card, FORTRAN computer language, microchip, and bar code had all been invented. By the second half of the twentieth century the automated teller machine (ATM), Ethernet, Internet, laser printer, cellular phone, and the personal computer had also been invented. These inventions quickly changed the actions *of* and *in* commerce and what students need to know and be able to do (Hosler & Meggison, 2008). Educational needs changed as the demand for knowledge workers surpassed the numbers of agricultural and factory workers. The

Digital Revolution, the next era of the Information Age, demanded new information and communication technology (ICT) skills and knowledge of employees and citizens. The major impetus to this revolution was the creation of the microchip that then created the personal computer in the 1970s and then the World Wide Web in the early 1990s. With the advent of the microcomputer for business and personal use, demand for courses such as data processing and desktop computer applications increased rapidly. By the start of the twenty-first century, electronic communication and commerce had a foothold in the global economy as the Internet permeated households and places of business. Emerging digital technologies are "changing the way we live, work, and learn" (Borko, Whitcomb, & Liston, 2009, p. 3). The field of education has evolved substantially in the last twenty-five years due to the near ubiquitous use of the microcomputer and the Internet in commerce, education, and personal use (Tapscott, 2009).

Business educators were early adopters of technology, preparing their students to use office technologies to complete business tasks (Hosler & Meggison, 2008). Secondary business educators, formerly called office educators, incorporated office technologies such as computer software and hardware, desktop computer applications, and web development into the business curriculum (Anderson, 2008). Information and communication technologies (ICT) are part of the content knowledge required of business educators (National Business Education Association, 2007). Personal and employment use of technology is part of the content taught by business teachers. However, "being a competent technology user is different from knowing how to effectively teach with technology" (Gaytan, 2008, p. 31).

In addition to focusing on technology as the subject area content, the majority of business education professionals agree, "priority should be given to integrating computing applications into business content in preference to stand alone, software-focused courses" (Lambrecht, 2007, p. 20). The digital revolution has enabled new content delivery methods, utilizing computer technologies, and has the potential to facilitate more student-centered activities. Ertmer and Ottenbreit-Leftwich define good teaching as "teaching that facilitates student learning by leveraging relevant ICT resources as meaningful pedagogical tools" (2010, p. 257). Educational leaders indicate classroom technology integration is necessary to serve the digital literacy needs of every student (U.S. Department of Education, 2010). Technology integration is defined as employing technology to support, enhance, inspire, and create learning (Kotrlik & Redmann, 2009a). Hew and Brush (2007) elaborate on the definition of technology integration in education as the use of computing devices such as desktop computers, laptops, handheld computers, software, or Internet in K-12 schools for instructional purposes.

The current national education technology plan directs educators to apply advanced technologies used in everyday personal and professional life throughout the educational system to improve student learning and adopt effective practices.

> To prepare students to learn throughout their lives and in settings far beyond classrooms, we must change what and how we teach to match what people need to know, how they learn, and where and when they learn and change our perception of who needs to learn. We must bring 21st-century technology into

> learning in meaningful ways to engage, motivate, and inspire learners of all ages to achieve (U.S. Department of Education, 2010, p. 10).

The International Society for Technology in Education (ISTE) has developed national educational technology standards for administrators (NETS*A), teachers (NETS*T), and students (NETS*S). The standards articulate performance indicators and benchmarks to help guide technology integration efforts in schools. In addition, ISTE (2009) has outlined the necessary conditions to effectively leverage technology for learning which point to the comprehensive scope of factors that influence integration of technology in the teaching and learning process. The teaching and learning process is defined as the implementation of instructional activities that are designed to result in student learning (Kotrlik & Redmann, 2002). The ISTE*T standards indicate K-12 teachers should design and develop digital-age learning experiences and assessments, model digital-age work and learning, and promote and model digital citizenship and responsibility. Minnesota school districts report using these standards to guide their school technology plans (Minnesota Department of Education, n.d.). However, little is known about teachers' technology adoption for teaching and learning processes in Minnesota secondary schools.

Rationale for the Study

The field of business education may be in a unique position to address the digital literacy needs of today's students by providing ICT coursework as well as integrating ICT learning technologies throughout the curriculum. Integration of technology into the business education curriculum is assumed since a large part of the field includes computer training. However, merely knowing how to use technology is not the same as knowing how to teach with it (Gaytan, 2008; Mishra & Koehler, 2006). It is unclear how, why, and to what degree teachers integrate technology into their teaching practice.

The results of this study may provide educational leaders with additional insight on the relationship between teachers' characteristics and their adoption of technology in teaching and learning practices. The study will compare the affordances and barriers to technology integration perceived by various teachers in Minnesota secondary schools. "The role technology plays in the nation's classrooms varies dramatically depending on the funding priorities of states, districts, and schools and individual educators' understanding of how to leverage it in learning in meaningful ways" (U.S. Department of Education, 2010, p. 9). The proposed study explores a national educational issue, grounded in Minnesota secondary schools.

Research Questions

This research study explores teachers' adoption of technologies in the teaching and learning process. Teacher characteristics, training sources utilized, and technologies available may differ by teacher subject area and have an effect on technology adoption for teaching and learning practices. The author hypothesized that business educators adopt technologies in the teaching and learning process at a higher level than other subject area teachers.

H_0 = There is no difference in levels of technology adoption between subject area teachers.

H_1 = Business teachers have higher levels of technology adoption than other subject area teachers.

This study sought to answer the following questions:

1. What are the selected demographic and personal characteristics of selected Minnesota secondary teachers?
2. To what extent have selected teachers adopted technology for teaching and learning practices?
3. Is there a relationship between teachers' levels of adoption of technology for teaching and learning practices and subject area?
4. Do differences exist in the classroom technologies available by teacher subject area?
5. Do differences exist in the technology integration barriers perceived by teachers by subject area?
6. Do differences exist in the technology anxiety perceived by teachers by subject area?
7. Do differences exist in the technology training sources used by teachers by subject area?
8. Do selected variables explain a significant portion of the variance in teachers' technology adoption? (Potential explanatory variables include subject area, age, gender, years of teaching experience, technology anxiety, barriers to technology integration, technology training sources used, and the types of technology available for classroom use.)

Statement of Purpose

Comparing various secondary teachers' levels of technology adoption and their perceived barriers to integrate technologies provides insight on the differing needs of teachers by subject area to integrate technologies in the teaching and learning process. Understanding the factors affecting these needs may facilitate increased levels of technology integration in the teaching and learning process (Mishra & Koehler, 2006). This new knowledge may inform administrators of how to best support the technology integration efforts of individual teachers or groups of teachers. Findings of this study may also inform initial teacher preparation and in-service professional development programs in developing subject area specific technology integration learning activities.

Summary of the Chapter

Technological innovations have changed the world we live and work in. The technologically-infused world has the potential to change the way people learn and work. Educators have been encouraged by national and state organizations to integrate technology into their teaching and learning practices to meet the ICT competency needs of today's students. The results of this study may provide educational leaders with additional insight on the relationship between teachers' characteristics and their adoption of technology in teaching and learning practices. This study will compare the affordances and barriers to technology integration as perceived by selected teachers in Minnesota secondary schools. The literature review and research questions provided direction for the focus of this study.

This dissertation is organized into five chapters. Chapter one presented the background, purpose, and research questions of the study. Chapter two synthesizes the findings of relevant literature related to factors associated with technology adoption for teaching and learning and presents the theoretical underpinning upon which this study is presented. Chapter three describes the study participants, survey instrument, data collection procedures, and statistical analysis techniques. The results of the research are presented in chapter four. Finally, chapter five includes the discussion, implications, and limitations of the research and recommendations for future study.

Chapter 2

Literature Review

Chapter two contains a review of the literature which begins with a discussion of the development of digital technologies available for teaching and learning. Next, the focus of the review moves to literature on teacher-related factors related to technology adoption for teaching and learning, including subject area; age; training; experience; and beliefs, attitudes, and anxiety. Then, the review explores the conceptual framework for the study, namely Rogers' (2003) diffusion of innovations theory. Finally, the literature review concludes with a summary and the implications of previous studies and the conceptual framework on the present study.

Technology Available for Teaching and Learning

Traditional classrooms have used a variety of technologies including textbooks, writing utensils, whiteboards, and overhead projectors to facilitate the teaching and learning process. Until recently, most technologies in classrooms had been fairly stable over the course of a teacher's career; classrooms have remained relatively unchanged for the past century (Collins & Halverson, 2009, Cuban, 2001). Today's usage of the term *technology* refers to "digital computers and computer software, artifacts and mechanisms that are new and not yet a part of the mainstream" (Mishra & Koehler, 2006, p. 1023). A range of new technologies, primarily digital, has become available since the 1990s, and the education field is struggling to learn how to apply them to teaching and learning practices.

Prensky (2001) coined the terms *digital native* and *digital immigrant* to reference individuals within the technological revolution. Individuals who grew up using digital technologies integrated into their daily lives are called *digital natives;* and those who have had to relearn how to perform everyday tasks with digital technology, such as communicating with others in oral, written, and graphical forms, are called *digital immigrants.* Digital natives have spent their entire lives surrounded by and using computers, video games, digital music players, video cameras, cellular phones, and all the other toys and tools of the digital age. Age, or when someone was born in relation to the technology revolution, is a fundamental component of the digital divide (Prensky, 2001).

The digital divide is a major concern for educators trying to incorporate the latest technologies into their courses. Individuals who have the opportunity to learn technology skills are in a better position to obtain and make use of technology than those who do not (Johnson, Adams, & Haywood, 2011). Warschauer, Knobel, and Stone (2004) define the *digital divide* as the inequities and differences in *access* and *use* of computers and the Internet due to demographic variables. As described by Mehra, Merkel, and Bishop (2004), the major components that contribute to the digital divide are "socioeconomic status with income, educational level, and race among other factors associated with technological attainment" (p. 782). Schools and societies are battling to overcome these inequities by ensuring schools and libraries have adequate computers with high-speed Internet access.

Legislative initiatives to improve access to technology. The American Recovery and Reinvestment Act of 2009 included broadband initiatives that are intended to accelerate deployment of Internet services in unserved, underserved, and rural areas as well as schools (Federal Communications Commission, n.d.). A 2005 National Center for Educational Statistics (NCES) survey of Internet access in U.S. public schools found 100 percent of all secondary schools in the United States have computers with access to the Internet with a 3.3:1 ratio of students to instructional computers with Internet access (Wells & Lewis, 2006). A 2009 NCES survey of U.S. teachers found the ratio of students in public secondary school classrooms to computers is down to 1.6:1, and 96 percent of those classroom computers had Internet access (Gray, Thomas, & Lewis, 2010). These statistics seem to indicate computers with Internet access are embedded throughout schools. However, Wells and Lewis (2006) reported that in 2005 a mere 14 percent of public secondary school classrooms had wireless Internet connections. Mobile technologies, such as laptops, tablet computers (such as iPads), and smart phones are emerging as the most widely used and in-demand technologies (Duggan & Smith, 2013; Johnson, Adams, & Haywood, 2011). As these emerging technologies become the norm, wireless Internet access is necessary (Smith, 2010). Current broadband initiatives seem to indicate wireless Internet access coverage has or will be expanding rapidly in recent years, but no more recent statistics were found specific to high-speed, wireless Internet access use in U.S. classrooms in the literature search.

Technology Use

Availability of computers and access to the Internet seem to be prevalent in schools. However, the picture of use and level of use in schools is neither universal nor equitable. The digital divide is measured not only by access but also by use. A 2003 NCES survey found that 97 percent of U.S. students in grades 9-12 use computers in and out of school, 79 percent use the Internet in and out of school, but only 63 percent use the Internet at school specifically to complete school assignments (DeBell & Chapman, 2006). A 2009 NCES survey of teachers reported how frequently their students performed activities using educational technology during their classes. A majority of U.S. secondary teachers reported their students used educational technologies sometimes or often to prepare written text (67%), create or use graphics or visual displays (59%), learn or practice basic skills (53%), and conduct research (69%). Other educational technologies teachers reported their students use either rarely, or sometimes or often, include respectively: corresponding with others (24% rarely, 40% sometimes or often), contribute to blogs or wikis (16% rarely, 13% sometimes or often), and use social networking websites (12% rarely, 9% sometimes or often) (Gray, Thomas, & Lewis, 2010). School enrollment, community type, and percent of students in the school eligible for free or reduced-price lunch did not significantly correlate to any of these statistics except learn or practice basic skills. It seems more schools with low-income students have students use educational technologies to practice or learn basic skills than schools with fewer students eligible for free or reduced price lunch. DeBell and Chapman (2006) report that schools help bridge the digital divide because disadvantaged students are able to use computers and the Internet at school. However, if teachers are not integrating computer technologies effectively and incorporating higher-order thinking objectives into teaching and learning practices, the divide will continue. Gray, Thomas, and Lewis (2010) indicated that a majority of secondary teachers reported their students were using educational technologies to solve problems, analyze data, or perform calculations; develop and present multimedia presentations; develop or run demonstrations, models, or simulations; and design and produce a product. Non-core subject area teachers such as art, music, health, physical, vocational, and career and technical education and 'others' were grouped into one category labeled 'other assignments'. The 'other assignments' category results reported were fairly similar, within a few percentage points, to the mean secondary teacher data of educational technology use. However, the study did not seek to answer if the differences between subject area teachers were significant. Additional analysis is necessary to determine if there are any differences in educational technology use based on teaching assignment.

The field of business education is in a unique position to address the digital divide problem because integration of technology into the business education curriculum is assumed since a large part of the field includes computer training. Rader and McCoy (2011) indicated business education instructors utilized the Internet to deliver and enhance classroom instruction using multiple modalities such as videos, simulations, tutorials, and instructional games. In a trend study utilizing the *Technology Adoption in the Teaching/Learning Process* scale, Redmann and Kotrlik (2008a) found that business educators had increased levels of technology adoption from 2002 (M = 4.09) to 2007 (M

= 4.34*)*. The scale included 15 statements with available responses that ranged from 1 (not like me) to 5 (just like me). Redmann and Kotrlik concluded that "business teachers are striving to remain on the cutting edge of technology" (2008a, p. 85) for use in teaching and learning. A few examples of technology adoption include using the Internet to teach content in the classroom (Gaytan, 2008; Terry, 2000), computer-based assessments (McEwen & Gaytan, 2006; Truell, 2004), and course management systems (Barsky, Catanach, & LaFond, 2007).

Types of technology use. Bebell, Russell, and O'Dwyer (2004) stressed the importance of examining the specific, discrete uses of technology rather than considering technology use as a general construct. In a longitudinal study of K-12 teachers in Nebraska, Bebel et al. (2004) examined the many different technology uses reported by teachers and found seven distinct categories of teachers' technology use: 1) teachers' use of technology for preparation, 2) teachers use of technology for delivering instruction, 3) teacher-directed student use of technology during class time, 4) teacher-directed student use of technology for creating products, 5) teachers' use of e-mail for professional purposes, 6) teachers' use of technology for recording grades, and 7) teachers' use of technology for special education and accommodation. Bebel et al. (2004) purported the necessity to address each specific type of use rather than simply focusing on teachers' use of technology in general when attempting to examine technology use or isolate ways for influencing teachers' behavior.

Through observation, Mouza, Cavalier, and Nadolny (2008) discovered the majority of technology-related teacher tasks "concentrated on uses that reinforced traditional instructional practices, such as word processing, drill and practice, and research on the Internet" (p. 447). However, they also reported observations of several teachers who implemented computers for more complex and sophisticated student activities such as communication through blogs, multimedia presentations, and real-world problem solving. These findings were similar to Smarkola (2008) who studied the types of technology usage between students and teachers using the NETS*S as a guide. Primary grades conformed more to NETS*S, integrating technologies throughout the learning process, while high school students primarily used desktop applications such as word processing.

Results of technology adoption. A study by Swan, van 't Hooft, Kratcoski, and Schenker (2007) reported most teachers said they were pleasantly surprised at how well they were able to individualize instruction when incorporating technology in the teaching and learning process. Teachers reported utilizing computer-assisted learning activities in conjunction with small-group instruction. Many reports point to changes in teachers and teaching practices related to computer and Internet access. When technology is widely available, teachers are becoming more student-centered, more constructivist, and more flexible (Swan, Cook, Kratcoski, Lin, Schenker, & van 't Hooft, 2006); are developing lessons that are more project-oriented and inquiry-based (Norris & Soloway, 2004); and are using technology to explore, create, and communicate knowledge (Pritchett, 2012; Roschelle, Penuel, & Abrahamson, 2004). Literature reviewed indicates that when computers are available, teachers change their practice to integrate the technology for teaching and learning.

Teacher Characteristics

Individual teachers choose teaching methods and practices. Various teacher characteristics have been analyzed in relation to technology integration in teaching and learning practices. Following is a review of pertinent literature in relation to teacher subject area; age; preparation; experience; and beliefs, attitudes, and anxiety as they relate to technology adoption.

Subject area. Stephenson, Gal-Ezer, Habersman, and Verno (2006) identified three areas of computing education typically included in the secondary curriculum: 1) educational technology, 2) information technology, and 3) computer science. Educational technology is defined as using computers across the curriculum, or more specifically, using computer technology (hardware and software) to learn about other disciplines. Information technology is defined as the proper use of technologies by which people manipulate and share information in its various forms. While information technology involves learning about computers, it emphasizes the technology itself. Computer science is the study of computers and algorithmic processes, including their principles, their hardware, and their impact on society (Stephenson, Gal-Ezer, Habersman, & Verno, 2006, p. 18). Business, math, and technology education teachers are licensed to teach information technology and computer science courses in Minnesota secondary schools (Minnesota Department of Education, n.d.). As part of the curricular content of these disciplines, it is expected that business, math, and technology education teachers adopt computer technologies for teaching and learning. However, no studies were found in the literature review regarding the technology adoption of business, math, and technology education teachers in Minnesota.

Using a forward regression model, Kotrlik and Redmann (2009a) found technology integration barriers, technologies available, and technology anxiety to explain the variance in technology adoption among CTE teachers. They found that business and marketing teachers were more likely to adopt technology for use in instruction than other CTE teachers in Louisiana. Leaders in the field of business education have proclaimed its mission for teaching ICT skills and knowledge necessary for occupations in business. The National Business Education Association (2007) has set forth communication and information technology content standards pertaining to input technologies, productivity software, interactive multimedia, web development, database management, programming, and telecommunications and networking infrastructures to be embedded across the curriculum.

Warschauer, Knobel, and Stone (2004) studied technology integration activities in science, math, language arts, and social studies courses in eight southern California high schools. They found both low and high-socioeconomic schools had universal access to Internet connected computers for instruction. The study revealed the level of technology integration differed depending on the type of course. Additional advanced courses were offered in high-socioeconomic schools and integrated technology in higher-order thinking activities. Lower-socioeconomic schools offered lower-level courses which had a higher tendency to utilize computers for remedial practice, word processing, and research. Across all schools, many teachers focused on the completion of technology tasks as an end in themselves, without attention to the relationship of these tasks to relevant learning goals. “More emphasis was frequently put on mastery of hardware or software functions rather than on underlying learning outcomes” (Warschauer et al., 2004, p. 576). Many teachers in lower-socioeconomic schools found it a complex undertaking to actually integrate computers into their teaching. High-stakes testing pressures in the core subject areas, language arts and math, had teachers focused on preparing students for testing rather than allotting time to innovating instructional practice. Limited time to plan and implement technology-infused lessons was reported to be a barrier for all teachers to adoption of technology for teaching and learning. Teachers of core content areas that are accountable to high stakes testing may adopt technology in teaching and learning practices differently than elective area teachers.

Age and gender. Guo, Dobson, and Petrina (2008) examined the relationship of age and information and communications technology (ICT) competency over the years of 2001 through 2004. Interestingly, they found little differences in ICT competency of elementary in-service and pre-service teachers 20 to 40 years old. ICT competency was determined based upon computer literacy, self-efficacy, and self-evaluation instruments. These findings contradict other interpretations of a digital divide based upon age (i.e. digital natives vs. digital immigrants, see Prensky, 2001). The age group comprised of 20 to 24 year olds fell within the category of “digital native” and may be expected to have scored higher on computer literacy. In contrast, other research discussed below found age to be a factor in technology use.

Alexander (2002) surveyed secondary and post-secondary business educators on their knowledge and use of web pages for professional and classroom use based upon age, gender, teaching experience, and institutional affiliation. She found that the majority of business educators had not had training on creating web pages and did not have their own web pages. Post- secondary instructors were more likely to have a web page than secondary teachers but were less likely to create their own. Teachers 40 years and older were less likely to utilize a web page for professional use, classroom use, or to teach web-page design to students than younger teachers. Like other recent studies, gender did not influence technological knowledge or use (see Waugh, 2004). Data collected were self-reported based upon "yes or no" survey questions. The study did not attempt to identify level of web-page knowledge, how web pages were being incorporated as an instructional tool, or the types and reasons web-page development was assigned to students.

Waugh (2004) conducted a causal-comparative study to predict technology adoption based on personal attributes. Predictor variables in the study included discipline (subject area), rank (experience), age, and gender. She found that age and discipline were the only two statistically significant technology adoption predictor variables of those that were studied. A faculty innovativeness score was calculated for the dependent variable, technology adoption. The results of the linear regression testing of age, $t(408) = -5.756$, $p < .01$, indicated that age was significant in estimating technology adoption. The regression weight was -4.53, which indicated that a lower estimated value was due to the respondent being a higher age. Technology adoption was found to be reduced as age increased. This study included 413 faculty members in Nebraska from technical and non-technical disciplines.

Studies reviewed found age may (Alexander, 2002; Waugh, 2004) or may not (Guo, Dobson, & Petrina, 2008; see also Tondeur et al., 2008) be a factor in technology integration in teaching and learning practices. Studies reviewed found gender was not a factor in technology adoption.

Teaching experience. Russell, O'Dwyer, Bebell, and Tao (2007) analyzed the relationship of use of computer technologies to the amount of time teachers' had taught versus tenure in their current position. In general, teachers who had been teaching for longer periods of time reported less frequent use of technology. However, the frequency with which teachers had students use technology during class time did not differ noticeably based on the number of years teachers were in the profession. School transfer for experienced teachers showed a negative effect on use. Teachers with 15 or more years of experience who had moved to a new school within the past two years reported noticeably lower levels of technology use than peers who had been at their current school for three years or more. This result follows the idea that teachers must develop comfort with the curriculum and also know about the technology-based tools that are available within the school before they are able to make use of these tools in the classroom. However, this pattern was less pronounced for teachers with 10 or fewer years' experience throughout their career. Less-experienced teachers who encountered a school change were more likely to use technology to prepare lessons than more experienced teachers.

Additional research is needed to determine if teachers' level of technology adoption is related with teaching experience, while controlling for age and school factors. Years of teaching experience may also be correlated with pre-service training experiences, which may also have an impact on teachers' level of technology adoption. No studies were found in the literature review which examined the relationships of all of these factors.

Preparation and training. Many studies found educational technology preparation through a college course to have a significant impact on a teachers' intention to use technology in the classroom (Anderson & Maninger, 2007; Smarkola, 2007). Milman and Molebash (2008) measured teachers' confidence levels five to seven years after taking an educational technology course designed for pre-service teachers. A modest dip in confidence over the years was found, but still remained significantly higher when compared to the confidence exhibited prior to taking a stand-alone technology course. Other studies reveal increased technology competence after completing an introductory computer applications course (Creighton, Kilcoyne, Tarver & Wright, 2006). However, the Creighton et al. (2006) study only discussed technological skill attainment, not use or intention to use technology in teaching and learning practices. All studies reviewed point to the importance of technology education courses in pre-service teacher education.

Shumack and Forde (2008) used an online survey to determine secondary business educators' motivators and barriers to seeking professional development. The survey asked participants to rank order a list of motivators and barriers to seeking professional development. The top three motivators reported were "A desire to learn specific skill so that I can teach better, constant technology changes, and in general, want to be more effective in the classroom" (p. 46). The results of this study imply that teachers seek out professional development activities to improve their technological skill level and want to improve their technology integration practices. The study did not seek to compare educators' technology integration professional development activities by subject area.

In their quantitative study of secondary teachers' use of interactive white boards, Turel and Johnson (2012) found teachers rely on support from other teachers to learn how to integrate technology into teaching and learning practices. Time and support from other teachers were found to be related to higher use frequencies and self-reported competencies of interactive white boards. Colleagues were found to be a significant training source. The participants in the study (N=174) were all interactive white board users.

Research reviewed suggests that college courses, ongoing professional development, and colleagues may have an impact on technology adoption for teaching and learning.

Beliefs, attitudes, and anxiety. In a study that sought to determine how a teacher uses computers in the classroom, Tondeur, Hermans, van Braak, and Valcke (2008) surveyed 525 elementary teachers in Belgium. The authors examined the relationship between teachers' educational beliefs and their computer use. They attempted to control the impact of technology-related determinants such as computer experience, supportive computer use, general computer attitudes, and the teacher-related demographic variables gender and age. Gender and age were not shown to be significantly related to class use of computers. The authors found that computer experience was positively related to computer attitudes. The more experience teachers had with computers, the more likely they were to report positive attitudes towards computers. In pursuit of a multidimensional approach to structure the belief system, four profiles were created by clustering teacher beliefs: 1) constructivist and traditional mixed, 2) constructivist, 3) traditional, and 4) undefined (reflects low scores on both constructivist and traditionalist profiles). Results of the study indicate a consistent relationship between teacher profiles, based on their educational beliefs, and the frequency of class use of computers. A teacher profile with relatively high constructivist beliefs tended to show a higher frequency of educational computer use than the other profiles. Also, teacher profiles pointed to different types of computer use. Teachers with traditional profiles were more likely to use basic computer skills such as word processing and projection of demonstration notes, while constructivists were more likely to integrate technologies into teaching and learning activities by using the computer as an information or learning tool. Yang and Huang (2008) reported teachers' perceived classroom management and teaching style to be related to technology integration. Similar to Tondeur et al. (2008), Yang and Huang concluded that "to maximize the effects of technology integration, the teachers should be well equipped with technological pedagogical knowledge, embracing constructive and active teaching as a theoretical framework on which to base the design and deployment of technology" (2008, p. 1098).

Substantial literature links computer self-efficacy to computer use (Conrad & Munro, 2008) and performance (Smith, 2004). Additional literature was reviewed which explored these links in pre-service (Kay, 2007; Shapka & Ferrari, 2003, Smith & Robbinson, 2003) and in-service (Ertmer & Ottenbreit-Leftwich, 2010; Smarkola, 2007) teachers. The literature reviewed revealed that self-efficacy and computer use are positively correlated; as one's level of computer self-efficacy increases, so does frequency of computer use. Many studies found a teacher's intention to use technology was related to their level of computer self-efficacy as reported through the *Computer Self-efficacy Scale* (Smith & Robinson, 2003; Smith-Weber, 2000). Sahin (2008) used the Social-Cognitive Career Theory (SCCT) model to analyze college of education faculty members' intention to use educational technology. Specifically, the four main variables studied included self-efficacy, outcome expectations, interests, and intentions. Correlations among all SCCT variables were statistically significant, ranging from 0.25 to 0.68. A positive relationship was found between faculty confidences in/awareness of educational technology and faculty interest in educational technology that may eventually result in a higher level of willingness to use educational technology (Sahin, 2008).

Shiue (2007) found the intention to use instructional technology was greater to the extent that the teacher had control over that technology. Perceived control may have three sources: access to technology, support to use technology in teaching practice, and own self-efficacy for using technology. As such, when a teacher believes computer technology use increases student achievement, is told by others that technology integration is a good thing to do, and believes they have the ability to integrate technology, he or she will actually change their teaching practice to incorporate digital technology.

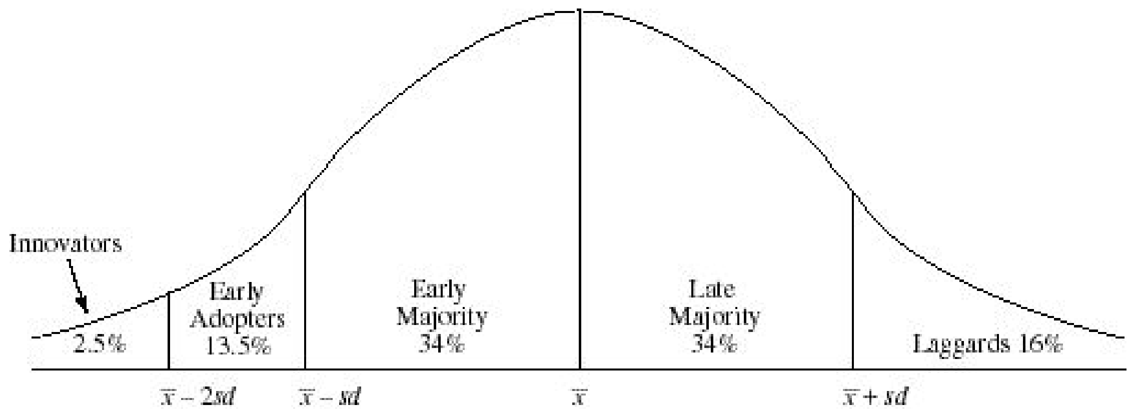
Smarkola (2007) reported 45-50% of the variance in technology integration intentions could be attributed to perceived ease of use and perceived usefulness with perceived usefulness having a stronger effect than perceived ease of use. Through path analysis, Ajjan and Hartshorne (2008) determined university faculty's decision to adopt web 2.0 technologies in teaching and learning practices was mostly attributed to attitude, as determined by perceived usefulness, ease of use, and compatibility with teaching beliefs, and self-efficacy. In contrast, Teo (2011) found teachers' perceptions on the usefulness and ease of technology use are dynamic and do not remain static, due to rapid technological advances. This is also reflected in Mishra and Koehler's (2007) idea that teaching with technology is a wicked problem, or a complex, ill-defined problem that has no linear solution.

Knowledge and ability. Gaytan (2008) found business teachers, who presumably held sufficient knowledge about using the Internet, experienced difficulty in understanding teaching with the Internet and in monitoring Internet-based assignments. Although the teachers were computer literate, they were ineffective in incorporating computer technologies in their teaching practice. In a meta-analysis of 48 empirical studies on technology integration, Hew and Brush (2008) identified 123 technology integration barriers which were classified into six main categories: (a) resources, (b) knowledge and skills, (c) institution, (d) attitudes and beliefs, (e) assessment, and (f) subject culture (listed in order of the relative frequency in which they were mentioned in the studies reviewed. "Knowledge and skills barriers go beyond a lack of specific technology knowledge and skills to technology-supported pedagogical knowledge and skills, and technology-related-classroom management knowledge and skills" (Hew & Brush, 2008, p. 227). In other words, technology integration depends not only on whether or not the teacher is technologically literate but also whether or not the teacher is able to adapt their teaching practice to integrate technology in the curriculum and manage a technology-integrated classroom environment. Related classroom management skills includes how to organize the class effectively so that students have equal opportunities to use computers and know what to do if students run into technical problems when working with computers.

In relation to meeting standardized technology objectives, Grimes and Warschauer (2008) found laptop immersion programs promoted all of the National Educational Technology Standards for students (ISTE NETS*S). Finding that many studies were equating technology integration ability with technology integration usage, Hsu (2010) explored the link between using the ISTE NETS*T ability and usage standards. Hsu found ability is positively correlated with technology usage and supports the assumption that teachers who are able to use technology more are generally better at integrating technology. This suggests that ability to use technology is necessary, but not sufficient, to support integration into teaching practices. In contrast to K-12 teachers, Rhoades, Friedel, and Irani (2008) reported college faculty have so far made minimal progress in adopting new web 2.0 technology into their curriculum. Web 2.0, or the use of the interactive web, has been cited to be particularly empowering for students to engage in higher order participatory and reflective educational activities (Davies & Merchant, 2009). Asselin and Moayeri (2011) report web 2.0 technologies are useful for locating and critically examining information as well as collaborating with others in sharing and building knowledge. Further exploration of new classroom technologies is necessary to determine if web 2.0 technologies are impacting the way teachers teach their content and manage the classroom environment. The level of teachers' technology use in teaching and learning and its relationships with their technology knowledge, access to classroom technology, and student use needs further exploration.

Conceptual Framework

Kotrlik and Redmann (2002) developed a conceptual framework to differentiate phases of technology adoption for teaching and learning. The Kotrlik-Redmann Technology Integration Model (2002) identifies four levels of technology adoption: exploration, experimentation, adoption, and advanced integration (see Appendix A). The authors based their model on Rogers' diffusion theory. Rogers' (2003) diffusion of innovations theory seeks to explain how, why, and at what rate new ideas and technology spread through cultures. The rate that new ideas spread is classified as level of innovativeness. "Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system" (Rogers, 2003, p. 22). To differentiate individuals' level of innovativeness within a system, Rogers identified five adopter categories: innovators, early adopters, early majority, late majority, and laggards (see Figure 1).



Source: Rogers (2003), p. 281

Figure 1. Adopter Categorization on the Basis of Innovativeness

Rogers (2003) explained the adopter categories as ideal types being "conceptualizations based on observations of reality that are designed to make comparisons possible" and are "based on abstractions from empirical investigations" (p. 263). In *Diffusion of Innovations,* Rogers provided dominant characteristics and values of each of the five adopter categories. *Innovators* are described as venturesome. They are the members in the system that tries out new ideas first. They are the ones to bring new technologies to the field and school. Others look at *innovators* as being too far "out there" or too risky and may not look at them as leaders. However, *early adopters* look to *innovators* for ideas. *Early adopters* make judicious innovation decisions about the technology and teaching methods they will use for teaching and learning. *Early adopters* serve as role models for others in the system and are highly respected. The *early majority* may deliberate for some time before adopting new ideas. They interact frequently with their peers but are not looked to for opinion leadership. The *early majority* adopt new ideas just before the average member of the system. In comparison, the *late majority* are even more skeptical than the *early majority*. They often adopt new ideas only after they receive pressure from others. Finally, *laggards* are the last members in a system to adopt an innovation. They must be certain that a new idea will not fail before they can adopt. *Laggards* often make decisions based on what was done previously and resist new ideas.

Diffusion theory may be useful in understanding which teachers choose to adopt technology in the teaching and learning process. Rogers (2003) explains diffusion as "the process by which (1) an *innovation* (2) is *communicated* through certain *channels* (3) over *time* (4) among members of a *social system*" (p. 11). Technology integration in the teaching and learning process, the innovation, is an idea or practice that may be perceived as new by teachers. Teachers may adopt technology in teaching and learning processes for various reasons. Diffusion research may be helpful to understand the various reasons teachers adopt technology in their practice. Through a synthesis of previous research, Rogers (2003, p. 272-274) summarized the following 25 generalizations about socioeconomic, personality, and communication variables related to innovativeness:

1. Earlier adopters are not different from later adopters in age.
2. Earlier adopters have more years of formal education than later adopters.
3. Earlier adopters are more likely to be literate than later adopters.
4. Earlier adopters have higher social status than later adopters.
5. Earlier adopters have a greater degree of upward social mobility than later adopters.
6. Earlier adopters are wealthier than later adopters.
7. Earlier adopters have greater empathy than later adopters.

8. Earlier adopters may be less dogmatic than later adopters.
9. Earlier adopters have a greater ability to deal with abstractions than do later adopters.
10. Earlier adopters have greater rationality than later adopters.
11. Earlier adopters have greater intelligence than later adopters.
12. Earlier adopters have a more favorable attitude toward change than later adopters.
13. Earlier adopters are better able to cope with uncertainty and risk than later adopters.
14. Earlier adopters have a more favorable attitude toward science than later adopters.
15. Earlier adopters are less fatalistic than later adopters.
16. Earlier adopters have higher aspirations (for formal education, occupations, and so on) than later adopters.
17. Earlier adopters have more social participation than later adopters.
18. Earlier adopters are more highly interconnected through interpersonal networks in their social system than later adopters.
19. Earlier adopters are more cosmopolite than later adopters.
20. Earlier adopters have more change agent contact than later adopters.
21. Earlier adopters have greater exposure to mass media communication channels than later adopters.

22. Earlier adopters have greater exposure to interpersonal communication channels than later adopters.
23. Earlier adopters seek information about innovations more actively than later adopters.
24. Earlier adopters have greater knowledge of innovations than later adopters.
25. Earlier adopters have a higher degree of opinion leadership than later adopters.

These generalizations may be useful for understanding the factors associated with teachers' technology adoption for teaching and learning.

Waugh (2004) studied Nebraska college faculty personal attributes in relation to technology adoption. Using Rogers' diffusion of innovations theory, Waugh classified faculty as early or late adopters according to their level of experience using 43 selected technologies. Waugh found that individuals teaching in the technical disciplines were at a higher level of adoption than those teaching in nontechnical disciplines.

Teaching at the secondary level is a fairly autonomous profession with little chance for observing peers. Teaching methods and practices are often learned in initial teacher preparation and updated through professional development activities outside of the classroom. Rogers' diffusion theory may be helpful in understanding the process by which technology is adopted by teachers for teaching and learning processes by differentiating teachers into various levels of technology adoption and evaluating the characteristics of individuals within each adopter category. Different teachers, based on innovativeness, may face different affordances and barriers to integrating technology.

Previous diffusion research studies show socioeconomic status, personality variables, and communication behaviors vary based upon adopter categories (Rogers, 2003). Age, subject area, education, teaching experience, technology anxiety, classroom technology available, and technology training may be related to a teacher's decision to adopt technology in teaching and learning. The adopter categories "can be used for *audience segmentation*, a strategy in which different communication channels and/or messages are used to reach each sub audience" (Rogers, 2003, p. 299). Identification of distinctive characteristics relative to each adopter category may inform future development of technology integration training and professional development activities.

Conclusion

This review of the literature provides the important foundation for the research protocol for this study. The research on technology adoption has significant implications for supporting teachers in their attempts to integrate technology in teaching and learning. Higher levels of technology adoption in teaching and learning provide an opportunity to help bridge the digital divide.

To determine which factors are related to teachers' level of technology adoption for teaching and learning, this study is based on the analysis of previous literature. Research reviewed examined various teacher characteristics such as age, gender, education, experience, attitudes, and ability. This study examines the relationship of various teacher characteristics and teachers' adoption of technology. Knowing these relationships may be helpful in planning appropriate professional development interventions for different groups of teachers.

Studies reviewed found age may or may not be a factor in technology integration in teaching and learning practices. Teachers 40 years and older seemed to integrate technology into their practice less than younger teachers. However, no clear support for a digital divide between *digital natives*, those born after the inception of the Internet, and *digital immigrants*, those born before computer use was ubiquitous in work and life, was found. In addition, of the studies reviewed, gender was not shown to be a factor in technology adoption for teaching and learning.

Research reviewed indicates that college courses, ongoing professional development, as well as colleagues and administrators efforts in technology integration may be related to teachers' technology adoption for teaching and learning. Technology knowledge and technology integration were found to be positively related. However, a direct relationship between the two cannot be assumed, as multiple confounding variables have been expressed. Attitudes and teaching styles were also shown to be related to how technology was adopted by teachers. Constructivist teachers, with student-centered practices, adopted technology in more innovative, integrated ways than traditional teachers. Results of the current analysis which included several of these teacher-background characteristics are presented in chapter four.

Chapter 3

Methods

Chapter three contains a description of the research design, variables, participants, survey instrument, and data analyses for this study.

Research Design

Research findings, as discovered through a literature review; Rogers' diffusion theory; and the author's own observations have informed the basis for the research problem, questions, and methods chosen. According to Gall, Gall and Borg (2007) survey research may yield valuable knowledge about opinions, attitudes, and practices. Causal-comparative research designs are useful for discovering causes for differential effects. An ex post facto research study was utilized because the research questions call for observing relationships between naturally occurring variations in teacher characteristics and their technology adoption for teaching and learning.

The primary purpose of this research was to explore possible causal factors for teachers' adoption of technology in their practice. An ex-post facto causal comparative research design is useful for initial exploratory investigations or when it is impossible to manipulate independent variables (Gall, Gall, & Borg, 2007). Technology adoption of Minnesota secondary teachers had yet to be reported so this is considered an initial exploratory investigation. In addition, due to the many contextual factors in school settings, it is nearly impossible to manipulate many of the independent variables analyzed in this study. A causal-comparative design was used whereas the independent variables were measured in the form of categories forming nominal and ordinal scales (Gall, Gall, & Borg, 2007). The variables are described next.

Variables

The variables for the study were determined by previous research. This study explored teachers' technology adoption for teaching and learning to determine if selected variables were associated. The dependent and independent variables of the study are described next.

Dependent variables. The primary dependent variable for this study is teachers' level of technology adoption. Participants' answers to the 19 survey questions in the *Technology Use in Teaching/Learning* scale (Kotrlik & Redmann, 2005) were used to develop a grand mean score for technology adoption. The technology adoption variable was measured on an interval scale. Teachers were asked to describe themselves and their efforts to integrate technology in the teaching/learning process by responding to the 19 statements as: 1 = not like me, 2 = very little like me, 3 = some like me, 4 = very much like me, or 5 = just like me. Higher grand mean scores indicate higher levels of technology adoption. The technology adoption score was also converted to an ordinal scale to be compared to Rogers' (2003) adopter categories for audience segmentation. Adopter categories included innovators, early adopters, early majority, late majority, and laggards (listed from highest to lowest level of adoption, comparatively).

Independent variables. The independent variables for this study include age, barriers to integration, education level, gender, subject area, teaching experience, technology anxiety, types of technology available, and training sources. Gender, subject area, and training sources are categorical/nominal scales. Participants were asked to identify if they had utilized four selected training sources. Each training source was included as a categorical variable. Age, education level, and years of teaching experience are ordinal scales. Technology available is an ordinal and nominal scale. Technology anxiety and barriers to integration are interval scales.

Participants were asked to identify if they had specific technologies available for their use in teaching. Participants' responses (yes or no) to the 13 items in the *Types of Technology Available for Use in Teaching* checklist were used to measure technology teachers had available to them for teaching. Technology available is measured as a sum score (0 – 13), an ordinal scale, and also as individual items, nominal scales. Each technology was included as a categorical variable.

Participants' answers to the 12 survey questions in the *Technology Anxiety* scale (Kotrlik & Redmann, 2005) were used to develop a grand mean for technology anxiety. Each of the 12 questions asked participants about their feelings of anxiety while thinking about and using technology was answered on scale of one to five (1 = no anxiety, 2 = some anxiety, 3 = moderate anxiety, 4 = high anxiety, 5= very high anxiety).

Participants' answers to the nine survey questions in the *Barriers to the Integration of Technology in the Teaching/Learning Process* scale (Kotrlik & Redmann, 2005) were used to develop a grand mean for barriers to integration. Each of the nine questions asked participants about barriers they encountered to integrate technology into teaching and learning practices was answered on a scale of one to four (1 = not a barrier, 2 = minor barrier, 3 = moderate barrier, 4 = major barrier).

Participants

Teachers from Minnesota secondary schools with a comprehensive curriculum that includes courses in business, English language arts (ELA), math, science, and social studies served as the population for this study. The Minnesota Department of Education 2011-12 Licensed Staff FTE by Subject data report was used to identify schools employing at least one .75 full-time equivalent in each of the aforementioned subject areas. Then, an Internet search of each school's website identified teachers' name and email address for each subject area identified.

One hundred and forty-five schools were identified that met the above criteria. Of the 699 public high schools in Minnesota, the initial sample represented approximately 20 percent of Minnesota public high schools. A stratified random sampling technique was employed to select participants for the study. The stratification variable was teacher subject area. Disproportional stratified sampling was utilized because the proportion of business teachers in schools compared to teachers of English language arts, math, social studies, and science was very small; hence, oversampling this group was necessary to ensure an adequate sample size from each subject area. One teacher from each of the five selected subject areas was randomly selected from each of the 145 schools for invitation to participate in the study. Of the 725 possible research participants, 187 completed surveys were submitted, a response rate of nearly 26 percent (N=187). Participants' school was not collected so number of schools from the original 145 included could not be determined.

Table 1 contains the descriptive statistics of participants in this study. Of the 187 participants, 57 (30%) were business teachers, 34 (18%) were English language arts teachers, 30 (16%) were math teachers, 35 (19%) were science teachers, and 31 (17%) were social studies teachers. A higher response rate from business teachers may be due to the author's professional connection to the business education community in Minnesota. It may also be associated with business teachers' connection to the topic of technology in education. Of the 187 teachers who participated in the study, 83 (44%) were male and 104 (56%) were female.

Table 1

Participant Subject Area and Gender

Subject Area	Male	Female	Total	
	N	N	N	%
Business	22	35	57	30.48
ELA	11	23	34	18.18
Math	17	13	30	16.04
Science	14	21	35	18.72
Social Studies	19	12	31	16.58
Total Teachers	83	104	187	
%	44.39%	55.61%	100%	

The *CEHD Survey Tool* was used to facilitate an online survey of participants. A link to the online survey was sent to all participants along with a request for participation via school email addresses in May, near the end of the 2012-2013 school year. To encourage timely completion of the survey, each participant was invited to be entered into a random drawing for one of three $25 gift certificates upon submitting a completed survey.

Participants received via email an invitation to participate in the study, including a brief explanation of the research, an informed consent statement, and a link to the survey.

Participants were notified of the estimated time commitment (20 minutes) to complete the survey and their right to withdraw from the research at any time. One week later, participants who had not already submitted a completed survey, received a reminder about the survey and duplicate message with informed consent statement and a link to the survey. Two weeks later, participants who had not already submitted a completed survey received a final reminder about the survey and duplicate message with informed consent statement and a link to the survey.

Survey Instrument

The *Kotrlik-Redmann Technology Integration Survey* (2005) was distributed to participants using an online survey method. The survey instrument included three scales measuring *Technology Use in Teaching/Learning* (19 items, 5-point Likert-type scale); *Barriers to the Integration of Technology in the Teaching/Learning Process* (9 items, 4-point Likert-type scale); *Technology Anxiety* (12 items, 5-point Likert-type scale)*;* *Technology Available for Teaching* (13 items, yes/no scale); and one additional section to capture demographics and other teacher characteristics. Demographics included age, education level, gender, subject area, years of teaching experience, years of additional work experience, and sources of technology training utilized.

Validity. The authors of the instrument previously reported extensive efforts to validate the instrument. They confirmed validation through expert panels of university faculty and graduate students and pilot tested the instrument with teachers in five studies with various populations of teachers including business (Redmann & Kotrlik, 2008a), marketing (Redmann & Kotrlik, 2008b), agriculture (Kotrlik & Redmann, 2009b), family and consumer science (Redmann & Kotrlik, 2009), and technology (Kotrlik & Redmann, 2009c). Face validity was assessed in the present study through careful review of each item on the instrument by the author, an educator.

Reliability. In order for an instrument to be valid, it must first be reliable. Reliability is the ability of the measure to produce the same results under the same conditions (Field, 2009). The authors of the survey instrument, *Kotrlik-Redmann Technology Integration Survey* (2005), reported high measures of reliability for all three scales in their most recent CTE study: technology adoption Cronbach's $\alpha = .97$, barriers to integration Cronbach's $\alpha = .86$, and technology anxiety Cronbach's $\alpha = .96$ (Kotrlik & Redmann, 2009a). Statistical methods were employed for the present study, as well, to test the reliability of the instrument. The *Technology Use in Teaching/Learning* scale, including 19 items, Cronbach's $\alpha = .95$. The *Barriers to the Integration of Technology in the Teaching/Learning Process* scale, including nine items, Cronbach's $\alpha = .72$. The *Technology Anxiety* scale, including 12 items, Cronbach's $\alpha = .93$. Each of the three scales of the instrument was found to have high reliabilities.

Data Analysis

SPSS Statistical Software was used to analyze the collected data. Prior to performing statistical analysis techniques to answer the research questions, an exploratory data analysis was conducted to test for normality. First, the shape of the distribution of technology adoption interval scores was visualized with a histogram and probability-probability (P-P) plot (see Appendix D). The histogram displays the technology adoption mean scores distributed fairly symmetrically around the center of all scores and can be characterized as a bell-shaped curve. The P-P plot ranked and sorted the technology adoption mean scores as *z*-scores and plotted them against expected *z*-scores of a normal curve. The dots graphed on the P-P plot are fairly close to the diagonal line, which indicates a normal curve (Field, 2009). Next, the kurtosis and skewness statistics were examined to ensure the data were normally distributed. The skew and kurtosis values were fairly close to zero, which indicated a normal distribution (Field, 2009). Finally, the frequency distributions were examined by subject area. Since the assumption of a normal distribution was not violated, statistical analysis of each research question followed.

Descriptive statistics, including measures of central tendency, measures of variability, and frequency distributions, were used to answer questions one and two.

The one-way independent analysis of variance (ANOVA) compares several means, when those means have come from different groups of people (Field, 2009). An ANOVA was used to answer questions three, five, and six. For further analysis, to determine which groups differed, post hoc procedures were utilized. Post hoc tests consist of pairwise comparisons that are designed to compare different combinations of the treatment groups. Gabriel's procedure is the best post hoc test when sample sizes are slightly different (Field, 2009). Since group sizes were slightly different (business N=57, science N = 35, English language arts N = 34, social studies N = 31, and math N = 30) Gabriel's post hoc tests were utilized to discover where differences existed between group means when associations between the dependent and independent variables were significant. Welch's F was reported when variances were not homogenous.

The chi-square statistic is a nonparametric statistical technique used to determine if a distribution of observed frequencies differs from the theoretical expected frequencies (Gall, Gall, and Borg; 2007). Chi-square statistics use nominal or ordinal level data, thus instead of using means and variances, this test uses frequencies. Pearson's chi-square test was used to answer questions four and seven, which involve comparing categorical variables. This statistic compares the frequencies observed in the identified categories to the frequencies expected in the categories by chance (Field, 2009).

Multivariate correlational statistics, specifically multiple regression techniques, were utilized to answer question eight. Variables which were explored to develop a potential explanatory model include: age (ordinal), subject area (nominal), teaching experience (ordinal), technology anxiety (interval), barriers to technology integration (interval), whether or not technology training sources were used (ordinal), and technology available for classroom use (ordinal). Before the categorical variable subject area could be used in the statistical analysis, dummy predictor variables were created to for business vs. English language arts, business vs. math, business vs. science, and business vs. social studies. Enter and forward stepwise methods were utilized to determine if the identified variables explained significant variances in teachers' technology adoption. All predictors which showed a significant correlation, $p < .05$ (Pearson product-moment correlation) with the dependent variable technology adoption were included in a forward stepwise linear multiple regression procedure respectively. The significance level in this study was defined as $\alpha = .05$.

Summary of Research Methods

The ex post facto causal comparative research design outlined explores possible relationships of factors with level of teachers' adoption of technology in teaching and learning. Independent variables studied include teachers' age, barriers to technology integration, level of education, gender, teaching experience, technology anxiety, technology available for use in teaching, training sources utilized, and the main predictor variable subject area. The dependent variable, level of teachers' adoption of technology in teaching and learning, was measured by the grand mean score on the *Technology Use in Teaching/Learning* scale.

Utilizing online survey methods, the Kotrlik-Redmann Technology Integration Survey (2002) was utilized to collect data from Minnesota secondary teachers within the areas of business, English language arts, math, science, and social studies. Of the 725 possible research participants, 187 completed surveys were submitted, a response rate of nearly 26 percent (N=187). Statistical analysis of the data included descriptive statistics, ANOVA and post hoc procedures, Pearson's chi-square tests, and multiple regression techniques.

Chapter 4

Results

This study was designed to explore teachers' levels of technology adoption for teaching and learning. Chapter four includes the results of the data collected for analysis. First, teachers included in the study are described by demographic and teacher characteristic variables. Next, participants' level of technology adoption is described and then compared by teacher subject area. After that, classroom technologies available are compared by teacher subject area. Then, technology anxiety and barriers to technology adoption are reported. Finally, a regression model for teacher adoption of technology for teaching and learning is presented. This study sought to answer the following research questions:

1. What are the selected demographic and personal characteristics of selected Minnesota secondary teachers?
2. To what extent have selected teachers adopted technology for teaching and learning practices?
3. Is there a relationship between teachers' levels of adoption of technology for teaching and learning practices and subject area?
4. Do differences exist in the classroom technologies available by teacher subject area?
5. Do differences exist in the technology integration barriers perceived by teachers by subject area?

6. Do differences exist in the technology anxiety perceived by teachers by subject area?
7. Do differences exist in the technology training sources used by teachers by subject area?
8. Do selected variables explain a significant portion of the variance in teachers' technology adoption? (Potential explanatory variables include age, subject area, years of teaching experience, technology anxiety, barriers to technology integration, technology training sources used, and the types of technology available for classroom use.)

Demographics and Personal Characteristics

The first research question sought to describe demographic and personal characteristics of selected Minnesota secondary teachers. Participants were asked to identify their age, education level, subject area taught, years of teaching experience, years of other work experience, and to rate their anxiety level when using or thinking about using technology.

First, the age of teachers in the study was examined. The age of participants varied greatly, as shown in Table 2. Digital natives, or those born after 1980, accounted for approximately 21 percent of the participants. Digital natives are individuals that have grown up in a digital world (Prensky, 2001). Digital immigrants, or those born before 1980, accounted for approximately 79 percent of the participants. Digital immigrants have had to adjust the way they work and learn to operate within a digital world

(Tapscott, 2009) and may adopt technology for teaching and learning differently than digital natives (Prensky, 2001).

Table 2

Age of Participants

	Age (years)	Frequency	Percent
Digital native	21-33	39	20.9
Digital immigrant	34-46	93	49.7
	47-59	46	24.6
	60 +	9	4.8
Total (N)		187	100.0

Second, the education of teachers in the study was examined. The majority of participants reported they had obtained a Master's degree (89.3 %). A minority of the participants reported they had obtained a bachelor degree (10.7%). No teachers included in the study had obtained a terminal degree.

Third, the teaching experience of teachers in the study was examined. Participants' years of teaching experience varied greatly, as shown in Table 3. Untenured teachers, those with three or fewer years of experience, accounted for 13.4 percent of the participants. Over half of the participants (51.3 %) reported 14 or more years of teaching experience.

Table 3

Years of Teaching Experience by Subject Area (N=187)

Years of Teaching Experience	Business		ELA		Math		Science		Social Studies		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
1-3	5	8.8	5	14.7	8	26.7	4	11.4	3	9.7	25	13.4
4-8	12	21.1	6	17.6	2	6.7	6	17.1	4	12.9	30	16.04
9-13	10	17.5	7	20.1	7	23.3	6	17.1	6	19.4	36	19.3
14+	30	52.6	16	47.1	13	43.3	19	54.3	18	58.1	96	51.3
Total	57		34		30		35		31		187	100.0

A chi-square test was utilized to determine if the two categorical variables, teacher subject area (business, math, English language arts, math, science, or social studies) and teaching experience (1-3, 4-8, 9-13, or 14+ years), were related. Pearson's chi-square test was conducted to compare the frequencies and expected frequencies of subject area and teaching experience. The Pearson's chi-square statistic 9.441, is not significant (p = .665), indicating that teacher subject area was not associated with years of teaching experience.

Fourth, the work experience of teachers in the study was examined. Participants' years of other work experience also varied greatly, as shown in Table 4. Most participants in the study, 117 (62.6%) reported five or fewer years of other work experience. Business and social studies teachers reported the highest levels of non-teaching work experience.

Table 4

Teachers' Years of Other Work Experience by Subject Area (N=187)

Years of Other Work Experience	Business		ELA		Math		Science		Social Studies		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
0 – 1	11	19.3	6	17.6	13	43.3	10	28.6	11	35.5	51	27.3
2 – 5	20	35.1	19	55.9	7	23.3	14	40.0	6	19.4	66	35.3
6 – 9	7	12.3	4	11.8	2	6.7	4	11.4	5	16.1	22	11.7
10 +	19	33.3	5	14.7	8	26.7	7	20.0	9	29.0	48	25.7
Total	57		34		30		35		31		187	100

A chi-square test was utilized to determine if the two categorical variables teacher subject area (business, English language arts, math, science, or social studies) and other work experience (0-1, 2-5, 6-9, or 10+ years) were related. Pearson's chi-square test was conducted to compare the frequencies and expected frequencies of teachers' subject area and work experience. The Pearson's chi-square statistic 18.525, is not significant (p = .101), indicating that teachers' years of other work experience was not significantly associated with subject area.

Finally, teachers' technology anxiety was examined. Teachers' were asked about their feelings of anxiety while thinking about and using technology. Each question was answered on scale of one to five (1 = no anxiety, 2 = some anxiety, 3 = moderate anxiety, 4 = high anxiety, 5= very high anxiety). As shown in Table 5, teachers reported feeling fairly low levels of anxiety, $\bar{x}$ = 2.06. The sixth research question explores technology anxiety by subject area (see Table 24).

Table 5

Teacher Technology Anxiety (N=187)

Technology Anxiety Items "How anxious do you feel when:"	Mean	Std. Dev.
You cannot keep up with important technological advances?	2.56	1.16
You are not certain what the options on various technologies will do?	2.35	1.01
You are faced with using new technology?	2.29	1.03
Someone uses a technology term that you do not understand?	2.10	1.06
You try to understand new technology?	2.07	.99
You avoid using unfamiliar technology?	2.03	.92
You try to use technology?	2.00	.92
You hesitate to use technology for fear of making mistakes you cannot correct?	2.00	1.03
You try to learn technology related skills?	1.94	.90
You think about your technology skills compared to the skills of other teachers?	1.89	1.01
You think about using technology in instruction?	1.76	.89
You fear you may break or damage the technology you are using?	1.69	.94
Technology Anxiety Grand Mean	2.06	.75

Technology Anxiety: 1 = *no anxiety*, 2 = *some anxiety*, 3 = *moderate anxiety*, 4 = *high anxiety*, 5 = *very high anxiety*.

Technology Adoption

The second research question sought to answer the extent to which selected teachers had adopted technology in their teaching and learning practices. Teachers were asked to describe themselves and their efforts to integrate technology in the teaching/learning process by responding to 19 statements as: 1 = not like me, 2 = very little like me, 3 = some like me, 4 = very much like me, or 5 = just like me. Higher scores indicate higher levels of technology adoption. As shown in Table 6, descriptive statistics, including measures of central tendency and measures of variability, were used to identify teachers' level of technology adoption. Measures of central tendency were calculated for each of the 19 items included in the technology use scale as well as a grand scale mean ($\bar{x}$ = 3.41).

Table 6

Technology Use Scale Item Responses (N=187)

Technology Use in Teaching/Learning Statements "Like Me"	Mean	Std. Dev.
I emphasize the use of technology as a learning tool in my classroom or laboratory	4.04	1.02
I expect my students to use technology to enable them to be self-directed learners	4.02	1.03
I discuss with students how they can use technology as a learning tool	3.93	.97
I design learning activities that result in my students being comfortable using technology in their learning	3.93	1.08
I assign students to use the computer to do content related activities on a regular basis	3.90	1.25
I have made physical changes to accommodate technology in my classroom or laboratory	3.86	1.10
I expect students to use technology to such an extent that they develop projects that are of a higher quality level than would be possible without them using technology	3.82	1.18
I use technology to encourage students to share the responsibility for their own learning	3.81	1.06
I expect my students to use technology so they can take on new challenges beyond traditional assignments and activities	3.77	1.08
I incorporate technology in my teaching to such an extent that it has become a standard learning tool for my students	3.76	1.16
I regularly pursue innovative ways to incorporate technology into the learning process for my students	3.73	1.07
I expect my students to fully understand the unique role that technology plays in their education	3.52	1.01
I am more of a facilitator of learning than the source of all information because my students use technology	3.50	1.13
I incorporate technology in my teaching to such an extent that my students use technology to collaborate with other students in my class during the learning process	3.18	1.24
I use technology based games or simulations on a regular basis in my classroom or laboratory	3.09	1.31
I often require my students to use e-mail to complete their assignments	2.58	1.40

Table continued

Table 6

Technology Use Item Responses (N=187) (continued)

Technology Use in Teaching/Learning Statements "Like Me"	Mean	Std. Dev.
I encourage students to design their own technology-based learning activities	2.33	1.14
I incorporate technology in my teaching to such an extent that my students use technology to collaborate with individuals in other disciplines	2.02	1.17
I incorporate technology in my teaching to such an extent that my students use technology to collaborate with individuals at other locations (other classes, other schools, other states or countries, etc.)	1.96	1.11
Technology Adoption Grand Scale Mean	3.41	.80

Technology Adoption: 1 = *not like me*, 2 = *very little like me*, 3 = *some like me*, 4 = *very much like me*, 5 = *just like me*.

Next, teachers' technology adoption was compared by age groups (Table 7) and teaching experience (Table 8) groups. Significant relationships were not found between teachers' age and their level of technology adoption nor teachers' years of teaching experience and technology adoption. The analysis revealed no significant main effects between age groups, $F(3, 183) = 1.052$, $p = .371$ or between teaching experience groups, $F(3, 183) = .652$, $p = .583$.

Table 7

Technology Adoption by Teachers' Age -- Mean, Standard Deviation, F-Ratio, and P-Value (N=187)

Age (in years)	N	Technology Adoption Mean	Std. Dev.	*F-Ratio*	*p*-Value
21-33	39	3.45	.80		
34-46	93	3.31	.79		
47-59	46	3.55	.83		
60+	9	3.52	.84		
Total	187	3.41	.80	1.052	.371

Technology Adoption: 1 = *not like me*, 2 = *very little like me*, 3 = *some like me*, 4 = *very much like me*, 5 = *just like me*.

Table 8

Technology Adoption by Teachers' Years of Teaching Experience -- Mean, Standard Deviation, F-Ratio, and P-Value (N=187)

Teaching Experience (in Years)	N	Technology Adoption Mean	Std. Dev.	*F-Ratio*	*p-Value*
1-3	25	3.54	.81		
4-8	30	3.38	.74		
9-13	36	3.26	.71		
14+	96	3.43	.86		
Total	187	3.41	.80	.652	.583

Technology Adoption: 1 = *not like me*, 2 = *very little like me*, 3 = *some like me*, 4 = *very much like me*, 5 = *just like me*.

Finally, data were analyzed to determine if descriptive categories could be applied to the technology adoption scale. The frequency distributions indicated that the technology adoption mean scores formed a normal curve. Since a normal distribution of interval scores existed, teachers were grouped into categories according to Rogers' (2003) adopter classification system. The mean of the teachers' technology adoption score and standard deviation from the mean were used to divide the distribution of scores into five categories with a standardized percentage of respondents in each category. The score values were reversed to fit Roger's adoption categories. As shown in Table 9, the area lying to the left of the mean minus two standard deviations includes participants with the highest 2.5 percent of technology adoption scores and is labeled *innovators.* The next 13.5 percent were labeled *early adopters*. The next 34 percent, including the mean minus one standard deviation, were labeled *early adopters*. The next category, *late majority,* included those individuals whose score fell between the mean and one standard deviation to the right of the mean, or approximately, the next 34 percent. The last 16 percent was labeled *laggards.* Categorization of the interval scores converted this variable to an ordinal scale. This categorization may provide a more meaningful description than interval scores for teachers, administrators, and other education stakeholders.

Table 9

Rogers' Adopter Categorization on the Basis of Innovativeness (N=187)

Rogers' Adopter Categorization	N	Percent of Scores	Technology Adoption Mean	Std. Dev.
Innovator	5	2.5	4.95	.05
Early Adopter	26	13.5	4.44	.19
Early Majority	64	34.0	3.81	.18
Late Majority	62	34.0	3.09	.28
Laggard	30	16.0	2.07	.29

Technology Adoption: 1 = *not like me*, 2 = *very little like me*, 3 = *some like me*, 4 = *very much like me*, 5 = *just like me*.

Technology Adoption by Subject Area

The third research question sought to determine if there was a relationship between teachers' level of technology adoption by subject area. The technology adoption score for business teachers ($\bar{x}$=3.95) was the highest, and math teachers ($\bar{x}$=2.91) was the lowest. Technology adoption mean scores by subject area are represented in Table 10.

Table 10

Technology Adoption for Subject Area Teachers -- Mean, Standard Deviation, F-Ratio, and P-Value (N=187)

Subject Area	N	Mean	Std. Dev.	*F*-Ratio	*P*-Value
Business	57	3.95	.50		
Social studies	31	3.43	.71		
ELA	34	3.32	.90		
Science	35	3.08	.80		
Math	30	2.81	.63		
Technology Adoption	187	3.41	.80	16.191*	.000

*. Significant at the .05 level.
Technology Adoption: 1 = *not like me*, 2 = *very little like me*, 3 = *some like me*, 4 = *very much like me*, 5 = *just like me*.

A one-way ANOVA was computed followed by Gabriel's post hoc test to determine if technology adoption scores differed significantly by subject area. All analyses were computed at the .05 significance level. Analysis of variance (ANOVA) was used to identify the main and interaction effects of the independent variable, subject area, on the dependent variable, technology adoption using the interval-scale score from the *Technology Use in Teaching/Learning* scale. The key statistic in ANOVA is the *F*-test of difference of treatment means. If the *F*-test is significant, follow up tests can be used to identify whether or not sample means significantly differ from one another (Field, 2009). The analysis revealed significant main effects between groups, $F(4, 182) = 16.191$, $p < .001$. Table 11 contains the mean differences in technology adoption among the five selected subject areas. Statistically significant differences were found between business and English language arts (MD = .632), business and math (MD = 1.141), business and science (MD = .872), business and social studies (MD = .523), English language arts and math (MD = .508), and social studies and math (MD = .617).

Table 11

ANOVA (Gabriel): Comparison of Technology Adoption by Subject Area (N=187)

Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	*p*-Value
Business	ELA	.632*	.151	.000
	Math	1.141*	.158	.000
	Science	.872*	.145	.000
	Social Studies	.523*	.156	.008
ELA	Business	-.632*	.151	.000
	Math	.508*	.175	.033
	Science	.239	.168	.614
	Social Studies	-.109	.173	.970
Math	Business	-1.141*	.158	.000
	ELA	-.508*	.175	.033
	Science	-.269	.174	.533
	Social Studies	-.617*	.179	.006
Science	Business	-.872*	.145	.000
	ELA	-.239	.168	.614
	Math	.269	.174	.533
	Social Studies	-.348	.172	.259
Social Studies	Business	-.523*	.156	.008
	ELA	.109	.173	.970
	Math	.617*	.179	.006
	Science	.348	.172	.259

*. The mean difference is significant at the .05 level.
Dependent Variable: Technology Adoption Mean Score

The 19 technology adoption scale items were also compared by subject area (see Appendix E). Mean scores of 17 of the 19 items on the *Technology Use in Teaching/ Learning* scale differed significantly by subject area. Mean differences were significant at the .0026 level (.05/19). For each of the 17 items that differed significantly, business teachers were found to have higher mean scores than other subject area teachers. The only items on the scale that did not differ significantly were “I expect my students to fully understand the unique role that technology plays in their education” and “I incorporate technology in my teaching to such an extent that my students use technology to collaborate with individuals at other locations".

Finally, the relationship between the two categorical variables teacher subject area and the Rogers' adopter categorization was examined by analyzing the frequencies of each combination of five subject areas and five adopter categories. Pearson's chi-square test was conducted to find the frequencies and expected frequencies. The expected frequencies assumption of no more than 20 percent of expected frequencies below 5 was violated with 11 cells (44%) with expected frequencies less than five. To continue to examine whether there was an association between the two categorical variables, a new variable called Merged Adopter Category was created which resulted in four groups of adopter categories instead of five. The *innovator* and *early adopter* categories were merged. All other categories remained the same. The four groups in the merged adopter categories include innovator/early adopter, early majority, late majority, and laggards. The chi-square statistic 56.691, is highly significant ($p < .001$), indicating that the teacher subject area had a significant relationship with the teacher adopter category. This significant finding reflected the fact that when the adopter category was *innovator/early adopter*, the teacher's subject area was most often business (61.3%). When the teacher's subject area was business, the adopter category was most likely to be *early majority* (52.6%) or *innovator/early adopter* (33.3%) whereas less than two percent of business teachers were *laggards*. When the teacher's subject area was math, the adopter category was most likely to be *late majority* (53.3%) or *laggard* (33.3%) whereas no math teachers fell within the *innovator/early adopter* category. The majority of social studies and

English language arts teachers were included in the *early majority* and *late majority* categories. Table 12 displays the cross tabulation of teacher subject area and adopter categories.

Table 12

Cross Tabulation of Teacher Subject Area and Rogers' Adopter Category (N=187)

Subject Area		Innovator/Early Adopter	Early Majority	Late Majority	Laggard	Total
Business	Count	19	**30**	7	**1**	57
	Expected Count	9.4	**19.5**	18.9	**9.1**	
	% within Subject area	33.3%	52.6%	12.3%	1.8%	100.0%
	% within Adopter category	61.3%	46.9%	11.3%	3.3%	
	% of Total	10.2%	16.0%	3.7%	0.5%	30.5%
ELA	Count	**5**	9	**14**	6	34
	Expected Count	**5.6**	11.6	**11.3**	5.5	
	% within Subject area	14.7%	26.5%	41.2%	17.6%	100.0%
	% within Adopter category	16.1%	14.1%	22.6%	20.0%	
	% of Total	2.7%	4.8%	7.5%	3.2%	18.2%
Math	Count	**0**	4	**16**	10	30
	Expected Count	**5.0**	10.3	**9.9**	4.8	
	% within Subject area	0.0%	13.3%	53.3%	33.3%	100.0%
	% within Adopter category	0.0%	6.3%	25.8%	33.3%	
	% of Total	0.0%	2.1%	8.6%	5.3%	16.0%
Science	Count	**3**	9	**13**	10	35
	Expected Count	**5.8**	12.0	**11.6**	5.6	
	% within Subject area	8.6%	25.7%	37.1%	28.6%	100.0%
	% within Adopter category	9.7%	14.1%	21.0%	33.3%	
	% of Total	1.6%	4.8%	7.0%	5.3%	18.7%
Social Studies	Count	4	**12**	12	**3**	31
	Expected Count	5.1	**10.6**	10.3	**5.0**	
	% within Subject area	12.9%	38.7%	38.7%	9.7%	100.0%
	% within Adopter category	12.9%	18.8%	19.4%	10.0%	
	% of Total	2.1%	6.4%	6.4%	1.6%	16.6%
Total	Count	31	64	62	30	187
	% within Subject area	16.6%	34.2%	33.2%	16.0%	100.0%

Classroom Technologies Available by Subject Area

The fourth research question explored differences in the technologies available for selected subject area teachers. Teachers were asked about the types of technology they had available to them for use in teaching. Responses to the 13 items in the *Types of Technology Available for Use in Teaching* checklist were compared by teacher subject area. Table 13 displays the number of participants and percentage of participants within each subject area that indicated each classroom technology was available for their use.

Table 13

Technology Available for Use in Teaching within Subject Area (N=187)

Technology Available		Business N=57	ELA N=34	Math N=30	Science N=35	Social Studies N=31	Total N=187
Teacher has computer with Internet connection at school	N	57	34	29	34	30	184
	%	100	100	96.7	97.1	96.8	98.4
Teacher has computer with Internet connection at home	N	57	33	28	32	28	178
	%	100	97.1	93.3	91.4	90.3	95.2
LCD or other projection display	N	52	29	26	32	26	165
	%	91.2	85.3	86.7	91.4	83.9	88.2
Most of the computers available for student use have Internet access	N	56	31	22	26	26	161
	%	98.2	91.2	73.3	74.6	83.9	86.1
DVD or BlueRay player	N	47	32	19	32	29	159
	%	82.5	94.1	63.3	91.4	93.5	85.0
Enough computers in classroom or lab for all students to work by themselves or with one other student	N	56	31	19	25	26	157
	%	98.2	91.2	63.3	71.4	83.9	84.0
Students have a school email account	N	49	27	25	25	26	152
	%	86.0	79.4	83.3	71.4	83.9	81.3
Interactive white board	N	43	24	22	24	22	135
	%	75.4	70.6	73.3	68.6	71.0	72.2
Digital photo camera	N	42	21	10	21	16	110
	%	73.7	61.8	33.3	60.0	51.6	58.8
Tablet computer (e.g. iPad)	N	38	20	19	13	19	109
	%	66.7	58.8	60.0	37.1	61.3	58.3
Digital video camera	N	36	24	12	16	15	103
	%	63.2	70.6	40.0	45.7	48.4	55.1
Smartphone/ mobile handheld device	N	23	12	12	8	12	67
	%	40.4	35.3	40.0	22.9	38.7	35.8
Global positioning system (GPS)	N	8	3	3	3	5	22
	%	14.0	8.8	10.0	8.6	16.1	11.8

As shown in Table 13, the vast majority of teachers reported they had a computer with an Internet connection at school (98%), had a computer with an Internet connection at home (95%), and had access to a LCD or other projection display (88%). A large majority of teachers reported they had access to enough computers for students to work by themselves or with one other student (84%) and that the majority of computers available for student use had access to the Internet (86%). The least likely technologies available for teachers were global positioning systems (11.8%) and smartphone/mobile handheld devices (35.8%).

Next, chi-square tests were used to determine whether the technologies available to teachers were related to teacher subject area. Pearson's chi-square tests were used to determine if there was a relationship between the categorical variable subject area and each of the 13 items in the classroom technologies checklist. The chi-square test was repeated 13 times, with the significance level of .05/13, $p < .0038$. Table 14 displays the Pearson chi-square statistic for each technology item association to teacher subject area. Three significant associations were found between teacher subject area and whether or not the following classroom technologies were available: 1) enough computers in a classroom or lab so that students may work by themselves or with one other student, 2) DVD or BlueRay player, and 3) most of the computers available for student use have Internet access.

Table 14

Relationship between Teacher Subject Area and Technology Available (N=187)

Technology Available	Pearson Chi-Square Value	*p*-Value
Enough computers in a classroom or lab so that students may work by themselves or with one other student	23.508	.000*
DVD or BlueRay Player	16.487	.002*
Most of the computers available for student use have Internet access	16.051	.003*
Digital video camera	9.368	.053
Tablet computer	8.187	.085
Teacher has computer with Internet connection at home	6.048**	.196
Smartphone/Mobile handheld device	3.412	.491
Students have a school email account	3.353	.501
Teacher has computer with Internet connection at school	2.916**	.572
LCD or other projection display	1.759**	.780
GPS	1.569**	.814
Interactive white board	0.614	.961

*. Significant at the .0038 level.

**. More than 20% of the cells have expected counts less than 5.

As shown in Table 14, there was a significant association between teacher subject area and whether or not the teacher had access to enough computers in a classroom or lab for all students to work by themselves or one other student χ^2 (4) = 23.508, $p < .001$. Table 15 displays the frequencies of whether or not subject area teachers have access to enough computers in a classroom or lab for all students to work by themselves or with one other student. Business teachers (98.2%) were most likely, whereas math teachers (63.3%) were least likely to have access to enough computers for students.

Table 15

Cross Tabulation of Teacher Subject Area and Enough Computers in a Classroom or Lab for All Students to Work by Themselves or with One Other Student (N=187)

Teacher has access to enough computers in a classroom or lab for all students to work by themselves or with one other student		Business	ELA	Math	Science	Social Studies	Total
No	Count	**1**	3	**11**	10	5	30
	Expected Count	**9.1**	5.5	**4.8**	5.6	5.0	
	% within Enough computers	3.3%	10.0%	36.7%	33.3%	16.7%	100.0%
	% within Subject area	1.8%	8.8%	36.7%	28.6%	16.1%	
	% of Total	0.5%	1.6%	5.9%	5.3%	2.7%	16.0%
Yes	Count	**56**	31	**19**	25	26	157
	Expected Count	**47.9**	28.5	**25.2**	29.4	26.0	
	% within Enough computers	35.7%	19.7%	12.1%	15.9%	16.6%	100.0%
	% within Subject area	98.2%	91.2%	63.3%	71.4%	83.9%	
	% of Total	29.9%	16.6%	10.2%	13.4%	13.9%	84.0%
Total	Count	57	34	30	35	31	187

As shown in Table 14, there was a significant association between teacher subject area and whether or not the teacher had access to a DVD or BlueRay player χ^2 (4) = 16.487, p = .002. Table 16 displays the frequencies of whether or not subject area teachers have a DVD or BlueRay player available for their use. English language arts teachers (94.1%) were most likely to have a DVD or BlueRay player available for use in teaching, whereas math teachers (63.3%) were least likely.

Table 16

Cross Tabulation of Teacher Subject Area and DVD or BlueRay Player Available for Use in Teaching (N=187)

DVD or BlueRay Player		Business	ELA	Math	Science	Social Studies	Total
No	Count	10	**2**	**11**	3	2	28
	Expected Count	8.5	**5.1**	**4.5**	5.2	4.6	
	% within DVD or BlueRay	35.7%	7.1%	39.3%	10.7%	7.1%	100.0%
	% within Subject area	17.5%	5.9%	36.7%	8.6%	6.5%	
	% of Total	5.3%	1.1%	5.9%	1.6%	1.1%	15.0%
Yes	Count	47	**32**	**19**	32	29	159
	Expected Count	48.5	**28.9**	**25.5**	29.8	26.4	
	% within DVD or BlueRay	29.6%	20.1%	11.9%	20.1%	18.2%	100.0%
	% within Subject area	82.5%	94.1%	63.3%	91.4%	93.5%	
	% of Total	25.1%	17.1%	10.2%	17.1%	15.5%	85.0%
Total	Count	57	34	30	35	31	187
	% within DVD or BlueRay	30.5%	18.2%	16.0%	18.7%	16.6%	100.0%

As shown in Table 14, there was a significant association between teacher subject area and whether or not most of the computers for student use had access to the Internet χ^2 (4) = 16.051, p = .003. Table 17 displays the count and expected count whether or not most of the computers for student use had access to the Internet by teacher subject area. Business teachers (98.2%) were most likely, whereas math teachers (73.3%) were least likely to have had access to sufficient student computers with Internet access.

Table 17

Cross Tabulation of Teacher Subject Area and Most Computers for Student Use Have Access to the Internet

Most Computers for Student Use Have Access to the Internet		Business	ELA	Math	Science	Social Studies	Total
No	Count	**1**	3	**8**	9	5	26
	Expected Count	**7.9**	4.7	**4.2**	4.9	4.3	
	% within Most computers for student use have access to the Internet	3.8%	11.5%	30.8%	34.6%	19.2%	100.0%
	% within Subject area	1.8%	8.8%	26.7%	25.7%	16.1%	
	% of Total	0.5%	1.6%	4.3%	4.8%	2.7%	13.9%
Yes	Count	**56**	31	**22**	26	26	161
	Expected Count	**49.1**	29.3	**25.8**	30.1	26.7	
	% within Most computers for student use have access to the Internet	34.8%	19.3%	13.7%	16.1%	16.1%	100.0%
	% within Subject area	98.2%	91.2%	73.3%	74.3%	83.9%	
	% of Total	29.9%	16.6%	11.8%	13.9%	13.9%	86.1%
Total	Count	57	34	30	35	31	187

To further explore the differences in technology available to the selected subject area teachers, a technology available sum score was computed. The technology available sum score was derived from the thirteen items of the *Technology Available for Use in Teaching and Learning* checklist. Possible scores ranged from 0 to 13, with zero being none of the technologies was available to the teacher, and 13 being all of the technologies on the checklist were available to the teacher. Business ($\bar{x}$ = 9.84) teachers had the highest technology available sum score. Math ($\bar{x}$ = 8.17) and science ($\bar{x}$ = 8.31) teachers had the lowest technology available sum scores. Table 18 displays the mean, standard deviation, *F*-Ratio, and *P*-value of technology available sum scores by teacher subject area.

Table 18

Technology Available Total Scores by Subject Area -- Mean, Standard Deviation, F-Ratio and P-Values (N=187)

Subject area	N	Mean	Std. Deviation	*F*-Ratio	*p*-Value
Business	57	9.84	1.71		
ELA	34	9.44	1.96		
Social Studies	31	9.00	2.37		
Science	35	8.31	2.22		
Math	30	8.17	2.02		
Total	187	9.07	2.11	5.095*	.001

* = Significant at the .05 level.
Technology available total scores range from 0 (*low*) to 13 (*high*).

A one-way ANOVA determined there was a significant main effect of teacher subject area on the amount of technology available for use in their teaching, F (4, 83.281) = 5.095, p = .001. Gabriel's post hoc test determined significant differences between business and math (MD = 1.675) and business and science (MD = 1.528). Table 19 displays the mean differences in technology available among subject area teachers.

Table 19

ANOVA (Gabriel): Comparison of Technology Available Differences by Subject Area (N=187)

Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	*p*-Value
Business	ELA	.401	.438	.987
	Math	1.675*	.456	.003
	Science	1.528*	.434	.005
	Social Studies	.842	.451	.460
ELA	Business	-.401	.438	.987
	Math	1.275	.506	.119
	Science	1.127	.487	.195
	Social Studies	.441	.502	.991
Math	Business	-1.675*	.456	.003
	ELA	-1.275	.506	.119
	Science	-.148	.503	1.000
	Social Studies	-.833	.518	.679
Science	Business	-1.528*	.434	.005
	ELA	-1.127	.487	.195
	Math	.148	.503	1.000
	Social Studies	-.686	.499	.841
Social Studies	Business	-.842	.451	.460
	ELA	-.442	.502	.991
	Math	.833	.518	.679
	Science	.686	.499	.841

*. The mean difference is significant at the .05 level.
Dependent variable: Technology Available Total Score

Statistical tests performed indicated there was a relationship between subject area and the technology teachers had available for their use in teaching. Business teachers had significantly more technology available for their use than math or science teachers.

Barriers to Technology Integration

The fifth research question explored the technology integration barriers perceived by teachers. Teachers' were asked about barriers they encountered to integrate technology into teaching and learning practices. The *Barriers to the Integration of Technology in the Teaching/Learning Process* scale included nine items that were answered on a scale of one to four (1 = not a barrier, 2 = minor barrier, 3 = moderate barrier, 4 = major barrier). Analysis of Variance (ANOVA) was used to determine if technology integration barriers differed by subject area. A one-way ANOVA was conducted to test the mean differences in each of the nine items in the *Barriers* scale among the five groups of selected teachers. Table 20 displays the mean, standard deviation, *F* ratio, and *p* value for each item on the *Barriers* scale. Significance level was .0056, $p < .05/9$. Three of the nine *Barriers* scale items differed significantly by teacher subject area: 1) scheduling enough time for students to use the internet, computers, or other technology in the teaching/learning process; 2) availability of technology for the number of students in my classes; and 3) types of courses I teach.

Table 20

Barriers to Technology Integration Scale Items by Subject Area Teachers -- Means, Standard Deviations, F-Ratios, and P-Values (N=187)

Barrier to Technology Integration Scale Item		N	Mean	Std. Dev.	*F*-Ratio	*p*-Value
Enough time to develop lessons that use technology	Business	57	3.19	.789		
	ELA	34	3.26	.790		
	Math	30	3.40	.770		
	Science	35	3.49	.702		
	Social Studies	31	3.52	.677		
	Total	187	3.35	.756	1.423	.228
Scheduling enough time for students to use the Internet, computers, or other technology in the teaching/learning process	Business	57	1.93	1.015		
	ELA	34	3.09	.996		
	Math	30	3.07	.868		
	Science	35	3.17	.891		
	Social Studies	31	3.29	.824		
	Total	187	2.78	1.088	17.191	.000*
Availability of technology for the number of students in my classes	Business	57	1.72	1.013		
	ELA	34	2.76	1.103		
	Math	30	2.73	1.112		
	Science	35	3.03	1.014		
	Social Studies	31	2.94	.998		
	Total	187	2.52	1.166	12.468	.000*
Availability of technical support to effectively use instructional technology in the teaching/learning process	Business	57	2.07	1.050		
	ELA	34	2.56	1.106		
	Math	30	2.40	1.102		
	Science	35	2.51	.853		
	Social Studies	31	2.61	.803		
	Total	187	2.39	1.011	2.227	.068
Availability of effective instructional software for the courses I teach	Business	57	2.12	.983		
	ELA	34	2.21	.880		
	Math	30	2.53	1.008		
	Science	35	2.49	.818		
	Social Studies	31	2.61	.803		
	Total	187	2.35	.924	2.239	.067

Table continued

Table 20

Barriers to Technology Integration Scale Items by Subject Area Teachers -- Means, Standard Deviations, F-Ratios, and P-Values (N=187) (continued)

Barrier to Technology Integration Scale Item		N	Mean	Std. Dev.	*F*-Ratio	*p*-Value
My ability to integrate technology in the teaching/learning process	Business	57	1.67	.740		
	ELA	34	2.18	.936		
	Math	30	2.10	.885		
	Science	35	2.26	.852		
	Social Studies	31	2.00	.816		
	Total	187	1.99	.858	3.583	.008
My students' ability to use technology in the teaching/learning process	Business	57	1.75	.714		
	ELA	34	1.76	.654		
	Math	30	2.00	.983		
	Science	35	2.00	.728		
	Social Studies	31	1.97	.706		
	Total	187	1.88	.756	1.108	.354
Administrative support for integration of technology in the teaching/learning process	Business	57	1.67	.831		
	ELA	34	1.59	.821		
	Math	30	1.93	.868		
	Science	35	2.06	.938		
	Social Studies	31	2.13	.885		
	Total	187	1.84	.881	2.796	.028
Type of courses I teach	Business	57	1.46	.758		
	ELA	34	1.85	.821		
	Math	30	2.27	.907		
	Science	35	1.89	.867		
	Social Studies	31	1.74	.930		
	Total	187	1.79	.878	4.802	.001*

*. Significant at the .0056 level.

Barriers: 1 = *not a barrier*, 2 = *minor barrier,* 3 = *moderate barrier*, 4 = *major barrier*.

Gabriel's post hoc tests were conducted next to determine where differences existed between subject area teachers for the scale items the significantly different scale items. Table 21 displays the mean differences for the three scale items that were shown to differ significantly in the ANOVA test. Business teachers were found to experience significantly lower barriers to technology use than other teachers. Availability of technology and scheduling enough time for students to use technology in teaching and learning was significantly less difficult for business teachers than the other subject area teachers. Business teachers were also significantly less likely to perceive the types of courses they teach as a barrier to technology integration compared to math teachers. Significant differences were not found between teachers other than business in any of the nine items on the *Barriers to Technology Integration* scale.

Table 21

ANOVA (Gabriel): Comparison of Barrier Items by Subject Area

Barrier Scale Item	Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	Sig.
Scheduling enough time for students to use the Internet, computers, or other technology in the teaching/learning process	Business	ELA	-1.158*	.203	.000
		Math	-1.137*	.211	.000
		Science	-1.242*	.201	.000
		Social Studies	-1.360*	.209	.000
Availability of technology for the number of students in my classes	Business	ELA	-1.045*	.226	.000
		Math	-1.014*	.235	.000
		Science	-1.309*	.224	.000
		Social Studies	-1.216*	.233	.000
Type of courses I teach	Business	ELA	-.397	.183	.260
		Math	-.811*	.190	.000
		Science	-.430	.181	.165
		Social Studies	-.286	.188	.736

*. The mean difference is significant at the .0056 level.
Dependent variable: Barrier scale item mean score.

A barrier grand mean score was developed for each subject area. Possible scores ranged from a low of 1, not experiencing any barriers, to a high of 4, experiencing major barriers to integrate technology. Teachers reported encountering fairly low levels of barriers to integrating technology in teaching and learning, $\bar{x} = 2.32$. Analysis of variance (ANOVA) was used to determine if technology integration barriers differed by subject area. A one-way ANOVA was conducted to test the mean differences in the grand mean barriers scores among the five selected subject area teacher groups. The grand mean barriers scores differed significantly by subject area $F(4, 182) = 13.874$, $p < .001$. The barrier score for business teachers ($\bar{x}$=1.96) was the lowest, whereas math ($\bar{x}$=2.53) and science ($\bar{x}$=2.54) teachers were the highest. Table 22 displays the barriers score grand mean, standard deviation, *F*-value, and *p*-value by subject area.

Table 22

Barriers Scores by Teacher Subject Area -- Grand Means, Standard Deviations, F-Ratios, and P-Values (N=187)

Subject Area	N	Mean	Std. Deviation	*F-Ratio*	*p*-Value
Business	57	1.96	.534		
ELA	34	2.49	.511		
Math	30	2.53	.402		
Science	35	2.54	.348		
Social Studies	31	2.36	.403		
Grand Mean Barrier Score	187	2.32	.516	13.874*	.000

*. Significant at the .05 level.

Barriers: 1 = *not a barrier*, 2 = *minor barrier,* 3 = *moderate barrier*, 4 = *major barrier*.

The one-way ANOVA test showed the grand mean barriers scores differed significantly by subject area. Table 23 displays the results of Gabriel's post hoc tests which were used to determine where the significant differences in barriers existed between subject area teachers. Significant main effects in the barriers grand mean score were found between business and English language arts (MD = -.404), math (MD = -.535), science (MD = -.584), and social studies (MD = -.575). Significant main effects were not found between subject area teachers other than business.

Table 23
ANOVA (Gabriel): Comparison of Barriers to Technology Integration by Subject Area (N=187)

Barrier to Technology Integration	Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	Sig.
Barriers Grand Mean Score	Business	ELA	-.404*	.099	.001
		Math	-.535*	.103	.000
		Science	-.584*	.098	.000
		Social Studies	-.575*	.102	.000

*. The mean difference is significant at the .05 level.
Dependent variable: Barrier mean score.

Technology Anxiety by Subject Area

The sixth research question explored technology anxiety perceived by subject area teachers. Teachers were asked about their level of anxiety when using or thinking about using technology (1 = no anxiety, 2 = some anxiety, 3 = moderate anxiety, 4 = high anxiety, 5= very high anxiety). Analysis of variance (ANOVA) was used to determine if technology anxiety differed by subject area. A one-way ANOVA was conducted to test the mean differences in each of the 12 items in the *Technology Anxiety* scale among the five groups of selected teachers. Significance level was .0042, $p < .05/12$. In conducting the ANOVA, Levene's test was found to be significant for multiple items, indicating that the homogeneity of variances assumption had been violated. Because the variances of the groups were not equal, Welch's F is reported. A table which displays the mean, standard deviation, F value, and p value for each item on the scale by subject area is included in Appendix H. None of the items on the *Anxiety* scale differed significantly by subject area.

For additional analysis of anxiety by teacher subject area, an anxiety grand mean score was developed for each subject area. Possible anxiety scores ranged from a low of 1, not experiencing any anxiety, to a high of 5, experiencing very high anxiety when using or thinking about using technology. Teachers reported experiencing fairly low levels of technology anxiety, $\bar{x}$ = 2.06 ± .754. Business teachers were found to have the lowest anxiety grand mean score, $\bar{x}$ = 1.86 ± .611. Analysis of variance (ANOVA) was used to determine if technology anxiety differed by subject area. In conducting a one-way ANOVA, Levene's test was found to be significant; homogeneity of variances had been violated, so the Welch's F-ratio is reported. The one-way ANOVA revealed no significant main effects for technology anxiety by subject area, F (4, 80.57) = 1.995, p = .103. Table 24 displays the technology anxiety grand mean, standard deviation, F value, and p value by subject area.

Table 24

Technology Anxiety for Selected Subject Area Teachers -- Mean, Standard Deviation, F-Ratio, and P-Values (N=187)

Subject Area	N	Technology Anxiety Grand Mean	Standard Deviation	*F*-Ratio	*p*-Value
Business	57	1.86	.611		
Math	30	2.00	.697		
Science	35	2.08	.642		
Social Studies	31	2.24	.919		
English Language Arts	34	2.24	.900		
Total	187	2.06	.754	1.995	.103

Significant at the .05 level.

Technology Anxiety: 1 = *no anxiety*, 2 = *some anxiety*, 3 = *moderate anxiety*, 4 = *high anxiety*, 5 = *very high anxiety*.

Technology Training Sources

The seventh research question explored the technology training sources used by teachers. Participants were asked about the technology training sources they used. Teachers utilized multiple training sources, including being self-taught (95.2%), attending workshops/conferences (95.2%), utilizing colleagues (85.6%), and completing college courses (57.8%). Table 25 displays the number of participants and percentage of participants within each subject area that utilized each training source. College courses as a technology training source had the greatest variance by subject area. English language arts (100%) teachers were most likely to utilize colleagues, business (100%) math (93%) and science (100%) teachers were most likely to use self-teaching, and social studies (97%) teachers were most likely to utilize conferences and workshops as a training source. College courses as a training source was not the most popular training source for any of the groups of subject area teachers, though business teachers (77.2%) used these the most.

Table 25

Training Sources Utilized by Subject Area Teachers (N=187)

Training Source	Frequency	Business	ELA	Math	Science	Social Studies	Total
Self-taught	N	57	32	28	35	26	178
	%	**100**	94.1	**93.3**	**100**	83.9	95.2
Workshops/ Conferences	N	56	32	27	33	30	178
	%	98.2	94.1	90.0	94.3	**96.8**	95.2
Colleagues	N	49	34	24	30	23	160
	%	86.0	**100**	80.0	85.7	74.2	85.6
College Courses	N	44	18	18	18	10	108
	%	77.2	52.9	60.0	51.4	32.3	57.8

Chi-square tests were used to determine whether the training sources utilized by teachers were related to teacher subject area. Pearson's chi-square tests were used to determine if there was a relationship between the categorical variable subject area and each of the four items in the *Training Sources Utilized* checklist, $p < .0125$ (.05/4). Whether or not a teacher utilized colleagues as a training source and whether or not a teacher utilized workshops or conferences were not found to be significantly associated with subject area. Chi-square tables for these two training sources by teacher subject area are provided in Appendix I. Significant associations were found between teacher subject area and the training sources self-teaching and college courses, which are described next.

There was a significant association between teacher subject area and whether or not the teacher utilized self-teaching as a training source χ^2 (4) = 13.627, $p = .009$. Table 26 displays the count and expected count whether or not subject area teachers utilized self-teaching as a training resource. Business (100%) and science (100%) teachers were the most likely whereas social studies (83.9%) teachers were the least likely to use self-teaching as a source for technology training.

Table 26

Cross Tabulation of Teacher Subject Area and Training Source Self-Taught (N=187)

Training Source: Self-taught		Business	ELA	Math	Science	Social Studies	Total
No	Count	**0**	2	2	0	**5**	9
	Expected Count	**2.7**	1.6	1.4	1.7	**1.5**	
	% within Self-taught	0.0%	22.2%	22.2%	0.0%	55.6%	100.0%
	% within Subject area	0.0%	5.9%	6.7%	0.0%	16.1%	4.8%
	% of Total	0.0%	1.1%	1.1%	0.0%	2.7%	
Yes	Count	**57**	32	28	35	**26**	178
	Expected Count	**54.3**	32.4	28.6	33.3	**29.5**	
	% within Self-taught	32.0%	18.0%	15.7%	19.7%	14.6%	100.0%
	% within Subject area	100.0%	94.1%	93.3%	100.0%	83.9%	95.2%
	% of Total	30.5%	17.1%	15.0%	18.7%	13.9%	
Total	Count	57	34	30	35	31	187

There was a significant association between teacher subject area and whether or not the teacher utilized college courses as a training source χ^2 (4) = 18.046, *p* = .001. Table 27 displays the frequencies of whether or not subject area teachers utilized college courses as a training resource. Business teachers were most likely (77.2%) and social studies were least likely (32.3%) to use college courses as a training source.

Table 27

Cross Tabulation of Teacher Subject Area and Training Source College Courses (N=187)

Training Source: College Courses		Business	ELA	Math	Science	Social Studies	Total
No	Count	**13**	16	12	17	**21**	79
	Expected Count	**24.1**	14.4	12.7	14.8	**13.1**	
	% within College courses	16.5%	20.3%	15.2%	21.5%	26.6%	100.0%
	% within Subject area	22.8%	47.1%	40.0%	48.6%	67.7%	42.2%
	% of Total	7.0%	8.6%	6.4%	9.1%	11.2%	
Yes	Count	**44**	18	18	18	**10**	108
	Expected Count	**32.9**	19.6	17.3	20.2	**17.9**	
	% within College courses	40.7%	16.7%	16.7%	16.7%	9.3%	100.0%
	% within Subject area	77.2%	52.9%	60.0%	51.4%	32.3%	57.8%
	% of Total	23.5%	9.6%	9.6%	9.6%	5.3%	
Total	Count	57	34	30	35	31	187

Variance in Teachers' Technology Adoption

The eighth research question explored the selected study variables which may explain a significant portion of the variance in teachers' technology adoption. The dependent variable in the analysis was the grand mean technology adoption score. Regression analysis is a way of predicting an outcome variable from one or more predictor variables (Field, 2009). Multivariate correlational statistics, specifically multiple regression techniques, were utilized to determine if the identified variables explain, or may predict, variances in the outcome variable teachers' technology adoption. Predictor variables explored to develop a potential explanatory model include: age (ordinal), subject area (nominal), years of teaching experience (ordinal), technology anxiety (interval), barriers to technology integration (interval), technology training used (interval), and the types of technology available for classroom use (interval).

Prior to running the regression analysis in SPSS, indicator (dummy) variables were created for the categorical variable subject area. Teacher subject area included five groups. For the regression test, business was assigned as the baseline, or control group. Indicator (dummy) variables were created for English language arts vs. business, math vs. business, science vs. business, and social studies vs. business. For each of these new fields, participants were assigned a code of 1 for their corresponding subject area and a code of zero if the indicator variable did not match their subject area. Business teachers were assigned codes of zero for each of the four new variables.

Next, regression methods were utilized. Subject area indicator variables were entered into the first block utilizing forced entry method. The remaining predictor variables were entered using stepwise forward method. Age, years of teaching experience, and the training source workshops/conferences were not shown to be correlated with technology adoption and were removed from the regression model. See Appendix J for the table of correlations between all study variables. Table 28 displays the regression analysis best fit models to predict technology adoption. Model 1 indicated that teacher subject area accounted for approximately 26 percent of the variation in technology adoption. Model 2 indicated that teacher subject area and barriers accounted for 31.4 percent of the variation in technology adoption. Model 3 indicated that when anxiety was added to the model, an additional 4.2 percent of the variation in technology adoption could be explained, or 35.6 percent. Model 4 indicated that when technology availability was added to the equation, 36.2 percent of the variation in technology adoption was accounted for. Model 5 indicated that nearly 40 percent of technology adoption could be explained by the subject area, anxiety, barriers, technology available, and whether or not the teacher utilized college courses as a training source, $R^2 = .395$, $F(8, 178) = 14.536$, $p < .001$.

Table 28

Technology Adoption Regression Model Summary

Model	*R*	R^2	Adjusted R^2	SE	SS	Df	MS	*F*-Value	*p*-Value
1	.512[a]	.262	.246	.698	31.582	4	7.896	16.191	.000
2	.560[b]	.314	.295	.675	37.803	5	7.561	16.581	.000
3	.588[c]	.346	.324	.661	41.643	6	6.941	15.876	.000
4	.601[d]	.362	.337	.655	43.514	7	6.216	14.484	.000
5	.629[e]	.395	.368	.639	47.552	8	5.944	14.536	.000

Dependent Variable: Technology Adoption Score
a. Predictors: (Constant), Business vs. ELA, Business vs. Math, Business vs. Social Studies, Business vs. Science
b. Predictors: (Constant), Business vs. ELA, Business vs. Math, Business vs. Social Studies, Business vs. Science, Barriers Score
c. Predictors: (Constant), Business vs. ELA, Business vs. Math, Business vs. Social Studies, Business vs. Science, Barriers Score, Anxiety Score
d. Predictors: (Constant), Business vs. ELA, Business vs. Math, Business vs. Social Studies, Business vs. Science, Barriers Score, Anxiety Score, Technology Available Total Score
e. Predictors: (Constant), Business vs. ELA, Business vs. Math, Business vs. Social Studies, Business vs. Science, Barriers Score, Anxiety Score, Technology Available Total Score, Technology Training Source College Courses

The beta value (β) tells us the change in the outcome due to a unit change in the predictor. In the indicator predictor variables for subject area, a unit change in the predictor was the change from 0 (not that subject area) to 1 (associated with that subject area). By including all three indicator variables at the same time, the baseline category was always zero, so this actually represented the difference in technology adoption if a participant was a business teacher, compared to someone who was one of the other subject area teachers. This difference was the difference between the two groups. The difference in the group means was the unstandardized beta value, *B*. The *B*-values tell us to what degree each predictor affected the outcome if the effects of all other predictors were held constant. Each *B*-value had an associated standard error indicating to what extent these values would vary across different samples, and these standard errors are used to determine whether or not the *B*-value differed significantly from zero (Field, 2009). If the *t* test associated with the *B*-value was significant ($p < .05$) then the predictor was making a significant contribution to the model; the smaller the value of *p (*and the larger the value of *t),* the greater the contribution of that predictor.

Table 29 displays the regression beta values, their standard errors, and significance value for the five models that significantly predicted technology adoption. The technology adoption score for business teachers ($\bar{x}$=3.95) is represented as the constant in Model 1, where the only predictor included in the model was the indicator variables for subject area. As shown in Tables 28 and 29, subject area was a significant predictor of technology adoption. As additional variables were added to the model, the difference between business and social studies became non-significant.

In Model 4, the teacher subject area of business vs. math ($t(179) = -5.25$, $p < .001$), business vs. science ($t(179) = -3.61$, $p < .001$), business vs. social studies ($t(179) = -1.47$, $p = .144$), business vs. English language arts ($t(179) = -2.83$, $p = .005$), the barriers score ($t(179) = -2.98$, $p = .003$), anxiety ($t(179) = -2.10$, $p = .037$), and technology available ($t(179) = 2.09$, $p = .038$) were all significant at the p < .05 level. From the magnitude of the *t*-statistics, we can conclude that the subject areas of math and science versus business had the most impact on the model. There was a negative relationship between barriers and technology adoption and anxiety and technology adoption. As barriers and anxiety increased, technology adoption levels decreased. There was a positive relationship between technology available and technology adoption. As technology available increased, technology adoption increased.

Model 5 added an additional predictor variable, whether or not the teacher utilized college courses as a source of technology training, to the regression equation. The addition of this predictor variable to the regression changed the impact the previous predictor variables had on the technology adoption model. In Model 5, the teacher subject area of business vs. math ($t(179) = -5.06$, $p < .001$), business vs. science ($t(179) = -3.18$, $p = .002$), business vs. social studies ($t(179) = -.62$, $p = .534$), business vs. English language arts ($t(179) = -2.41$, $p = .017$), the barriers score ($t(179) = -3.17$, $p = .002$), anxiety ($t(179) = -1.66$, $p = .099$), technology available ($t(179) = 1.89$, $p = .060$), and college courses ($t(179) = 3.14$, $p = .002$) were all significant at the $p < .05$ level. From the magnitude of the *t*-statistics, we can conclude that the subject areas of math and science versus business as well as barriers and the technology training source college courses had the most impact on the model. There was a positive relationship between college courses and technology adoption. There was a negative relationship between barriers and technology adoption. As the last predictor variable college course was added to the regression, technology anxiety and technology availability became non-significant.

Table 29

Coefficients of the Predictor Variables for Technology Adoption

Regression Model		*B*	*SE B*	*β*	*t*-Value	*p*-Value
1	(Constant)	3.95	.09		42.74	.000
	Business vs. Math	-1.14	.16	-.52	-7.24	.000
	Business vs. Science	-.87	.15	-.42	-5.81	.000
	Business vs. Social Studies	-.52	.16	-.24	-3.36	.001
	Business vs. ELA	-.63	.15	-.30	-4.18	.000
2	(Constant)	4.75	.23		20.39	.000
	Business vs. Math	-.92	.16	-.42	-5.66	.000
	Business vs. Science	-.64	.16	-.31	-4.01	.000
	Business vs. Social Studies	-.29	.16	-.14	-1.78	.077
	Business vs. ELA	-.47	.15	-.23	-3.07	.002
	Barriers Score	-.41	.11	-.26	-3.69	.000
3	(Constant)	4.98	.24		20.67	.000
	Business vs. Math	-.93	.16	-.43	-5.84	.000
	Business vs. Science	-.63	.16	-.31	-4.07	.000
	Business vs. Social Studies	-.26	.16	-.12	-1.59	.114
	Business vs. ELA	-.42	.15	-.20	-2.80	.006
	Barriers Score	-.33	.11	-.21	-3.03	.003
	Anxiety Score	-.20	.07	-.19	-2.96	.003
4	(Constant)	4.34	.39		11.20	.000
	Business vs. Math	-.86	.16	-.39	-5.25	.000
	Business vs. Science	-.57	.16	-.28	-3.61	.000
	Business vs. Social Studies	-.23	.16	-.11	-1.47	.144
	Business vs. ELA	-.42	.14	-.20	-2.83	.005
	Barriers Score	-.33	.11	-.21	-2.98	.003
	Anxiety Score	-.15	.07	-.14	-2.10	.037
	Technology Available Total Score	.05	.03	.14	2.09	.038
5	(Constant)	4.12	.39		10.70	.000
	Business vs. Math	-.81	.16	-.37	-5.06	.000
	Business vs. Science	-.49	.16	-.24	-3.18	.002
	Business vs. Social Studies	-.10	.16	-.05	-.62	.534
	Business vs. ELA	-.36	.15	-.17	-2.41	.017
	Barriers Score	-.34	.11	-.22	-3.17	.002
	Anxiety Score	-.12	.07	-.11	-1.66	.099
	Technology Available Total Score	.05	.03	.13	1.89	.060
	Technology Training Source College Courses	.32	.10	.20	3.14	.002

To test the model overall, a minimum sample size of 50 + 8*k* (where *k* is the number of predictors) is necessary (Green, 1991). The sample size in this study is adequate whereas, N = 187 > 50 + 8(8) = 114. The regression analysis provided above is representative of the sample of the study. Adjusted R^2 was fairly close to the value of R^2 (.395 - .368 = .027), which means that if the model were derived from the population rather than a sample it would account for approximately 2.7 percent less variance in the outcome. Finally, the model was evaluated to determine if it may be generalized to the population.

To determine if the findings could be generalized to a wider population, underlying assumptions for regression were evaluated. Multicollinearity, independent errors, and normally distributed errors assumptions are explained next.

Multicollinearity exists when there is a strong correlation between two or more predictors in the regression model (Field, 2009). As collinearity increases, the standard errors of the *b* coefficients increases and it limits the size of *R*. Multicollinearity between predictors makes it difficult to assess the individual importance of a predictor. The variance inflation factor (VIF) computed by SPSS for each predictor variable was approximately 1.1. The tolerance statistic computed by SPSS for each predictor variable ranged between .6 and .9, which fell within acceptable limits. No perfect multicollinearity existed in the sample. The residuals in the model were random, normally distributed variables with a mean of 0. The residual statistics computed in SPSS confirm this assumption was met. The data were checked for independent errors. The Durbin-Watson test determines whether adjacent residuals are correlated. A value below 2.0 indicates a positive correlation between adjacent residuals. The size of the Durbin-Watson statistic depends on the number of predictors in the model and the number of observations (Field, 2009). The Durbin-Watson statistic reported in the regression model was .7, which indicates evidence for autocorrelation and may be cause for concern.

Summary of Results

The results of statistical tests for each of the eight research questions are reported in chapter four. Descriptions of technology adoption, anxiety, barriers, training sources, technology adoption are reported for the selected subject area teachers. Relationships between subject area and the study variables are reported. Business teachers were shown to have higher levels of technology adoption, lower levels of anxiety, and perceive lower levels of barriers than other subject area teachers. Business teachers were more likely to utilize self-teaching as a training source and had access to more technology for teaching than other subject area teachers. Teacher subject area, technology integration barriers, technology anxiety, technology available for teaching, and whether or not the teacher had taken a technology training college course were significant in predicting technology adoption.

Chapter 5

Discussion and Recommendations

This chapter reports and interprets the findings of this study, discusses various limitations of the study, outlines potential implications for the findings of the study, and presents recommendations for future research on technology adoption in teaching and learning.

Summary of Research Problem and Study Design

The research problem of this study was to explore possible factors related to teachers' adoption of technology in teaching and learning. The purpose for examining these relationships was to see if they might lead to recommendations for teacher preparation in the instructional use of technology. The ex post facto causal comparative research design examined relationships between teachers' technology adoption and age, gender, years of teaching experience, technology anxiety, perceived barriers to technology integration, technology available for use in teaching, training sources utilized, and the main predictor variable, subject area. The research questions that framed this study are as follows:

1. What are the selected demographic and personal characteristics of selected Minnesota secondary teachers?
2. To what extent have selected teachers adopted technology for teaching and learning practices?
3. Is there a relationship between teachers' levels of adoption of technology for teaching and learning practices and subject area?

4. Do differences exist in the classroom technologies available by teacher subject area?
5. Do differences exist in the technology integration barriers perceived by teachers by subject area?
6. Do differences exist in the technology anxiety perceived by teachers by subject area?
7. Do differences exist in the technology training sources used by teachers by subject area?
8. Do selected variables explain a significant portion of the variance in teachers' technology adoption? (Potential explanatory variables include age, subject area, years of teaching experience, technology anxiety, barriers to technology integration, technology training sources used, and the types of technology available for classroom use.)

Utilizing online survey methods, the Kotrlik-Redmann Technology Integration Survey (2002) was utilized to collect data from Minnesota secondary teachers within the areas of business, English language arts, math, science, and social studies. One hundred and forty five public secondary schools were identified through the Minnesota Department of Education 2011-12 Licensed Staff FTE by Subject data report to employ at least one .75 full-time equivalent in each of the aforementioned subject areas. An Internet search of each school's website identified teachers' names and email addresses for each subject area identified. The initial sample represented approximately 20 percent of Minnesota public high schools. One teacher from each subject area at each of the 145 schools was randomly selected for invitation to participate in the study. Teachers were invited via school email to participate in the study. Two reminder invitations were sent to non-responders approximately one week after each previous invitation. Of the 725 possible research participants, 187 completed surveys were submitted, a response rate of nearly 26 percent (N=187). The data collection period was May 2 – May 31, 2013.

Statistical analysis of the data, conducted via SPSS, included descriptive statistics, ANOVA and Gabriel's post hoc tests, Pearson's chi-square tests, and multiple regression techniques.

Studies reviewed found age may (Alexander, 2002; Waugh, 2004) or may not (Guo, Dobson & Petrina, 2008; Tondeur et al., 2008) be a factor in technology integration in teaching and learning practices. Teachers 40 years and older seemed to integrate technology into their practice less than younger teachers. However, no clear support for a digital divide between *digital natives* (those born after the inception of the Internet) and *digital immigrants* (those born before computer use was ubiquitous in work and life) was found. More recent studies have reported no significant associations between age and technology adoption. In addition, of the studies reviewed, gender was not shown to be a factor in technology adoption for teaching and learning.

Studies reviewed indicated that college courses, ongoing professional development, and help from colleagues were related to technology adoption for teaching and learning (Kotrlik & Redmann, 2009a). Technology knowledge and technology integration were found to be positively related (Anderson & Maninger, 2007; Smarkola, 2007). However a direct relationship between the two cannot be assumed (Gayton, 2008). Attitudes and teaching styles were also shown to be related to how technology was adopted by teachers (Anderson & Maninger, 2007; Smarkola, 2007). Constructivist teachers, with student-centered practices, adopted technology in more innovative, integrated ways than traditional teachers (Tondeur et al., 2008).

Rogers' (2003) diffusion of innovations theory served as the conceptual framework for the study. Diffusion theory may be useful in understanding which teachers choose to adopt technology in the teaching and learning process. Rogers (2003) explains diffusion as "the process by which (1) an *innovation* (2) is *communicated* through certain *channels* (3) over *time* (4) among members of a *social system*" (p. 11). The rate that new ideas spread is classified as level of innovativeness. "Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than the other members of a system" (Rogers, 2003, p. 22). To differentiate individuals' level of innovativeness within a system, Rogers identified five adopter categories: innovators-venturesome, early adopters-respect, early majority-deliberate, late majority-skeptical, and laggards-traditional. Technology integration in the teaching and learning process, the innovation, is an idea or practice that may be perceived as new by teachers. Teachers may adopt technology in teaching and learning processes for various reasons. Diffusion research has provided additional understanding of variables associated with various teachers' adoption of technology in their practice.

Major Findings

Findings suggest that technology adoption was significantly associated with the following predictor variables: technology available for teaching, barriers to technology integration, technology anxiety, and whether or not the teacher utilized college courses as a training source. Further, teachers' level of technology adoption differed by subject area. Business teachers were found to have the highest whereas math and science teachers were found to have the lowest levels of technology adoption for teaching and learning. Business teachers were most likely to fall within Rogers' *innovator/early adopter* category, while math and science teachers were most likely to fall within Rogers' *late adopter or laggard* categories.

Demographic information. The majority of teachers who participated in this study were born before 1980 (79%), making them *digital immigrants*. Slightly more than half of the secondary teachers were female; thus, slightly less than half of teachers were male. Most secondary teachers in the selected subject areas held a Master's degree and have been teaching for more than 14 years. This was similar to the Minnesota state average of 15 years of teaching experience (Minnesota Department of Education, n.d.).

***Technology adoption*.** The teachers in this study had adopted technology for teaching and learning. The mean technology adoption score for teachers was 3.41 out of a high of 5. The analysis of technology adoption revealed no significant main effects between age groups or between years of teaching experience groups. Findings revealed technology adoption levels differed significantly by subject area. Business teachers' adopted technology ($\bar{x} = 3.95 \pm .50$) at significantly higher levels than other subject area teachers, especially math (MD = 1.141) and science (MD = .872) teachers. Business teachers' technology adoption was most similar to, but still significantly different from social studies (MD = .523) and English language arts (MD = .632) teachers.

Technology available. Findings of the study revealed a positive relationship between technology available and technology adoption (r = .342, p < .001); as the technology available for teaching increased, teachers' level of technology adoption also increased. Further, relationships existed between subject area and the type of technologies teachers had available for their use in teaching, F (4, 182) = 5.095, p = .001. Business teachers ($\bar{x}$ = 9.84 ± 1.71) had significantly more technology available for their use than math (MD = 1.675) or science teachers (MD = 1.528).

Barriers. Teachers in this study reported low to moderate barriers to integrating technology in teaching and learning ($\bar{x}$ = 2.32 ± .516) on a scale from 1 to 4. The findings of this study revealed a negative relationship between barriers to technology integration and technology adoption, (r = -.418, p < .001), as barriers decreased, technology adoption increased. Further, findings revealed significant differences in technology integration barriers between selected subject area teachers: F (4, 182) = 13.874, p < .001. Business teachers ($\bar{x}$ = 2.32 ± .516) perceived significantly fewer barriers to technology integration than English language arts (MD = -.404), math (MD = -.535), social studies (MD = -.575), and science (MD = -.584) teachers.

Anxiety. The findings of this study revealed technology anxiety perceived by teachers was fairly low ($\bar{x}$ = 2.06 ± .75) on a scale from 1 to 5. No significant main effects were found for technology anxiety between subject area teachers. Technology anxiety was negatively correlated with technology adoption (r = -.272, p < .001); as technology anxiety increased the teachers' level of technology adoption decreased.

Technology training. Most teachers utilized a variety of training sources, such as self-teaching (95.2%), workshops/conferences (95.2%), and colleagues (85.6%), and completing college courses (57.8%). Relationships existed between teacher subject area and whether or not the teacher utilized the training sources self-teaching ($\chi^2(4) = 13.627$, $p = .009$) and college courses ($\chi^2(4) = 18.046$, $p = .001$). Business (100%) and science (100%) teachers were most likely and social studies (83.9%) were least likely to use self-teaching as a source for technology training. Business teachers (77.2%) were most likely and social studies (32.3%) were least likely to use college courses as a training source. Whether or not a teacher utilized college courses or self-teaching as a technology training source was significantly related to technology adoption. Teachers who utilized these training sources were more likely to have higher levels of technology adoption.

Explanation of variance in technology adoption. Multiple regression techniques revealed that subject area, technology integration barriers, technology anxiety, technology available for teaching, and whether or not the teacher utilized a college course as a training source were significant in predicting technology adoption for the teachers in this study. The regression found the teacher subject area of business vs. math ($t(179) = -5.06$, $p < .001$), business vs. science ($t(179) = -3.18$, $p = .002$), business vs. social studies ($t(179) = -.62$, $p = .534$), business vs. English language arts ($t(179) = -2.41$, $p = .017$), the barriers score ($t(179) = -3.17$, $p = .002$), anxiety ($t(179) = -1.66$, $p = .099$), technology available ($t(179) = 1.89$, $p = .060$), and college courses ($t(179) = 3.14$, $p = .002$) were significant predictors of technology adoption.

Discussion

Similar to the results of the Kotrlik and Redmann studies conducted with Louisiana teachers, Minnesota teachers adopted technology in teaching and learning at varying levels. Kotrlik and Redmann examined the technology adoption of teachers in various career and technical education (CTE) fields such as agricultural education, business, family and consumer science, marketing, and industrial technology education. This study extended the scope of teachers examined to include the subject areas of business as well as core content areas of English language arts, math, social studies, and science. Kotrlik and Redmann (2009a) found that business teachers in Louisiana adopted technology in teaching and learning at higher levels than other CTE teachers. The present study found that business teachers in Minnesota also adopted technology for teaching and learning at higher levels than the core content area teachers studied. (Note: marketing education is part of business education in Minnesota. The present study did not differentiate between business and marketing teachers since both are licensed as business teachers in Minnesota.) In addition to teacher subject area, barriers to technology integration, and technology availability for teaching were associated with the level of technology adoption. Discussion of the characteristics of teachers within varying levels of technology adoption, or innovation category, follows.

Adopter categories. Adopter categories are the classifications of members of a social system on the basis of innovativeness, the degree to which an individual is relatively earlier in adopting new ideas than other members in the system. The technology adoption score was used in this study to measure teachers' level of innovativeness. In *Diffusion of Innovations,* Rogers outlined dominant characteristics, or generalizations, of individuals within each of the five adopter categories (see pp. 268 – 276). Findings of the current study indicate teachers within the technology adoption categories share similar characteristics as other diffusion studies. Rogers (2003) explained the adopter categories as ideal types being "conceptualizations based on observations of reality that are designed to make comparisons possible" and "based on abstractions from empirical investigations" (p. 263). Dominant attributes of each category are: *innovators*-venturesome; *early adopters*-respect; *early majority*-deliberate; *late majority*-skeptical; and *laggards*-traditional.

Earlier adopters. Teachers that are relatively earlier in adopting technology than other teachers include participants in the innovator, early adopter, and early majority categories. Both *innovators and early adopters* are key individuals to bring new ideas to their local system, schools and classrooms. *Early adopter* and *innovator* categories were combined in this study because too few participants fell within the *innovator* category to conduct comparisons using statistical analysis techniques. Business teachers make up the vast majority (61%) of *innovator/early adopters*, followed by English language arts (16%), social studies (13%), and science (10%) teachers in this study. No math teachers were classified as *innotavator/early adopters.* This finding supported business education leaders' proclamation that business teachers have been leaders in the area of technology adoption (National Business Education Association, 2007). The e*arly majority* adopts new technologies before the average individual, but may deliberate for some time before completely adopting a new idea (Rogers, 2003). Business (47%) teachers made up the majority of participants in the *early majority* category, followed by social studies (19%), English language arts (14%), science (14%), and math (6%).

Technology adoption and curricular content knowledge seem to be overlapping knowledge required of business teachers. “Business teachers have been at the forefront of the computer revolution; nearly all business subjects at the secondary school level have some relationship to the use of the computer” (Anderson, 2008, p. 24). Technology is threaded throughout the national standards for business education, including eleven curricular areas with information technology being one of those eleven fundamental areas, because “it is the problem-solving and decision-making tool that supports every discipline” (National Business Education Association, 2007, p. xi). This suggested that if a teacher knows more about a technology, such as technology being a fundamental part of the content of a field, the teacher may be more able or willing to use technology in other ways, such as to support teaching. While knowledge of how to use information technology may not necessarily lead to the use of technology as a tool for teaching, without such in-depth knowledge, a teacher may be less likely to use technology to support their teaching. In addition, business teachers were found to have significantly greater access to technology for teaching and learning than other subject area teachers. This may imply that, because business teachers already have computing technology in their classrooms as the object of instruction, using such technology to also support teaching may have been easier. As such, it is not surprising that business educators were adopting technology at higher levels than other subject area teachers.

Later adopters. The *late majority* are even more skeptical than the *early majority* in their adoption of new ideas. They often adopt new ideas only after they receive pressure from others to do so. In the current study, teachers who fell into the *late majority* category were more unevenly divided among subject areas, led by math teachers (26% math, 23% English language arts, 21% science, 19% social studies, and 11% business). These teachers may likely have been influenced to integrate technology into their practice by school systems that endorse the National Educational Technology Standards (NETS), which stress technology integration in every subject area as the norm rather than a novelty. They were also likely to be influenced by uneven pressure from their peers. Colleagues and school-led staff development activities might have been helpful for these teachers' technology integration training needs. Finally, *laggards* are the last in the system to adopt an innovation. They must be certain that a new idea will not fail before they can adopt. *Laggards* often make decisions based on what was done previously and resist new ideas (Rogers, 2003). Math (33%) science (33%), and English language arts (20%) were more likely than social studies (10%) or business (3%) teachers to fall within the *laggards* category. School districts are required to put state standards into place so all students have access to high-quality content and instruction (Minnesota Department of Education, n.d.). Minnesota curricular standards ask for the integration of technology into every subject area. Although math and science are core curricular areas necessary to prepare all students for life and work in the 21st century, secondary teachers in these areas were not adopting technology at the same levels as other subject area teachers.

Teacher characteristics and adopter categories. Findings of this study indicated earlier adopters were not different from later adopters in age. Rogers (2003) reports in his meta-analysis of diffusion research that "there is inconsistent evidence about the relationship of age and innovativeness; about half of the some 228 studies on this subject show no relationship, a few show that earlier adopters are younger, and some indicate they are older" (p. 269). Findings of this study indicated that earlier adopters experienced less anxiety when thinking about and using technology and perceived fewer barriers than later adopters. This finding supports Rogers' (2003) adoption generalization that "earlier adopters are better able to cope with uncertainty and risk than later adopters" (p. 273). This study found that business teachers were more likely than other teachers to use college courses as a source of technology training and business teachers also adopted technology at higher levels than other subject area teachers. This may support Rogers' (2003) adoption generalization that "earlier adopters have higher aspirations for formal education than later adopters" (p. 273) and "seek information about innovations more actively than other adopters" (p. 274). However, this is not a surprising finding since business teachers have been required to take computer technology courses as part of their licensure preparation.

The regression findings indicated that teachers' subject area had the greatest impact on the variance of technology adoption in this study. Teacher subject area was also found to be associated with barriers, technology availability, and training sources. Business teachers were found to have the highest level of technology adoption, experienced the lowest level of barriers to technology integration, and had the most technology available for their use in teaching and learning. That math and science (technical discipline) teachers had less access to technology, and experienced moderate barriers of scheduling enough time for students to use technology in the teaching and learning process was surprising. Recent education reform efforts have pushed STEM (science, technology, engineering, and math) across the curriculum. With technology so intricately linked to math and science, one would expect that these teachers would embrace technology and be the leaders in integrating technology in teaching and learning practices. However, the U.S. government has acknowledged the need and developed a strategic plan to revamp math and science and make these subjects more engaging for students (National Science and Technology Council, 2013). The federal government has recently provided support for STEM education through the "development of instructional materials and learning resources such as videos and computer simulations, and platforms for building and delivering interactive online courses and learning objects" (p. 4). These recently created computer technology resources may influence teachers' future perception of barriers and technologies available.

Implications of Findings

Based on the results of this study, the following should be considered when developing technology integration policies and learning opportunities for teachers:

1. Leaders of professional development programs must understand who the change agent is in the system. Business teachers may hold this role within the system for certain, but not all, subject area teachers.

2. Initial teacher preparation programs should include technology training in order to have an impact on technology adoption.
3. Teachers need sufficient access to classroom technologies for student use in order to adopt technology in teaching and learning.

Change agents. Results of this study found that business teachers have been earlier adopters of technology than other subject area teachers. Schools hoping to increase technology integration in all subject areas could seek out business teachers to lead staff development or operate as technology integration coaches. Over 95 percent of teachers indicated that they utilized workshops or conferences as a technology training source. Structured technology training activities offered by schools, led by knowledgeable teachers would be helpful to meet other teachers' technology integration training needs. Nearly 86 percent of all teachers indicated that they utilized colleagues as a training source. This indicates that technology integration coaches may be well received by the majority of teachers in meeting their technology integration training needs. Most English language arts and social studies teachers fall within the *early majority* and *late majority* adopter categories. These teachers may be likely to see business teachers as change agents and could be open to learning new technology integrated teaching methods from them. All English language arts teachers (100%) in the study indicated that they utilized colleagues and nearly all social studies teachers (97%) utilized workshops or conferences as training sources. School sponsored workshops or district supported professional development opportunities led by knowledgeable technology integrators could help meet the technology training needs of these teachers.

Math and science teachers have been more likely to be later adopters of technology than other subject area teachers. However, both groups of teachers were users of self-learning and conferences/workshops. Schools hoping to increase technology integration into math and science classrooms should offer content-specific professional development, stressing the subject area academic standards (see the Minnesota Department of Education K-12 Academic Standards in Math (2007) and Science (2009)). Schools should identify technology integration leaders within the subject areas of math and science to act as change agents. As STEM reform efforts move through schools, it is anticipated that math and science teachers will be the focus of attention to learn how to integrate technology into their teaching and learning practices.

The Minnesota Department of Education added a teacher licensure renewal requirement, effective June 30, 2012, in which applicants must include professional development activities that integrate technology effectively with student learning to increase engagement and student achievement. This requirement will likely have a positive impact on teachers' use of technology for teaching and learning in the years to come. Initial teacher preparation should also stress effective technology integration in all teaching methods courses.

Initial teacher preparation. Whether or not a teacher completed a college course for technology training was associated with teachers' level of technology adoption. Teachers who utilized college courses as a source of technology training had higher levels of technology adoption. Business teachers were most likely to utilize a college course for technology training. This is likely due to the fact that computer technology courses focused on business applications are required for graduation from Minnesota business teacher licensure programs. Initial teacher preparation institutions may consider content-specific technology courses as well as integrating technology in every teaching methods course for all licensure areas. Teacher preparation faculty should adapt their teaching practices and consistently model technology integrated methods in the preparation of new teachers. In order to do that, college faculty must have the support of their educational institutions to change their practices. Support should be provided in the areas of time, technology, and training.

Student access to technology. Business teachers (98.2%) were most likely while math (63.3%) and science (71.4%) teachers were least likely to have access to enough computers for students to work by themselves or with one other student. In addition, the availability of technology for the number of students in teachers' classes and scheduling enough time for students to use the Internet, computers, or other technology in the teaching/learning process were barrier items that differed significantly by subject area. Business teachers perceived significantly lower barriers than other subject area teachers. Schools need to provide access to technology for all subject area teachers so that they may integrate technology into their teaching and learning practices.

The graphic calculator, a technology tool used throughout secondary mathematics courses, was not specified as a stand-alone technology in the classroom technologies checklist. If this item had been added to the checklist, the technology availability total scores in the study may have differed. However, this is not the only technology tool necessary to fulfill the math standards in geometry and measurement, data analysis and problem solving (Minnesota Department of Education, 2009). If math teachers are to fully implement the state curricular standards, they will need additional access to student computers. All teachers need sufficient access to computers with Internet access for student use in order to integrate digital technologies in teaching and learning. Teachers perceptions of barriers are likely to change as schools adopt bring your own device (BYOD) policies (Johnson et al., 2011), implement laptop immersion programs (Grimes & Warschauer, 2008), and increase wireless Internet access throughout schools (Smith, 2010).

Recommendations

This study compared teacher technology adoption to technology anxiety, barriers to integration, technology available, and technology training sources utilized by subject area. The subject area of the teacher had the greatest impact on the variance of technology adoption scores. Results of the study indicate business teachers had higher levels of technology adoption, less anxiety when using or thinking about using technology, perceived lower barriers to integrating technology in teaching and learning practices, had more technology available for teaching, and utilized conferences, workshops, and self-teaching training sources more often than other teachers. Results of this study revealed some suggestions for future research as follows:

First, additional research examining the intersections of content knowledge and technological knowledge would be useful for understanding why and how different subject area teachers adopt technology in their practice. Minnesota standards in English language arts, math, science, and social studies indicate technology is integrated throughout the curriculum. Business education is unique in the fact that technology is not only integrated throughout the curriculum, but is also one of the eleven discipline areas within business education. This is likely a factor which contributed to business teachers' higher level of technology adoption for teaching and learning. However, additional research examining the intersections of teachers' subject area and technological knowledge is necessary. This need is particularly acute in the math and science content areas; these are technical content fields that were using technology to support teaching at significantly lower levels than might be expected. Mishra and Koehler (2009, 2007, & 2006) have developed a framework of teacher knowledge in three overlapping domains of content, technology, and pedagogy. Research comparing these three domains of teacher knowledge for business and the technical disciplines of math and science could help teacher preparation institutions and professional development providers meet the differentiated technology integration training needs of various teachers.

Second, research examining why technology availability differs by subject area is needed. This study found differences in technology available for teaching and learning by subject area. The survey did not include a large variety of non-computer based digital technologies which may be specific to the technical disciplines of math and science. Research of technology-integrated lesson plans in each of the subject areas, including but not limited to math and science, would further understanding about which technologies are being adopted by various teachers.

Third, a follow-up qualitative study might bring additional insight to teachers' experiences with technology adoption and the barriers they perceive that could not be determined through predetermined scales and multiple-choice answers. This study found differences in barriers to technology integration by subject area. Interviews of teachers, school administrators, technology integrators, and technology directors about classroom technology could provide additional understanding about why these differences exist. Furthermore, research which compares the barriers and affordances to teacher technology adoption by subject area in schools with bring your own device (BYOD) policies could likely hold classroom technologies available constant, enabling further examination of other variables. Other variables to be examined include technology funding, school supported professional development opportunities, school technology plans, and teaching styles.

Fourth, a trend study conducted at two-year intervals would be helpful in understanding changes in technology adoption over time. Digital technologies available for educational purposes are changing quickly. Educational applications available online at no or low cost are increasing at rapid rates. Teachers' perceptions of barriers, technologies they have available to them for teaching, and how they utilize various technologies are likely to change quickly as wireless technologies improve and access to multi-use mobile digital devices become more prevalent (Duggan & Smith, 2013; Smith, 2010).

Fifth, additional research examining students' technology literacy and how teachers approach students' readiness to engage in technology-infused instruction is needed. The National Assessment of Educational Progress (NAEP) Technology and Engineering Literacy Assessment may be helpful in understanding what U.S. students know and can do with technology. Like math, reading, science, geography, civics, economics, foreign languages, and the arts; the U.S. Department of Education Institute of Education Sciences has developed an assessment for technology and engineering literacy to be piloted in 2014. An examination of how various teachers use the future Technology and Engineering Literacy Assessment data in preparation of their lesson plans could add to the understanding of why teachers integrate technology into their teaching and learning practices differently. Additional understanding of students' level of technological knowledge could help inform educators of the technology instruction needed to prepare their students to engage in content-related technology-infused learning activities.

Finally, additional research on the impact of teachers' technology adoption on student achievement is needed. Technology integration is professed to be necessary to prepare all students to operate in a digital world. Educational theorists concerned about the digital divide (Collins & Halvorson, 2009; Mehra, Merkel, & Bishop, 2004; Tapscott, 2009; Warschauer, Knobel, & Stone, 2004) have professed that all teachers must be prepared to effectively teach their students in the digital world by integrating technology throughout the curriculum. Additional research is needed to understand how various technologies are implemented throughout the curriculum and whether or not those technologies and teaching methods have an impact on student achievement, specific to the curricular area.

Limitations of the Study

The findings of this study provided full or partial support for the hypothesis of this research. There were limitations in this study that should be considered in interpreting its results.

First, external validity, or generalizability, of the study should be considered. The sample of the study included 187 teachers of business, English language arts, math, science, and social studies from selected Minnesota secondary schools. The possible sample included in this study represented 145 schools. Schools that did not employ a full-time business teacher during the 2011-2012 school year were excluded from this study. Minnesota has 699 public high schools; teachers from less than 21 percent of the schools were invited to participate in the study. The results of the study may not be representative of all teachers in Minnesota secondary schools. Schools that do not employ business teachers may allocate technology integration resources (i.e. classroom technology and professional development opportunities) differently for other subject area teachers.

Second, this study of teachers' technology adoption utilized an online survey. Participants were contacted via email only. No schools without websites or teacher email addresses were found during the participant selection process. However, study participation may have been limited to those teachers that had easy and reliable access to the Internet and felt comfortable utilizing a computer to complete a survey.

Third, a limitation of conducting survey research is the inability to explore more fully why teachers gave the responses they chose. Predetermined scales and multiple choice answers might not adequately reflect teachers' experiences with technology adoption.

Fourth, the survey instrument might have been a limitation. While it had good validity and reliability support, the *Technology Use in the Teaching-Learning Process* scale focused largely on computing technology and may have missed other types of discrete discipline-specific technology, such as those only useful in math or science.

Finally, it is important to emphasize that the data from this study were gathered at one point of time and analyzed based on the research purposes. Data were collected for this study May 2013. Further, digital technologies available for educational purposes are changing quickly. Educational applications available online at no or low cost are increasing at rapid rates. Discipline-specific applications may differ significantly in cost or availability, which couldn't be accounted for in this study.

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Appendices

Appendix A

The Kotrlik/Redmann Technology Integration Model

THE KOTRLIK/REDMANN TECHNOLOGY INTEGRATION MODEL©

Technology for teaching and learning is defined as "employing the Internet, computers, CDROMs, interactive media, satellites, teleconferencing, and other technological means to support, enhance, inspire and create learning. The four phases of the Kotrlik/Redmann Technology Integration Model include:

1) **Exploration - Thinking About Using Technology**. Teachers seek to learn about technology and how to use it.

2) **Experimentation - Beginning to Use Technology**. Physical changes start to occur in classrooms and laboratories. Instructors focus more on using technology in instruction by presenting information using presentation software and doing a few instructional exercises using spreadsheets, databases, word processors, games, simulations, the Internet, and/or other technology tools.

3) **Adoption - Using Technology Regularly**. Physical changes are very evident in the classroom and/or laboratory with technology becoming a focal point in the classroom and/ or laboratory organization. Instructors employ presentation software and technology-based instructional exercises using games, simulations, spreadsheets, databases, word processors, the Internet or other technology tools as a regular and normal feature of instructional activities. Student-shared responsibility for learning emerges as a major instructional theme.

4) **Advanced Integration - Using Technology Innovatively**. Instructors pursue innovative ways to use technology to improve learning. Students take on new challenges beyond traditional assignments and activities. Learners use technology to collaborate with others from various disciplines to gather and analyze information for student learning projects. The integration of technology into the teaching/learning process leads to a higher level of learning.

Appendix B

Survey Instrument

Technology Use in the Teaching-Learning Process (*KRTIS©2005)*

This survey is designed to determine how you use technology in the teaching/learning process. Three terms used in the survey are defined as follows:

1. ***Teaching/Learning Process*** **-** Implementation of instructional activities that are designed to result in student learning.
2. ***Technology*** - High-tech media utilized in instruction, such as computers (e-mail, Internet, listservs, CD-ROMs, software, laser disc players, interactive CDs, etc.) and digital imaging (digital cameras, scanners, digital camcorders, etc.).
3. ***Technology Integration*** **-** Employing technology to support, enhance, inspire, and create learning.

This is not a test. There are no incorrect answers. Your answers will be kept confidential. **By completing and submitting this survey, you are agreeing to participate in this study.**

Technology Use in Teaching/Learning

Please select the response that indicates how much each statement describes you and your efforts to integrate technology in the teaching/learning process.	**Not like me**	**Very little like me**	**Some like me**	**Very much like me**	**Just like me**
1. I discuss with students how they can use technology as a learning tool.	1	2	3	4	5
2. I have made physical changes to accommodate technology in my classroom or laboratory.	1	2	3	4	5
3. I emphasize the use of technology as a learning tool in my classroom or laboratory.	1	2	3	4	5
4. I assign students to use the computer to do content related activities on a regular basis.	1	2	3	4	5
5. I use technology based games or simulations on a regular basis in my classroom or laboratory.	1	2	3	4	5
6. I use technology to encourage students to share the responsibility for their own learning.	1	2	3	4	5
7. I expect my students to use technology to enable them to be self-directed learners.	1	2	3	4	5
8. I expect my students to use technology so they can take on new challenges beyond traditional assignments and activities.	1	2	3	4	5
9. I regularly pursue innovative ways to incorporate technology into the learning process for my students.	1	2	3	4	5
10. I expect my students to fully understand the unique role that technology plays in their education.	1	2	3	4	5
11. I design learning activities that result in my students being comfortable using technology in their learning.	1	2	3	4	5
12. I expect students to use technology to such an extent that they develop projects that are of a higher quality level than would be possible without them using technology.	1	2	3	4	5
13. I am more of a facilitator of learning than the source of all information because my students use technology.	1	2	3	4	5

Survey instrument continued on next page

Technology Use in Teaching/Learning (continued)

Please select the response that indicates how much each statement describes you and your efforts to integrate technology in the teaching/learning process.	**Not like me**	**Very little like me**	**Some like me**	**Very much like me**	**Just like me**
14. I incorporate technology in my teaching to such an extent that it has become a standard learning tool for my students.	1	2	3	4	5
15. I incorporate technology in my teaching to such an extent that my students use technology to collaborate with other students in my class during the learning process.	1	2	3	4	5
16. I often require my students to use e-mail to complete their assignments.	1	2	3	4	5
17. I encourage students to design their own technology-based learning activities.	1	2	3	4	5
18. I incorporate technology in my teaching to such an extent that my students use technology to collaborate with individuals or at other locations (other classes, other schools, others states or countries, etc.).	1	2	3	4	5
19. I incorporate technology in my teaching to such an extent that my students use technology to collaborate with individuals in other disciplines.	1	2	3	4	5

Barriers to the Integration of Technology in the Teaching/Learning Process

Select the response that best represents the magnitude of each barrier below that may prevent you from integrating technology into the teaching/learning process.	**Not a barrier**	**Minor barrier**	**Moderate barrier**	**Major barrier**
1. Enough time to develop lessons that use technology.	1	2	3	4
2. Scheduling enough time for students to use the Internet, computers, or other technology in the teaching/learning process.	1	2	3	4
3. Availability of technology for the number of students in my classes.	1	2	3	4
4. Availability of technical support to effectively use instructional technology in the teaching/learning process.	1	2	3	4
5. Administrative support for integration of technology in the teaching/learning process.	1	2	3	4
6. My ability to integrate technology in the teaching/learning process.	1	2	3	4
7. My students' ability to use technology in the teaching/learning process.	1	2	3	4
8. Type of courses I teach.				
9. Availability of effective instructional software for the courses I teach.	1	2	3	4

Survey Instrument continued on next page

Technology Anxiety

Select the response that best represents your level of technology anxiety for each statement.	**No anxiety**	**Some anxiety**	**Moderate anxiety**	**High anxiety**	**Very High anxiety**
1. How anxious do you feel when you think about using technology in instruction?	1	2	3	4	5
2. How anxious do you feel when you are not certain what the options on various technology will do?	1	2	3	4	5
3. How anxious do you feel when you are faced with using new technology?	1	2	3	4	5
4. How anxious do you feel when you think about your technology skills compared to the skills of other teachers?	1	2	3	4	5
5. How anxious do you feel when someone uses a technology term that you do not understand?	1	2	3	4	5
6. How anxious do you feel when you try to learn technology related skills?	1	2	3	4	5
7. How anxious do you feel when you try to understand new technology?	1	2	3	4	5
8. How anxious do you feel when you try to use technology?	1	2	3	4	5
9. How anxious do you feel when you fear you may break or damage the technology you are using?	1	2	3	4	5
10. How anxious do you feel when you avoid using unfamiliar technology?	1	2	3	4	5
11. How anxious do you feel when you cannot keep up with important technological advances?	1	2	3	4	5
12. How anxious do you feel when you hesitate to use technology for fear of making mistakes you cannot correct?	1	2	3	4	5

Other Information. Please provide the information requested by selecting the choice that best describes you.

1. Subject Area You Teach
   1 Business
   2 English/Language Arts
   3 Math
   4 Science
   5 Social Studies

2. Your gender
   1 male
   2 female

3. Your age (in years)
   1 21 - 33
   2 34 - 46
   3 47 - 59
   4 60 +

Survey Instrument continued on next page

4. Your level of education
   1 Bachelor Degree
   2 Master Degree
   3 Doctoral Degree

5. Your years of teaching experience
   1 1 - 3
   2 4 - 8
   3 9 - 13
   4 14 +

6. Your years of other work experience
   1 0 - 1
   2 2 - 5
   3 6 - 9
   4 10 +

7. Sources of Technology Training You Have Used. (Select all that apply.)
   1 Self-taught
   2 Workshops/Conferences
   3 College courses
   4 Colleagues

8. Types of Technology Available for Use in Teaching in Your Current Position. (Select all that apply.)
   1 Students have a school e-mail account
   2 Interactive white board (e.g. SmartBoard)
   3 LCD or other projection display screen
   4 DVD or BlueRay Player
   5 Digital video camera
   6 Digital photo camera
   7 Tablet computer (e.g. iPad)
   8 Smartphone/Mobile Handheld Device (e.g. iPhone)
   9 GPS (Global Positioning System)
   10 Teacher has computer with Internet connection at home
   11 Teacher has computer with Internet connection at school
   12 Teacher has access to enough computers in a classroom or lab for all students to work by themselves or with one other student
   13 Check this response if most of the computers listed in item above have Internet access

Appendix C

Informed Consent

[Today's Date]

Dear [Teacher]:

As a public school teacher, I would like to invite you to participate in a study entitled "The Relationship Between Teacher Content Area and Technology Integration in Minnesota Secondary Schools." The purpose of this study is to identify factors affecting various teachers' efforts to integrate technology into their practice. To participate in this study you should currently be teaching in a school in Minnesota.

If you are willing to participate in this voluntary study, you will be asked to complete an online survey, which should take approximately 20 minutes to complete. This research will be anonymous, and the survey results will be reported in an aggregate manner. Participation in this study is voluntary and you may choose to withdraw at any time.

The potential benefits to you and others in our field will come from the synthesized information that will be shared with all interested participants. Your responses will help provide a greater understanding of technology integration affordances and barriers. The results of this study may inform educational administrators of how to best support technology integration efforts of individuals and groups of teachers.

To encourage participation in the study a drawing for one of three $25 Visa gift cards is offered. Chances of receiving a gift card will depend on the number of participants completing the survey. You will be asked at the end of the survey if you would like to participate in the random drawing.

If you have any questions, concerns, or complaints about this study please contact Jennifer Cherry by e-mail at cherry@umn.edu. Additionally, if you have questions about your rights as a participant in this study, or have any complaints, concerns or issues you want to discuss with someone outside the research, call 612-626-5654 or email irb@umn.edu. IRB Study Number 1304E31564.

I appreciate your time and would like to thank you in advance for your consideration in participating in this study. By clicking the link to go directly to the survey, you are hereby granting your informed consent to take part in this research.

https://survey.cehd.umn.edu/Survey.aspx?s=f9f9f23c1dcc44f89b4aa5f73dcbb6f2

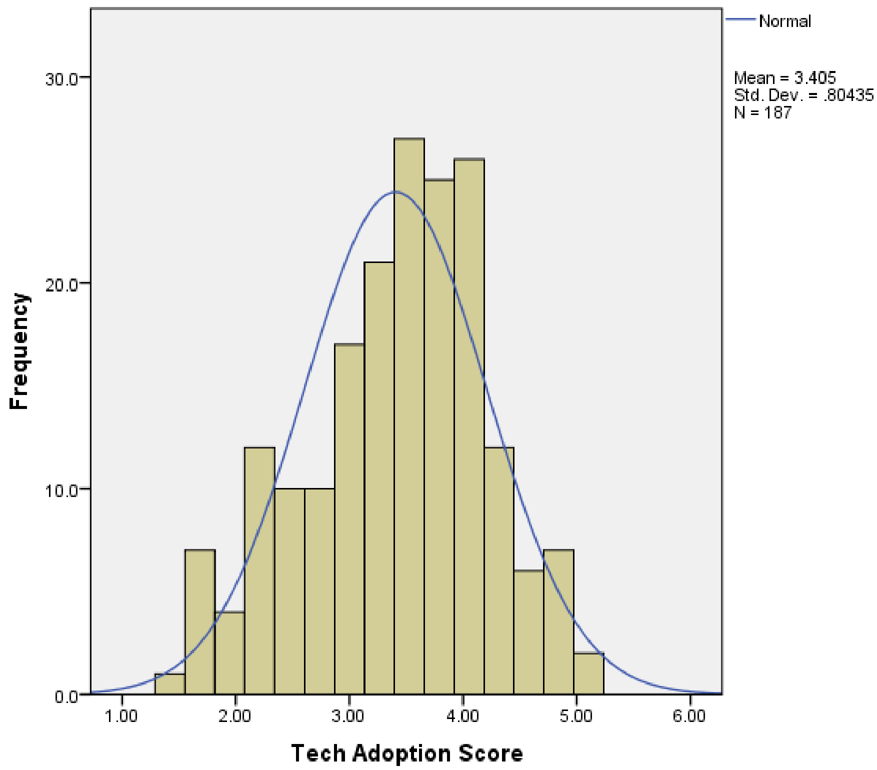
Sincerely,

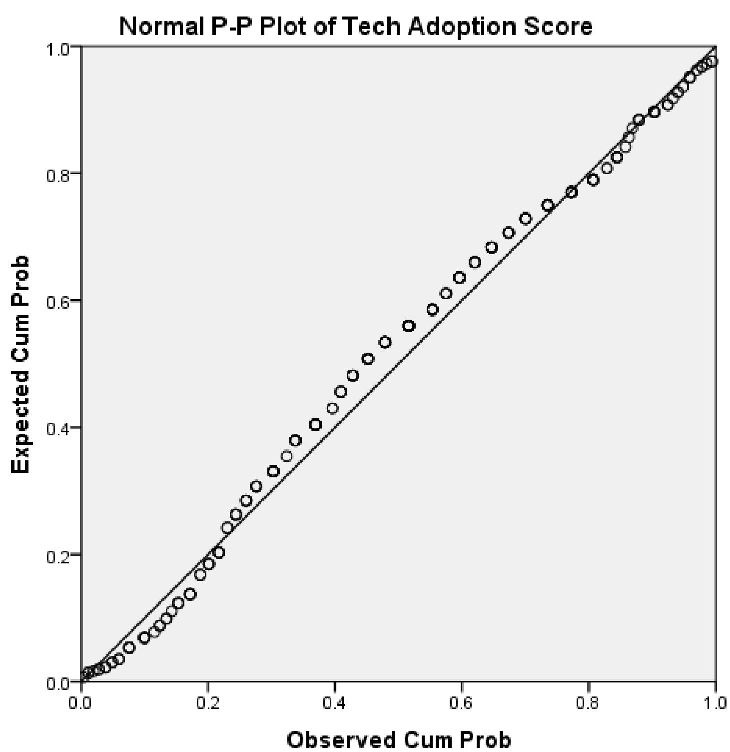
Jennifer Cherry, PhD Candidate
Organizational Leadership Policy and Development
University of Minnesota

Appendix D

Histogram and P-P Plot of Technology Adoption Scores

Histogram


Normal
Mean = 3.405
Std. Dev. = .80435
N = 187
Frequency
30.0
20.0
10.0
0.0
1.00
2.00
3.00
4.00
5.00
6.00
Tech Adoption Score


Normal P-P Plot of Tech Adoption Score
Expected Cum Prob
1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0
Observed Cum Prob

Appendix E

ANOVA (Gabriel): Comparison of Technology Use Scale by Subject Area

ANOVA: Technology Use in Teaching/Learning Scale Items by Subject Area

Technology Use Item "like me"	Sum of Squares	df	Mean Square	*F*-Value	*p*-Value
I assign students to use the computer to do content related activities on a regular basis	105.332	4	26.333	25.915	.000
I use technology based games or simulations on a regular basis in my classroom or laboratory	69.460	4	17.365	12.786	.000
I expect my students to use technology so they can take on new challenges beyond traditional assignments and activities	46.371	4	11.593	12.504	.000
I expect students to use technology to such an extent that they develop projects that are of a higher quality level than would be possible without them using technology	53.528	4	13.382	11.806	.000
I often require my students to use e-mail to complete their assignments	73.257	4	18.314	11.401	.000
I am more of a facilitator of learning than the source of all information because my students use technology	42.867	4	10.717	10.060	.000
I incorporate technology in my teaching to such an extent that it has become a standard learning tool for my students	45.431	4	11.358	9.999	.000
I emphasize the use of technology as a learning tool in my classroom or laboratory	34.714	4	8.679	9.995	.000
I expect my students to use technology to enable them to be self-directed learners	35.249	4	8.812	9.860	.000
I incorporate technology in my teaching to such an extent that my students use technology to collaborate with other students in my class during the learning process	43.773	4	10.943	8.183	.000
I use technology to encourage students to share the responsibility for their own learning	31.747	4	7.937	8.175	.000
I design learning activities that result in my students being comfortable using technology in their learning	30.718	4	7.680	7.505	.000
I encourage students to design their own technology-based learning activities	28.572	4	7.143	6.107	.000
I discuss with students how they can use technology as a learning tool	19.964	4	4.991	5.818	.000
I regularly pursue innovative ways to incorporate technology into the learning process for my students	21.815	4	5.454	5.202	.001
I have made physical changes to accommodate technology in my classroom or laboratory	22.617	4	5.654	5.082	.001
I incorporate technology in my teaching to such an extent that my students use technology to collaborate with individuals in other disciplines	25.400	4	6.350	5.057	.001
I expect my students to fully understand the unique role that technology plays in their education	15.335	4	3.834	4.026	.004
I incorporate technology in my teaching to such an extent that my students use technology to collaborate with individuals at other locations (other classes, other schools, other states or countries, etc.)	17.250	4	4.313	3.676	.007

ANOVA (Gabriel): Comparison of Technology Adoption Scale Items by Subject Area

Technology Adoption Item	Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	Sig.
I discuss with students how they can use technology as a learning tool	Business	ELA	.580	.201	.039
		Math	.637	.209	.023
		Science	.861*	.199	.000
		Social Studies	.629	.207	.024
	ELA	Business	-.580	.201	.039
		Math	.057	.232	1.000
		Science	.281	.223	.901
		Social Studies	.049	.230	1.000
	Math	Business	-.637	.209	.023
		ELA	-.057	.232	1.000
		Science	.224	.230	.981
		Social Studies	-.008	.237	1.000
	Science	Business	-.861*	.199	.000
		ELA	-.281	.223	.901
		Math	-.224	.230	.981
		Social Studies	-.231	.228	.975
	Social Studies	Business	-.629	.207	.024
		ELA	-.049	.230	1.000
		Math	.008	.237	1.000
		Science	.231	.228	.975
I have made physical changes to accommodate technology in my classroom or laboratory	Business	ELA	.692	.229	.026
		Math	.635	.238	.072
		Science	.740	.227	.012
		Social Studies	.885*	.235	.002
	ELA	Business	-.692	.229	.026
		Math	-.057	.264	1.000
		Science	.048	.254	1.000
		Social Studies	.193	.262	.998
	Math	Business	-.635	.238	.072
		ELA	.057	.264	1.000
		Science	.105	.262	1.000
		Social Studies	.249	.270	.987
	Science	Business	-.740	.227	.012
		ELA	-.048	.254	1.000
		Math	-.105	.262	1.000
		Social Studies	.145	.260	1.000
	Social Studies	Business	-.885*	.235	.002
		ELA	-.193	.262	.998
		Math	-.249	.270	.987
		Science	-.145	.260	1.000

Table continued

Technology Adoption Item	Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	Sig.
I emphasize the use of technology as a learning tool in my classroom or laboratory	Business	ELA	.755*	.202	.002
		Math	1.033*	.210	.000
		Science	1.038*	.200	.000
		Social Studies	.796*	.208	.002
	ELA	Business	-.755*	.202	.002
		Math	.278	.233	.927
		Science	.283	.224	.900
		Social Studies	.041	.231	1.000
	Math	Business	-1.033*	.210	.000
		ELA	-.278	.233	.927
		Science	.005	.232	1.000
		Social Studies	-.238	.239	.978
	Science	Business	-1.038*	.200	.000
		ELA	-.283	.224	.900
		Math	-.005	.232	1.000
		Social Studies	-.242	.230	.967
	Social Studies	Business	-.796*	.208	.002
		ELA	-.041	.231	1.000
		Math	.238	.239	.978
		Science	.242	.230	.967
I assign students to use the computer to do content related activities on a regular basis	Business	ELA	.607	.218	.054
		Math	2.121*	.227	.000
		Science	1.469*	.216	.000
		Social Studies	.754	.225	.008
	ELA	Business	-.607	.218	.054
		Math	1.514*	.253	.000
		Science	.861	.243	.005
		Social Studies	.147	.250	1.000
	Math	Business	-2.121*	.227	.000
		ELA	-1.514*	.253	.000
		Science	-.652	.251	.095
		Social Studies	-1.367*	.258	.000
	Science	Business	-1.469*	.216	.000
		ELA	-.861	.243	.005
		Math	.652	.251	.095
		Social Studies	-.714	.249	.044
	Social Studies	Business	-.754	.225	.008
		ELA	-.147	.250	1.000
		Math	1.367*	.258	.000
		Science	.714	.249	.044

Table continued

Technology Adoption Item	Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	Sig.
I use technology based games or simulations on a regular basis in my classroom or laboratory	Business	ELA	1.631*	.253	.000
		Math	1.307*	.263	.000
		Science	.521	.250	.313
		Social Studies	.710	.260	.061
	ELA	Business	-1.631*	.253	.000
		Math	-.324	.292	.954
		Science	-1.109*	.281	.001
		Social Studies	-.920	.289	.017
	Math	Business	-1.307*	.263	.000
		ELA	.324	.292	.954
		Science	-.786	.290	.071
		Social Studies	-.597	.298	.378
	Science	Business	-.521	.250	.313
		ELA	1.109*	.281	.001
		Math	.786	.290	.071
		Social Studies	.189	.287	.999
	Social Studies	Business	-.710	.260	.061
		ELA	.920	.289	.017
		Math	.597	.298	.378
		Science	-.189	.287	.999
I use technology to encourage students to share the responsibility for their own learning	Business	ELA	.539	.214	.110
		Math	1.100*	.222	.000
		Science	.933*	.212	.000
		Social Studies	.430	.220	.393
	ELA	Business	-.539	.214	.110
		Math	.561	.247	.215
		Science	.394	.237	.639
		Social Studies	-.109	.245	1.000
	Math	Business	-1.100*	.222	.000
		ELA	-.561	.247	.215
		Science	-.167	.245	.999
		Social Studies	-.670	.252	.083
	Science	Business	-.933*	.212	.000
		ELA	-.394	.237	.639
		Math	.167	.245	.999
		Social Studies	-.503	.243	.330
	Social Studies	Business	-.430	.220	.393
		ELA	.109	.245	1.000
		Math	.670	.252	.083
		Science	.503	.243	.330

Table continued

Technology Adoption Item	Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	Sig.
I expect my students to use technology to enable them to be self-directed learners	Business	ELA	.438	.205	.278
		Math	1.260*	.213	.000
		Science	.812*	.203	.001
		Social Studies	.430	.211	.338
	ELA	Business	-.438	.205	.278
		Math	.822	.237	.006
		Science	.374	.228	.654
		Social Studies	-.009	.235	1.000
	Math	Business	-1.260*	.213	.000
		ELA	-.822	.237	.006
		Science	-.448	.235	.448
		Social Studies	-.830	.242	.007
	Science	Business	-.812*	.203	.001
		ELA	-.374	.228	.654
		Math	.448	.235	.448
		Social Studies	-.382	.233	.655
	Social Studies	Business	-.430	.211	.338
		ELA	.009	.235	1.000
		Math	.830	.242	.007
		Science	.382	.233	.655
I expect my students to use technology so they can take on new challenges beyond traditional assignments and activities	Business	ELA	.480	.209	.193
		Math	1.433*	.217	.000
		Science	.933*	.207	.000
		Social Studies	.430	.215	.361
	ELA	Business	-.480	.209	.193
		Math	.953*	.241	.001
		Science	.453	.232	.411
		Social Studies	-.050	.239	1.000
	Math	Business	-1.433*	.217	.000
		ELA	-.953*	.241	.001
		Science	-.500	.240	.319
		Social Studies	-1.003*	.247	.001
	Science	Business	-.933*	.207	.000
		ELA	-.453	.232	.411
		Math	.500	.240	.319
		Social Studies	-.503	.237	.299
	Social Studies	Business	-.430	.215	.361
		ELA	.050	.239	1.000
		Math	1.003*	.247	.001
		Science	.503	.237	.299

Table continued

Technology Adoption Item	Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	Sig.
I regularly pursue innovative ways to incorporate technology into the learning process for my students	Business	ELA	.816	.222	.003
		Math	.828	.231	.004
		Science	.657	.220	.029
		Social Studies	.551	.229	.146
	ELA	Business	-.816	.222	.003
		Math	.012	.256	1.000
		Science	-.160	.247	.999
		Social Studies	-.266	.254	.969
	Math	Business	-.828	.231	.004
		ELA	-.012	.256	1.000
		Science	-.171	.255	.999
		Social Studies	-.277	.262	.966
	Science	Business	-.657	.220	.029
		ELA	.160	.247	.999
		Math	.171	.255	.999
		Social Studies	-.106	.253	1.000
	Social Studies	Business	-.551	.229	.146
		ELA	.266	.254	.969
		Math	.277	.262	.966
		Science	.106	.253	1.000
I expect my students to fully understand the unique role that technology plays in their education	Business	ELA	.506	.211	.154
		Math	.647	.220	.032
		Science	.690	.210	.011
		Social Studies	.593	.218	.063
	ELA	Business	-.506	.211	.154
		Math	.141	.244	1.000
		Science	.184	.235	.996
		Social Studies	.086	.242	1.000
	Math	Business	-.647	.220	.032
		ELA	-.141	.244	1.000
		Science	.043	.243	1.000
		Social Studies	-.055	.250	1.000
	Science	Business	-.690	.210	.011
		ELA	-.184	.235	.996
		Math	-.043	.243	1.000
		Social Studies	-.098	.241	1.000
	Social Studies	Business	-.593	.218	.063
		ELA	-.086	.242	1.000
		Math	.055	.250	1.000
		Science	.098	.241	1.000

Table continued

Technology Adoption Item	Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	Sig.
I design learning activities that result in my students being comfortable using technology in their learning	Business	ELA	.626	.219	.043
		Math	1.009*	.228	.000
		Science	.937*	.217	.000
		Social Studies	.799	.226	.004
	ELA	Business	-.626	.219	.043
		Math	.382	.253	.754
		Science	.311	.244	.893
		Social Studies	.173	.251	.999
	Math	Business	-1.009*	.228	.000
		ELA	-.382	.253	.754
		Science	-.071	.252	1.000
		Social Studies	-.210	.259	.995
	Science	Business	-.937*	.217	.000
		ELA	-.311	.244	.893
		Math	.071	.252	1.000
		Social Studies	-.138	.249	1.000
	Social Studies	Business	-.799	.226	.004
		ELA	-.173	.251	.999
		Math	.210	.259	.995
		Science	.138	.249	1.000
I expect students to use technology to such an extent that they develop projects that are of a higher quality level than would be possible without them using technology	Business	ELA	.674	.231	.036
		Math	1.505*	.240	.000
		Science	1.039*	.229	.000
		Social Studies	.374	.238	.693
	ELA	Business	-.674	.231	.036
		Math	.831	.267	.021
		Science	.365	.256	.812
		Social Studies	-.300	.264	.947
	Math	Business	-1.505*	.240	.000
		ELA	-.831	.267	.021
		Science	-.467	.265	.558
		Social Studies	-1.131*	.273	.001
	Science	Business	-1.039*	.229	.000
		ELA	-.365	.256	.812
		Math	.467	.265	.558
		Social Studies	-.665	.263	.115
	Social Studies	Business	-.374	.238	.693
		ELA	.300	.264	.947
		Math	1.131*	.273	.001
		Science	.665	.263	.115

Table continued

Technology Adoption Item	Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	Sig.
I am more of a facilitator of learning than the source of all information because my students use technology	Business	ELA	.588	.224	.084
		Math	1.388*	.233	.000
		Science	.916*	.222	.000
		Social Studies	.507	.230	.239
	ELA	Business	-.588	.224	.084
		Math	.800	.259	.022
		Science	.329	.249	.871
		Social Studies	-.081	.256	1.000
	Math	Business	-1.388*	.233	.000
		ELA	-.800	.259	.022
		Science	-.471	.257	.499
		Social Studies	-.881	.264	.010
	Science	Business	-.916*	.222	.000
		ELA	-.329	.249	.871
		Math	.471	.257	.499
		Social Studies	-.409	.255	.680
	Social Studies	Business	-.507	.230	.239
		ELA	.081	.256	1.000
		Math	.881	.264	.010
		Science	.409	.255	.680
I incorporate technology in my teaching to such an extent that it has become a standard learning tool for my students	Business	ELA	.868*	.231	.002
		Math	.923*	.240	.001
		Science	1.342*	.229	.000
		Social Studies	.843	.238	.004
	ELA	Business	-.868*	.231	.002
		Math	.055	.267	1.000
		Science	.474	.257	.492
		Social Studies	-.025	.265	1.000
	Math	Business	-.923*	.240	.001
		ELA	-.055	.267	1.000
		Science	.419	.265	.701
		Social Studies	-.080	.273	1.000
	Science	Business	-1.342*	.229	.000
		ELA	-.474	.257	.492
		Math	-.419	.265	.701
		Social Studies	-.499	.263	.453
	Social Studies	Business	-.843	.238	.004
		ELA	.025	.265	1.000
		Math	.080	.273	1.000
		Science	.499	.263	.453

Table continued

Technology Adoption Item	Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	Sig.
I incorporate technology in my teaching to such an extent that my students use technology to collaborate with other students in my class during the learning process	Business	ELA	.766	.251	.023
		Math	1.270*	.261	.000
		Science	.965*	.248	.001
		Social Studies	.221	.258	.992
	ELA	Business	-.766*	.251	.023
		Math	.504	.290	.576
		Science	.199	.278	.998
		Social Studies	-.546	.287	.451
	Math	Business	-1.270*	.261	.000
		ELA	-.504	.290	.576
		Science	-.305	.288	.966
		Social Studies	-1.049	.296	.005
	Science	Business	-.965*	.248	.001
		ELA	-.199	.278	.998
		Math	.305	.288	.966
		Social Studies	-.745	.285	.093
	Social Studies	Business	-.221	.258	.992
		ELA	.546	.287	.451
		Math	1.049	.296	.005
		Science	.745	.285	.093
I often require my students to use e-mail to complete their assignments	Business	ELA	.580	.275	.293
		Math	1.749*	.286	.000
		Science	1.287*	.272	.000
		Social Studies	.671	.283	.160
	ELA	Business	-.580	.275	.293
		Math	1.169	.317	.003
		Science	.707	.305	.195
		Social Studies	.090	.315	1.000
	Math	Business	-1.749*	.286	.000
		ELA	-1.169	.317	.003
		Science	-.462	.315	.784
		Social Studies	-1.078	.325	.011
	Science	Business	-1.287*	.272	.000
		ELA	-.707	.305	.195
		Math	.462	.315	.784
		Social Studies	-.617	.313	.397
	Social Studies	Business	-.671	.283	.160
		ELA	-.090	.315	1.000
		Math	1.078	.325	.011
		Science	.617	.313	.397

Table continued

Technology Adoption Item	Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	Sig.
I encourage students to design their own technology-based learning activities	Business	ELA	.284	.234	.917
		Math	1.154*	.244	.000
		Science	.640	.232	.059
		Social Studies	.400	.241	.629
	ELA	Business	-.284	.234	.917
		Math	.871	.271	.015
		Science	.356	.260	.845
		Social Studies	.116	.269	1.000
	Math	Business	-1.154*	.244	.000
		ELA	-.871	.271	.015
		Science	-.514	.269	.441
		Social Studies	-.755	.277	.068
	Science	Business	-.640	.232	.059
		ELA	-.356	.260	.845
		Math	.514	.269	.441
		Social Studies	-.241	.267	.989
	Social Studies	Business	-.400	.241	.629
		ELA	-.116	.269	1.000
		Math	.755	.277	.068
		Science	.241	.267	.989
I incorporate technology in my teaching to such an extent that my students use technology to collaborate with individuals at other locations (other classes, other schools, other states or countries, etc.)	Business	ELA	.217	.235	.986
		Math	.791	.244	.012
		Science	.301	.233	.880
		Social Studies	-.165	.242	.999
	ELA	Business	-.217	.235	.986
		Math	.575	.271	.300
		Science	.084	.261	1.000
		Social Studies	-.381	.269	.815
	Math	Business	-.791	.244	.012
		ELA	-.575	.271	.300
		Science	-.490	.269	.512
		Social Studies	-.956	.277	.007
	Science	Business	-.301	.233	.880
		ELA	-.084	.261	1.000
		Math	.490	.269	.512
		Social Studies	-.465	.267	.574
	Social Studies	Business	.165	.242	.999
		ELA	.381	.269	.815
		Math	.956	.277	.007
		Science	.465	.267	.574

Table continued

Technology Adoption Item	Subject Area	Compared to: Subject Area	Mean Difference	Std. Error	Sig.
I incorporate technology in my teaching to such an extent that my students use technology to collaborate with individuals in other disciplines	Business	ELA	.544	.243	.221
		Math	1.056*	.253	.000
		Science	.656	.241	.064
		Social Studies	.263	.250	.965
	ELA	Business	-.544	.243	.221
		Math	.512	.281	.509
		Science	.112	.270	1.000
		Social Studies	-.282	.278	.975
	Math	Business	-1.056*	.253	.000
		ELA	-.512	.281	.509
		Science	-.400	.279	.804
		Social Studies	-.794	.287	.061
	Science	Business	-.656	.241	.064
		ELA	-.112	.270	1.000
		Math	.400	.279	.804
		Social Studies	-.394	.276	.811
	Social Studies	Business	-.263	.250	.965
		ELA	.282	.278	.975
		Math	.794	.287	.061
		Science	.394	.276	.811

*. The mean difference is significant at the .0026 level.
Dependent variable: Technology Use Scale Item

Appendix F

Chi Square Table for Teacher Subject Area and Rogers' Adopter Category

Subject Area		Adopter Categorization on the Basis of Innovativeness: Innovator	Early Adopter	Early Majority	Late Majority	Laggard	Total
Social Studies	Count	0	4	12	12	3	31
	Expected Count	.8	4.3	10.6	10.3	5.0	
	% within Subject Area	0.0%	12.9%	38.7%	38.7%	9.7%	100.0%
	% within Adopter Categorization	0.0%	15.4%	18.8%	19.4%	10.0%	
	% of Total	0.0%	2.1%	6.4%	6.4%	1.6%	16.6%
Science	Count	0	3	9	13	10	35
	Expected Count	.9	4.9	12.0	11.6	5.6	
	% within Subject Area	0.0%	8.6%	25.7%	37.1%	28.6%	100.0%
	% within Adopter Categorization	0.0%	11.5%	14.1%	21.0%	33.3%	
	% of Total	0.0%	1.6%	4.8%	7.0%	5.3%	18.7%
Math	Count	0	0	4	16	10	30
	Expected Count	.8	4.2	10.3	9.9	4.8	
	% within Subject Area	0.0%	0.0%	13.3%	53.3%	33.3%	100.0%
	% within Adopter Categorization	0.0%	0.0%	6.3%	25.8%	33.3%	
	% of Total	0.0%	0.0%	2.1%	8.6%	5.3%	16.0%
ELA	Count	3	2	9	14	6	34
	Expected Count	.9	4.7	11.6	11.3	5.5	
	% within Subject Area	8.8%	5.9%	26.5%	41.2%	17.6%	100.0%
	% within Adopter Categorization	60.0%	7.7%	14.1%	22.6%	20.0%	
	% of Total	1.6%	1.1%	4.8%	7.5%	3.2%	18.2%
Business	Count	2	17	30	7	1	57
	Expected Count	1.5	7.9	19.5	18.9	9.1	
	% within Subject Area	3.5%	29.8%	52.6%	12.3%	1.8%	100.0%
	% within Adopter Categorization	40.0%	65.4%	46.9%	11.3%	3.3%	
	% of Total	1.1%	9.1%	16.0%	3.7%	0.5%	30.5%
Total	Count	5	26	64	62	30	187
	% within Subject Area	2.7%	13.9%	34.2%	33.2%	16.0%	100.0%

Appendix G

Chi Square Tables for Classroom Technologies and Teacher Subject Area

Cross Tabulation of Subject Area by Students Have a School E-mail Account

Subject area		Students have a school e-mail account No	Students have a school e-mail account Yes	Total
Business	Count	8	49	57
	Expected Count	10.7	46.3	
	% within Subject area	14.0%	86.0%	100.0%
	% within Students have a school e-mail account	22.9%	32.2%	
	% of Total	4.3%	26.2%	30.5%
	Std. Residual	-.8	.4	
ELA	Count	7	27	34
	Expected Count	6.4	27.6	
	% within Subject area	20.6%	79.4%	100.0%
	% within Students have a school e-mail account	20.0%	17.8%	
	% of Total	3.7%	14.4%	18.2%
	Std. Residual	.3	-.1	
Math	Count	5	25	30
	Expected Count	5.6	24.4	
	% within Subject area	16.7%	83.3%	100.0%
	% within Students have a school e-mail account	14.3%	16.4%	
	% of Total	2.7%	13.4%	16.0%
	Std. Residual	-.3	.1	
Science	Count	10	25	35
	Expected Count	6.6	28.4	
	% within Subject area	28.6%	71.4%	100.0%
	% within Students have a school e-mail account	28.6%	16.4%	
	% of Total	5.3%	13.4%	18.7%
	Std. Residual	1.3	-.6	
Social Studies	Count	5	26	31
	Expected Count	5.8	25.2	
	% within Subject area	16.1%	83.9%	100.0%
	% within Students have a school e-mail account	14.3%	17.1%	
	% of Total	2.7%	13.9%	16.6%
	Std. Residual	-.3	.2	
Total	Count	35	152	187
	% within Subject area	18.7%	81.3%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.353[a]	4	.501
N of Valid Cases	187		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.61.

Cross Tabulation of Subject Area by Interactive White Board (e.g. SmartBoard)

Subject Area		Interactive White Board		
		No	Yes	Total
Business	Count	14	43	57
	Expected Count	15.9	41.1	
	% within Subject area	24.6%	75.4%	100.0%
	% within Interactive white board	26.9%	31.9%	
	% of Total	7.5%	23.0%	30.5%
	Std. Residual	-.5	.3	
ELA	Count	10	24	34
	Expected Count	9.5	24.5	
	% within Subject area	29.4%	70.6%	100.0%
	% within Interactive white board	19.2%	17.8%	
	% of Total	5.3%	12.8%	18.2%
	Std. Residual	.2	-.1	
Math	Count	8	22	30
	Expected Count	8.3	21.7	
	% within Subject area	26.7%	73.3%	100.0%
	% within Interactive white board	15.4%	16.3%	
	% of Total	4.3%	11.8%	16.0%
	Std. Residual	-.1	.1	
Science	Count	11	24	35
	Expected Count	9.7	25.3	
	% within Subject area	31.4%	68.6%	100.0%
	% within Interactive white board	21.2%	17.8%	
	% of Total	5.9%	12.8%	18.7%
	Std. Residual	.4	-.3	
Social Studies	Count	9	22	31
	Expected Count	8.6	22.4	
	% within Subject area	29.0%	71.0%	100.0%
	% within Interactive white board	17.3%	16.3%	
	% of Total	4.8%	11.8%	16.6%
	Std. Residual	.1	-.1	
Total	Count	52	135	187
	% within Subject area	27.8%	72.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.614[a]	4	.961
N of Valid Cases	187		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 8.34.

Cross Tabulation of Subject Area by LCD or Other Projection Display Screen

Subject Area		LCD or Other Projection Display Screen No	Yes	Total
Business	Count	5	52	57
	Expected Count	6.7	50.3	57.0
	% within Subject area	8.8%	91.2%	100.0%
	% within LCD or other projection display screen	22.7%	31.5%	
	% of Total	2.7%	27.8%	30.5%
	Std. Residual	-.7	.2	
ELA	Count	5	29	34
	Expected Count	4.0	30.0	34.0
	% within Subject area	14.7%	85.3%	100.0%
	% within LCD or other projection display screen	22.7%	17.6%	18.2%
	% of Total	2.7%	15.5%	18.2%
	Std. Residual	.5	-.2	
Math	Count	4	26	30
	Expected Count	3.5	26.5	30.0
	% within Subject area	13.3%	86.7%	100.0%
	% within LCD or other projection display screen	18.2%	15.8%	
	% of Total	2.1%	13.9%	16.0%
	Std. Residual	.3	-.1	
Science	Count	3	32	35
	Expected Count	4.1	30.9	35.0
	% within Subject area	8.6%	91.4%	100.0%
	% within LCD or other projection display screen	13.6%	19.4%	
	% of Total	1.6%	17.1%	18.7%
	Std. Residual	-.6	.2	
Social Studies	Count	5	26	31
	Expected Count	3.6	27.4	31.0
	% within Subject area	16.1%	83.9%	100.0%
	% within LCD or other projection display screen	22.7%	15.8%	
	% of Total	2.7%	13.9%	16.6%
	Std. Residual	.7	-.3	
Total	Count	22	165	187
	% within Subject area	11.8%	88.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.759[a]	4	.780
N of Valid Cases	187		

a. 4 cells (40.0%) have expected count less than 5. The minimum expected count is 3.53.

Cross Tabulation of Subject Area by DVD or BlueRay Player

Subject area		DVD or BlueRay Player		
		No	Yes	Total
Business	Count	10	47	57
	Expected Count	8.5	48.5	57.0
	% within Subject area	17.5%	82.5%	100.0%
	% within DVD or BlueRay Player	35.7%	29.6%	
	% of Total	5.3%	25.1%	30.5%
	Std. Residual	.5	-.2	
ELA	Count	2	32	34
	Expected Count	5.1	28.9	34.0
	% within Subject area	5.9%	94.1%	100.0%
	% within DVD or BlueRay Player	7.1%	20.1%	
	% of Total	1.1%	17.1%	18.2%
	Std. Residual	-1.4	.6	
Math	Count	11	19	30
	Expected Count	4.5	25.5	30.0
	% within Subject area	36.7%	63.3%	100.0%
	% within DVD or BlueRay Player	39.3%	11.9%	
	% of Total	5.9%	10.2%	16.0%
	Std. Residual	3.1	-1.3	
Science	Count	3	32	35
	Expected Count	5.2	29.8	35.0
	% within Subject area	8.6%	91.4%	100.0%
	% within DVD or BlueRay Player	10.7%	20.1%	
	% of Total	1.6%	17.1%	18.7%
	Std. Residual	-1.0	.4	
Social Studies	Count	2	29	31
	Expected Count	4.6	26.4	31.0
	% within Subject area	6.5%	93.5%	100.0%
	% within DVD or BlueRay Player	7.1%	18.2%	16.6%
	% of Total	1.1%	15.5%	16.6%
	Std. Residual	-1.2	.5	
Total	Count	28	159	187
	% within Subject area	15.0%	85.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.487[a]	4	.002
N of Valid Cases	187		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 4.49.

Cross Tabulation of Subject Area by Digital Video Camera

Subject Area		Digital Video Camera No	Digital Video Camera Yes	Total
Business	Count	21	36	57
	Expected Count	25.6	31.4	57.0
	% within Subject area	36.8%	63.2%	100.0%
	% within Digital video camera	25.0%	35.0%	
	% of Total	11.2%	19.3%	30.5%
	Std. Residual	-.9	.8	
ELA	Count	10	24	34
	Expected Count	15.3	18.7	34.0
	% within Subject area	29.4%	70.6%	100.0%
	% within Digital video camera	11.9%	23.3%	
	% of Total	5.3%	12.8%	18.2%
	Std. Residual	-1.3	1.2	
Math	Count	18	12	30
	Expected Count	13.5	16.5	30.0
	% within Subject area	60.0%	40.0%	100.0%
	% within Digital video camera	21.4%	11.7%	
	% of Total	9.6%	6.4%	16.0%
	Std. Residual	1.2	-1.1	
Science	Count	19	16	35
	Expected Count	15.7	19.3	35.0
	% within Subject area	54.3%	45.7%	100.0%
	% within Digital video camera	22.6%	15.5%	
	% of Total	10.2%	8.6%	18.7%
	Std. Residual	.8	-.7	
Social Studies	Count	16	15	31
	Expected Count	13.9	17.1	31.0
	% within Subject area	51.6%	48.4%	100.0%
	% within Digital video camera	19.0%	14.6%	
	% of Total	8.6%	8.0%	16.6%
	Std. Residual	.6	-.5	
Total	Count	84	103	187
	% within Subject area	44.9%	55.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.368[a]	4	.053
N of Valid Cases	187		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 13.48.

Cross Tabulation of Subject Area by Digital Photo Camera

Subject Area		Digital Photo Camera No	Digital Photo Camera Yes	Total
Business	Count	15	42	57
	Expected Count	23.5	33.5	57.0
	% within Subject area	26.3%	73.7%	100.0%
	% within Digital photo camera	19.5%	38.2%	
	% of Total	8.0%	22.5%	30.5%
	Std. Residual	-1.7	1.5	
ELA	Count	13	21	34
	Expected Count	14.0	20.0	34.0
	% within Subject area	38.2%	61.8%	100.0%
	% within Digital photo camera	16.9%	19.1%	
	% of Total	7.0%	11.2%	18.2%
	Std. Residual	-.3	.2	
Math	Count	20	10	30
	Expected Count	12.4	17.6	30.0
	% within Subject area	66.7%	33.3%	100.0%
	% within Digital photo camera	26.0%	9.1%	
	% of Total	10.7%	5.3%	16.0%
	Std. Residual	2.2	-1.8	
Science	Count	14	21	35
	Expected Count	14.4	20.6	35.0
	% within Subject area	40.0%	60.0%	100.0%
	% within Digital photo camera	18.2%	19.1%	
	% of Total	7.5%	11.2%	18.7%
	Std. Residual	-.1	.1	
Social Studies	Count	15	16	31
	Expected Count	12.8	18.2	31.0
	% within Subject area	48.4%	51.6%	100.0%
	% within Digital photo camera	19.5%	14.5%	
	% of Total	8.0%	8.6%	16.6%
	Std. Residual	.6	-.5	
Total	Count	77	110	187
	% within Subject area	41.2%	58.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.051[a]	4	.007
N of Valid Cases	187		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.35.

Cross Tabulation of Subject Area by Tablet Computer (e.g. iPad)

		Tablet Computer		
Subject Area		No	Yes	Total
Business	Count	19	38	57
	Expected Count	24.1	32.9	57.0
	% within Subject area	33.3%	66.7%	100.0%
	% within Tablet computer	24.1%	35.2%	
	% of Total	10.2%	20.3%	30.5%
	Std. Residual	-1.0	.9	
ELA	Count	14	20	34
	Expected Count	14.4	19.6	34.0
	% within Subject area	41.2%	58.8%	100.0%
	% within Tablet computer	17.7%	18.5%	
	% of Total	7.5%	10.7%	18.2%
	Std. Residual	-.1	.1	
Math	Count	12	18	30
	Expected Count	12.7	17.3	30.0
	% within Subject area	40.0%	60.0%	100.0%
	% within Tablet computer	15.2%	16.7%	
	% of Total	6.4%	9.6%	16.0%
	Std. Residual	-.2	.2	
Science	Count	22	13	35
	Expected Count	14.8	20.2	35.0
	% within Subject area	62.9%	37.1%	100.0%
	% within Tablet computer	27.8%	12.0%	
	% of Total	11.8%	7.0%	18.7%
	Std. Residual	1.9	-1.6	
Social Studies	Count	12	19	31
	Expected Count	13.1	17.9	31.0
	% within Subject area	38.7%	61.3%	100.0%
	% within Tablet computer	15.2%	17.6%	
	% of Total	6.4%	10.2%	16.6%
	Std. Residual	-.3	.3	
Total	Count	79	108	187
	% within Subject area	42.2%	57.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.187[a]	4	.085
N of Valid Cases	187		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 12.67.

Cross tabulation of Subject Area by GPS (Global Positioning System)

Subject Area		GPS No	GPS Yes	Total
Business	Count	49	8	57
	Expected Count	50.3	6.7	57.0
	% within Subject area	86.0%	14.0%	100.0%
	% within GPS	29.7%	36.4%	
	% of Total	26.2%	4.3%	30.5%
	Std. Residual	-.2	.5	
ELA	Count	31	3	34
	Expected Count	30.0	4.0	34.0
	% within Subject area	91.2%	8.8%	100.0%
	% within GPS	18.8%	13.6%	
	% of Total	16.6%	1.6%	18.2%
	Std. Residual	.2	-.5	
Math	Count	27	3	30
	Expected Count	26.5	3.5	30.0
	% within Subject area	90.0%	10.0%	100.0%
	% within GPS	16.4%	13.6%	
	% of Total	14.4%	1.6%	16.0%
	Std. Residual	.1	-.3	
Science	Count	32	3	35
	Expected Count	30.9	4.1	35.0
	% within Subject area	91.4%	8.6%	100.0%
	% within GPS	19.4%	13.6%	
	% of Total	17.1%	1.6%	18.7%
	Std. Residual	.2	-.6	
Social Studies	Count	26	5	31
	Expected Count	27.4	3.6	31.0
	% within Subject area	83.9%	16.1%	100.0%
	% within GPS	15.8%	22.7%	
	% of Total	13.9%	2.7%	16.6%
	Std. Residual	-.3	.7	
Total	Count	165	22	187
	% within Subject area	88.2%	11.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.569[a]	4	.814
N of Valid Cases	187		

a. 4 cells (40.0%) have expected count less than 5. The minimum expected count is 3.53.

Cross Tabulation of Subject Area * Teacher Has Computer with Internet Connection at Home

Subject Area		Teacher Has Computer with Internet Connection at Home: No	Yes	Total
Business	Count	0	57	57
	Expected Count	2.7	54.3	57.0
	% within Subject area	0.0%	100.0%	100.0%
	% within Teacher has computer with Internet connection at home	0.0%	32.0%	
	% of Total	0.0%	30.5%	30.5%
	Std. Residual	-1.7	.4	
ELA	Count	1	33	34
	Expected Count	1.6	32.4	34.0
	% within Subject area	2.9%	97.1%	100.0%
	% within Teacher has computer with Internet connection at home	11.1%	18.5%	
	% of Total	0.5%	17.6%	18.2%
	Std. Residual	-.5	.1	
Math	Count	2	28	30
	Expected Count	1.4	28.6	30.0
	% within Subject area	6.7%	93.3%	100.0%
	% within Teacher has computer with Internet connection at home	22.2%	15.7%	
	% of Total	1.1%	15.0%	16.0%
	Std. Residual	.5	-.1	
Science	Count	3	32	35
	Expected Count	1.7	33.3	35.0
	% within Subject area	8.6%	91.4%	100.0%
	% within Teacher has computer with Internet connection at home	33.3%	18.0%	
	% of Total	1.6%	17.1%	18.7%
	Std. Residual	1.0	-.2	
Social Studies	Count	3	28	31
	Expected Count	1.5	29.5	31.0
	% within Subject area	9.7%	90.3%	100.0%
	% within Teacher has computer with Internet connection at home	33.3%	15.7%	
	% of Total	1.6%	15.0%	16.6%
	Std. Residual	1.2	-.3	
Total	Count	9	178	187
	% within Subject area	4.8%	95.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.048[a]	4	.196
N of Valid Cases	187		

a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is 1.44.

Cross Tabulation of Subject Area by Smartphone/Mobile Handheld Device (e.g. iPhone)

Subject Area		Smartphone/Mobile Handheld Device No	Yes	Total
Business	Count	34	23	57
	Expected Count	36.6	20.4	57.0
	% within Subject area	59.6%	40.4%	100.0%
	% within Smartphone/Mobile Handheld Device	28.3%	34.3%	
	% of Total	18.2%	12.3%	30.5%
	Std. Residual	-.4	.6	
ELA	Count	22	12	34
	Expected Count	21.8	12.2	34.0
	% within Subject area	64.7%	35.3%	100.0%
	% within Smartphone/Mobile Handheld Device	18.3%	17.9%	
	% of Total	11.8%	6.4%	18.2%
	Std. Residual	.0	-.1	
Math	Count	18	12	30
	Expected Count	19.3	10.7	30.0
	% within Subject area	60.0%	40.0%	100.0%
	% within Smartphone/Mobile Handheld Device	15.0%	17.9%	
	% of Total	9.6%	6.4%	16.0%
	Std. Residual	-.3	.4	
Science	Count	27	8	35
	Expected Count	22.5	12.5	35.0
	% within Subject area	77.1%	22.9%	100.0%
	% within Smartphone/Mobile Handheld Device	22.5%	11.9%	
	% of Total	14.4%	4.3%	18.7%
	Std. Residual	1.0	-1.3	
Social Studies	Count	19	12	31
	Expected Count	19.9	11.1	31.0
	% within Subject area	61.3%	38.7%	100.0%
	% within Smartphone/Mobile Handheld Device	15.8%	17.9%	
	% of Total	10.2%	6.4%	16.6%
	Std. Residual	-.2	.3	
Total	Count	120	67	187
	% within Subject area	64.2%	35.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.412[a]	4	.491
N of Valid Cases	187		

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 10.75.

Cross Tabulation of Subject Area by Teacher has Computer with Internet Connection at School

Subject Area		Teacher has Computer with Internet Connection at School: No	Yes	Total
Business	Count	0	57	57
	Expected Count	.9	56.1	57.0
	% within Subject area	0.0%	100.0%	100.0%
	% within Teacher has computer with Internet connection at school	0.0%	31.0%	
	% of Total	0.0%	30.5%	30.5%
	Std. Residual	-1.0	.1	
ELA	Count	0	34	34
	Expected Count	.5	33.5	34.0
	% within Subject area	0.0%	100.0%	100.0%
	% within Teacher has computer with Internet connection at school	0.0%	18.5%	
	% of Total	0.0%	18.2%	18.2%
	Std. Residual	-.7	.1	
Math	Count	1	29	30
	Expected Count	.5	29.5	30.0
	% within Subject area	3.3%	96.7%	100.0%
	% within Teacher has computer with Internet connection at school	33.3%	15.8%	
	% of Total	0.5%	15.5%	16.0%
	Std. Residual	.7	-.1	
Science	Count	1	34	35
	Expected Count	.6	34.4	35.0
	% within Subject area	2.9%	97.1%	100.0%
	% within Teacher has computer with Internet connection at school	33.3%	18.5%	
	% of Total	0.5%	18.2%	18.7%
	Std. Residual	.6	-.1	
Social Studies	Count	1	30	31
	Expected Count	.5	30.5	31.0
	% within Subject area	3.2%	96.8%	100.0%
	% within Teacher has computer with Internet connection at school	33.3%	16.3%	
	% of Total	0.5%	16.0%	16.6%
	Std. Residual	.7	-.1	
Total	Count	3	184	187
	% within Subject area	1.6%	98.4%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.916[a]	4	.572
N of Valid Cases	187		

a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is .48.

Cross Tabulation of Subject Area by Teacher Has Access to Enough Computers in a Classroom or Lab for All Students to Work by Themselves or With One Other Student

Subject Area		Teacher Has Access to Enough Computers No	Yes	Total
Business	Count	1	56	57
	Expected Count	9.1	47.9	57.0
	% within Subject area	1.8%	98.2%	100.0%
	% within Teacher has access to enough computers	3.3%	35.7%	
	% of Total	0.5%	29.9%	30.5%
	Std. Residual	-2.7	1.2	
ELA	Count	3	31	34
	Expected Count	5.5	28.5	34.0
	% within Subject area	8.8%	91.2%	100.0%
	% within Teacher has access to enough computers	10.0%	19.7%	
	% of Total	1.6%	16.6%	18.2%
	Std. Residual	-1.1	.5	
Math	Count	11	19	30
	Expected Count	4.8	25.2	30.0
	% within Subject area	36.7%	63.3%	100.0%
	% within Teacher has access to enough computers	36.7%	12.1%	
	% of Total	5.9%	10.2%	16.0%
	Std. Residual	2.8	-1.2	
Science	Count	10	25	35
	Expected Count	5.6	29.4	35.0
	% within Subject area	28.6%	71.4%	100.0%
	% within Teacher has access to enough computers	33.3%	15.9%	
	% of Total	5.3%	13.4%	18.7%
	Std. Residual	1.9	-.8	
Social Studies	Count	5	26	31
	Expected Count	5.0	26.0	31.0
	% within Subject area	16.1%	83.9%	100.0%
	% within Teacher has access to enough computers	16.7%	16.6%	
	% of Total	2.7%	13.9%	16.6%
	Std. Residual	.0	.0	
Total	Count	30	157	187
	% within Subject area	16.0%	84.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	23.508[a]	4	.000
N of Valid Cases	187		

a. 2 cells (20.0%) have expected count less than 5. The minimum expected count is 4.81.

Cross Tabulation of Subject Area by Most of the Student Computers Have Internet Access

Subject Area		Most of the Student Computers Have Internet Access No	Yes	Total
Business	Count	1	56	57
	Expected Count	7.9	49.1	57.0
	% within Subject area	1.8%	98.2%	100.0%
	% within Most of the student computers have Internet access	3.8%	34.8%	
	% of Total	0.5%	29.9%	30.5%
	Std. Residual	-2.5	1.0	
ELA	Count	3	31	34
	Expected Count	4.7	29.3	34.0
	% within Subject area	8.8%	91.2%	100.0%
	% within Most of the student computers have Internet access	11.5%	19.3%	
	% of Total	1.6%	16.6%	18.2%
	Std. Residual	-.8	.3	
Math	Count	8	22	30
	Expected Count	4.2	25.8	30.0
	% within Subject area	26.7%	73.3%	100.0%
	% within Most of the student computers have Internet access	30.8%	13.7%	
	% of Total	4.3%	11.8%	16.0%
	Std. Residual	1.9	-.8	
Science	Count	9	26	35
	Expected Count	4.9	30.1	35.0
	% within Subject area	25.7%	74.3%	100.0%
	% within Most of the student computers have Internet access	34.6%	16.1%	
	% of Total	4.8%	13.9%	18.7%
	Std. Residual	1.9	-.8	
Social Studies	Count	5	26	31
	Expected Count	4.3	26.7	31.0
	% within Subject area	16.1%	83.9%	100.0%
	% within Most of the student computers have Internet access	19.2%	16.1%	
	% of Total	2.7%	13.9%	16.6%
	Std. Residual	.3	-.1	
Total	Count	26	161	187
	% within Subject area	13.9%	86.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.051[a]	4	.003
N of Valid Cases	187		

a. 4 cells (40.0%) have expected count less than 5. The minimum expected count is 4.17.

Appendix H

Technology Anxiety Scale Item by Teacher Subject Area

The Mean, Standard Deviation, Welch's F, and p-Values of Technology Anxiety Item by Subject Area Teachers

Technology Anxiety Statement How anxious do you feel when:		N	Mean	Std. Deviation	*F*-Value	*p*-Value
You cannot keep up with important technological advances?	Business	57	2.54	1.103		
	ELA	34	2.35	1.125		
	Math	30	2.33	.994		
	Science	35	2.71	1.178		
	Social Studies	31	2.87	1.408		
	Total	187	2.56	1.164	1.147	.340
You are not certain what the options on various technologies will do?	Business	57	2.12	.927		
	ELA	34	2.59	1.104		
	Math	30	2.53	.860		
	Science	35	2.29	1.073		
	Social Studies	31	2.42	1.089		
	Total	187	2.35	1.013	1.614	.178
You are faced with using new technology?	Business	57	2.05	.934		
	ELA	34	2.47	1.080		
	Math	30	2.27	1.015		
	Science	35	2.31	.900		
	Social Studies	31	2.52	1.235		
	Total	187	2.29	1.028	1.358	.256
Someone uses a technology term that you do not understand?	Business	57	1.93	.884		
	ELA	34	2.26	1.377		
	Math	30	1.97	.964		
	Science	35	2.06	.873		
	Social Studies	31	2.42	1.177		
	Total	187	2.10	1.055	1.258	.293
You try to understand new technology?	Business	57	1.88	.847		
	ELA	34	2.35	1.228		
	Math	30	1.90	.803		
	Science	35	2.11	.932		
	Social Studies	31	2.23	1.117		
	Total	187	2.07	.989	1.513	.206
You avoid using unfamiliar technology?	Business	57	1.96	.886		
	ELA	34	2.03	.937		
	Math	30	1.90	.759		
	Science	35	2.11	.832		
	Social Studies	31	2.16	1.214		
	Total	187	2.03	.924	.445	.776
You try to use technology?	Business	57	1.74	.745		
	ELA	34	2.47	1.134		
	Math	30	2.00	.788		
	Science	35	1.91	.853		
	Social Studies	31	2.06	.964		
	Total	187	2.00	.916	3.025	.022

Table continued

Technology Anxiety Statement How anxious do you feel when:		N	Mean	Std. Deviation	*F*-Value	*p*-Value
You hesitate to use technology for fear of making mistakes you cannot correct?	Business	57	1.79	.901		
	ELA	34	2.03	1.141		
	Math	30	2.00	.983		
	Science	35	2.00	1.000		
	Social Studies	31	2.35	1.142		
	Total	187	2.00	1.027	1.455	.224
You try to learn technology related skills?	Business	57	1.67	.690		
	ELA	34	2.29	1.169		
	Math	30	1.77	.728		
	Science	35	1.91	.781		
	Social Studies	31	2.23	.990		
	Total	187	1.94	.896	3.422	.012
You think about your technology skills compared to the skills of other teachers?	Business	57	1.60	.728		
	ELA	34	2.21	1.366		
	Math	30	1.90	.803		
	Science	35	1.89	.900		
	Social Studies	31	2.06	1.209		
	Total	187	1.89	1.012	2.369	.060
You think about using technology in instruction?	Business	57	1.49	.630		
	ELA	34	2.18	1.086		
	Math	30	1.80	.805		
	Science	35	1.80	.901		
	Social Studies	31	1.74	.965		
	Total	187	1.76	.885	3.323	.014
You fear you may break or damage the technology you are using?	Business	57	1.53	.782		
	ELA	34	1.65	.849		
	Math	30	1.67	.884		
	Science	35	1.89	1.105		
	Social Studies	31	1.84	1.128		
	Total	187	1.69	.939	.951	.439

1 = no anxiety, 2 = some anxiety, 3 = moderate anxiety, 4 = high anxiety, 5= very high anxiety

*. Significant at the .0042 level.

Appendix I

Chi Square Tables for Technology Training Sources and Teacher Subject Area

Cross Tabulation of Subject Area by Self-Taught

Subject Area		Self-taught No	Self-taught Yes	Total
Business	Count	0	57	57
	Expected Count	2.7	54.3	
	% within Subject area	0.0%	100.0%	100.0%
	% within Self-taught	0.0%	32.0%	
	% of Total	0.0%	30.5%	30.5%
	Std. Residual	-1.7	.4	
ELA	Count	2	32	34
	Expected Count	1.6	32.4	
	% within Subject area	5.9%	94.1%	100.0%
	% within Self-taught	22.2%	18.0%	
	% of Total	1.1%	17.1%	18.2%
	Std. Residual	.3	-.1	
Math	Count	2	28	30
	Expected Count	1.4	28.6	
	% within Subject area	6.7%	93.3%	100.0%
	% within Self-taught	22.2%	15.7%	
	% of Total	1.1%	15.0%	16.0%
	Std. Residual	.5	-.1	
Science	Count	0	35	35
	Expected Count	1.7	33.3	
	% within Subject area	0.0%	100.0%	100.0%
	% within Self-taught	0.0%	19.7%	
	% of Total	0.0%	18.7%	18.7%
	Std. Residual	-1.3	.3	
Social Studies	Count	5	26	31
	Expected Count	1.5	29.5	
	% within Subject area	16.1%	83.9%	100.0%
	% within Self-taught	55.6%	14.6%	
	% of Total	2.7%	13.9%	16.6%
	Std. Residual	2.9	-.6	
Total	Count	9	178	187
	% within Subject area	4.8%	95.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	13.627[a]	4	.009
N of Valid Cases	187		

a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is 1.44.

Significant at the .0125.

Cross Tabulation of Subject Area by Workshops/Conferences

Subject Area		Workshops/Conferences No	Yes	Total
Business	Count	1	56	57
	Expected Count	2.7	54.3	57.0
	% within Subject area	1.8%	98.2%	100.0%
	% within Workshops/Conferences	11.1%	31.5%	
	% of Total	0.5%	29.9%	30.5%
	Std. Residual	-1.1	.2	
ELA	Count	2	32	34
	Expected Count	1.6	32.4	34.0
	% within Subject area	5.9%	94.1%	100.0%
	% within Workshops/Conferences	22.2%	18.0%	
	% of Total	1.1%	17.1%	18.2%
	Std. Residual	.3	-.1	
Math	Count	3	27	30
	Expected Count	1.4	28.6	30.0
	% within Subject area	10.0%	90.0%	100.0%
	% within Workshops/Conferences	33.3%	15.2%	
	% of Total	1.6%	14.4%	16.0%
	Std. Residual	1.3	-.3	
Science	Count	2	33	35
	Expected Count	1.7	33.3	35.0
	% within Subject area	5.7%	94.3%	100.0%
	% within Workshops/Conferences	22.2%	18.5%	
	% of Total	1.1%	17.6%	18.7%
	Std. Residual	.2	-.1	
Social Studies	Count	1	30	31
	Expected Count	1.5	29.5	31.0
	% within Subject area	3.2%	96.8%	100.0%
	% within Workshops/Conferences	11.1%	16.9%	
	% of Total	0.5%	16.0%	16.6%
	Std. Residual	-.4	.1	
Total	Count	9	178	187
	% within Subject area	4.8%	95.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.243[a]	4	.518
N of Valid Cases	187		

a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is 1.44.

Significant at the .0125 level.

Cross Tabulation of Subject Area by Colleagues

Subject Area		Colleagues No	Colleagues Yes	Total
Business	Count	8	49	57
	Expected Count	8.2	48.8	57.0
	% within Subject area	14.0%	86.0%	100.0%
	% within Colleagues	29.6%	30.6%	
	% of Total	4.3%	26.2%	30.5%
	Std. Residual	-.1	.0	
ELA	Count	0	34	34
	Expected Count	4.9	29.1	34.0
	% within Subject area	0.0%	100.0%	100.0%
	% within Colleagues	0.0%	21.3%	
	% of Total	0.0%	18.2%	18.2%
	Std. Residual	-2.2	.9	
Math	Count	6	24	30
	Expected Count	4.3	25.7	30.0
	% within Subject area	20.0%	80.0%	100.0%
	% within Colleagues	22.2%	15.0%	
	% of Total	3.2%	12.8%	16.0%
	Std. Residual	.8	-.3	
Science	Count	5	30	35
	Expected Count	5.1	29.9	35.0
	% within Subject area	14.3%	85.7%	100.0%
	% within Colleagues	18.5%	18.8%	
	% of Total	2.7%	16.0%	18.7%
	Std. Residual	.0	.0	
Social Studies	Count	8	23	31
	Expected Count	4.5	26.5	31.0
	% within Subject area	25.8%	74.2%	100.0%
	% within Colleagues	29.6%	14.4%	
	% of Total	4.3%	12.3%	16.6%
	Std. Residual	1.7	-.7	
Total	Count	27	160	187
	% within Subject area you teach	14.4%	85.6%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.740[a]	4	.045
N of Valid Cases	187		

a. 3 cells (30.0%) have expected count less than 5. The minimum expected count is 4.33.

Appendix J

Pearson Correlation Table for Variables

Variable		Tech Adopt	Math vs Bus	Science vs Bus	SS vs Bus	ELA vs Bus	Anxiety	Barrier	Tech Avail	Self-taught	College course	Col-leagues	Gender	Age	Edu-cation	Tchg Exp
Technology	*r*	1.00	-.323	-.194	.014	-.050	-.272	-.418	.342	.200	.298	.112	.039	.058	-.008	-.019
Adoption Mean Score	*p*	.	.000	.004	.427	.250	.000	.000	.000	.003	.000	.064	.297	.216	.456	.400
Math vs. Business	*r*	-.323	1.00	-.210	-.195	-.206	-.031	.145	-.189	-.038	.020	-.069	-.108	-.092	.104	-.101
	p	.000	.	.002	.004	.002	.335	.023	.005	.303	.394	.173	.071	.105	.078	.085
Science vs.	*r*	-.194	-.210	1.00	-.214	-.226	.017	.205	-.174	.108	-.061	.002	.042	.023	.166	.025
Business	*p*	.004	.002	.	.002	.001	.408	.002	.009	.071	.202	.489	.282	.378	.012	.367
Social Studies vs.	*r*	.014	-.195	-.214	1.00	-.210	.110	.183	-.016	-.236	-.230	-.144	-.152	-.057	-.078	.070
Business	*p*	.427	.004	.002	.	.002	.067	.006	.415	.001	.001	.024	.019	.219	.143	.170
ELA vs. Business	*r*	-.050	-.206	-.226	-.210	1.00	.115	.037	.082	-.024	-.046	.194	.114	-.044	-.061	-.037
	p	.250	.002	.001	.002	.	.058	.310	.132	.374	.266	.004	.060	.273	.203	.309
Anxiety Mean	*r*	-.272	-.031	.017	.110	.115	1.00	.265	-.349	-.241	-.227	.053	.108	.174	-.131	.123
Score	*p*	.000	.335	.408	.067	.058	.	.000	.000	.000	.001	.236	.071	.009	.037	.046
Barriers Mean	*r*	-.418	.145	.205	.183	.037	.265	1.00	-.221	-.129	-.134	-.025	.031	-.020	.070	.034
Score	*p*	.000	.023	.002	.006	.310	.000	.	.001	.040	.034	.368	.337	.394	.170	.320
Technology	*r*	.342	-.189	-.174	-.016	.082	-.349	-.221	1.00	.186	.169	.130	-.014	.036	-.062	.044
Available Total Score	*p*	.000	.005	.009	.415	.132	.000	.001	.	.005	.010	.038	.423	.314	.201	.277
Self-taught	*r*	.200	-.038	.108	-.236	-.024	-.241	-.129	.186	1.00	.212	.192	.000	.069	.569	-.005
Training Source	*p*	.003	.303	.071	.001	.374	.000	.040	.005	.	.002	.004	.499	.173	.000	.472
College courses	*r*	.298	.020	-.061	-.230	-.046	-.227	-.134	.169	.212	1.00	.172	-.001	-.020	.089	-.151
Training Source	*p*	.000	.394	.202	.001	.266	.001	.034	.010	.002	.	.009	.492	.395	.112	.020
Colleagues	*r*	.112	-.069	.002	-.144	.194	.053	-.025	.130	.192	.172	1.000	.062	.108	.055	.088
Training Source	*p*	.064	.173	.489	.024	.004	.236	.368	.038	.004	.009	.	.201	.071	.228	.117
Gender	*r*	.039	-.108	.042	-.152	.114	.108	.031	-.014	.000	-.001	.062	1.00	.042	-.031	-.068
	p	.297	.071	.282	.019	.060	.071	.337	.423	.499	.492	.201	.	.284	.339	.178
Age	*r*	.058	-.092	.023	-.057	-.044	.174	-.020	.036	.069	-.020	.108	.042	1.00	-.007	.645
	p	.216	.105	.378	.219	.273	.009	.394	.314	.173	.395	.071	.284	.	.461	.000
Education Level	*r*	-.008	.104	.166	-.078	-.061	-.131	.070	-.062	.569	.089	.055	-.031	-.007	1.00	-.020
	p	.456	.078	.012	.143	.203	.037	.170	.201	.000	.112	.228	.339	.461	.	.391
Teaching	*r*	-.019	-.101	.025	.070	-.037	.123	.034	.044	-.005	-.151	.088	-.068	.645	-.020	1.00
Experience	*p*	.400	.085	.367	.170	.309	.046	.320	.277	.472	.020	.117	.178	.000	.391	.