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DEVELOPMENT OF TECHNOLOGY KNOWLEDGE AND BELIEFS: DOES
INSTRUCTIONAL MODALITY MATTER?

By
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A DISSERTATION

Submitted to the faculty of the Graduate School of the Creighton University in Partial
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Abstract

Despite an increased focus on classroom technology integration in the United States, most teachers do not effectively integrate technology in their classrooms. Many factors influence a teacher's choice or ability to integrate technology in the classroom, including his or her technology knowledge and beliefs about technology. This study investigated the technology knowledge and beliefs of undergraduate online and face-to-face pre-service teachers enrolled at one university. Participants completed two surveys presented concurrently via a web-based survey tool. The surveys measured self-reported technology knowledge and technology beliefs. Nonparametric tests were run to determine if there were statistically significant differences between the online and face-to-face pre-service teacher groups for two scales and 10 total subscales, but none were found. However, there were statistically significant findings regarding 1) modality for three individual items from the technology knowledge scale, 2) outcome expectations and technology beliefs, 3) self-efficacy and technology knowledge, and 4) age and pedagogical knowledge. These findings are important for teacher educators so they can purposefully provide learning experiences that positively influence the technology knowledge and beliefs of pre-service teachers in an effort to increase the likelihood of those students integrating technology in their future classrooms.

Keywords: technology integration, technology knowledge, technology beliefs

Dedication

This dissertation is dedicated to my husband, Neal, and our three daughters, Harper, Kinzie, and Keaton. Thank you all for your unconditional love. You each inspire me every day, and I hope experiencing this journey with me has done the same for you.

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I started this experience by sitting as the only female at Table 19 in Omaha, Nebraska. Not only did I survive that first trip, I made friendships that will last a lifetime, and I cherish each one of them. Peter and Steve were my sounding boards, support, and shoulders to cry on. I look forward to the day I can call them both doctor.

Table of Contents

	Page
Abstract	iii
Dedication	iv
Acknowledgements	v
Table of Contents	vi
List of Tables	x
List of Figures	xi
CHAPTER ONE: INTRODUCTION.....	1
Background of the Problem	1
Statement of the Problem.....	5
Purpose of the Study	5
Research Question	6
Hypotheses	6
Method Overview	8
Definition of Terms.....	9
Assumptions.....	10
Delimitations.....	11
Limitations	11
Significance of the Study	12
Summary	13
CHAPTER TWO: REVIEW OF THE LITERATURE	14
Introduction.....	14

Technology Integration in Non-Education Fields.....	14
Technology Integration in Education.....	15
Potential Benefits of Technology Integration.....	16
Barriers to Teacher Technology Integration.....	17
Efforts to Overcome Teacher Technology Integration Barriers	18
The National Educational Technology Plan (NETP).....	18
ConnectED.....	19
The E-Rate Program	19
International Technology Standards	20
Technology Knowledge.....	21
Development of PCK.....	21
Evolution of TPACK	22
TPACK Conceptual Framework.....	23
Content knowledge (CK).....	24
Pedagogical knowledge (PK).....	24
Pedagogical content knowledge (PCK)	24
Technology knowledge (TK).....	24
Technological content knowledge (TCK).....	25
Technological pedagogical knowledge (TPK).....	25
Technological pedagogical content knowledge (TPACK)	25
TPACK Research.....	25
TPACK in content areas	26
Measuring TPACK	28

Technology Beliefs	29
Social Cognitive Career Theory.....	30
SCCT and Classroom Technology Integration.....	30
Instructional Modality and Teacher Education.....	32
Summary	34
CHAPTER THREE: METHODOLOGY	36
Introduction.....	36
Research Questions and Hypotheses	36
Method	37
Participants.....	38
Instrumentation	39
Technology Knowledge	40
Technology Beliefs	42
Demographic Information.....	44
Variables	45
Data Collection Procedures.....	46
Data Analysis	47
Ethical Considerations	49
Summary.....	49
CHAPTER FOUR: FINDINGS	51
Introduction.....	51
Methodology.....	52
Data Analyses	53

Results.....	53
Reliability.....	54
Hypothesis One.....	55
Hypothesis Two	57
Additional Analyses.....	57
Summary.....	60
CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS	62
Introduction.....	62
Summary of Study	63
Conclusions about Modality and PCK.....	64
Conclusions about Knowledge and Beliefs Scales	66
Outcome Expectations	66
Self-Efficacy (SE).....	67
Technology and Pedagogy	68
Implications for Practice.....	68
Suggestions for Further Research	70
Summary.....	71
References.....	74
Appendices.....	86

List of Tables

	Page
Table 1. Internal Consistency of Revised TPACK Instrument.....	42
Table 2. ITIS Internal Consistency	44
Table 3. Gender Frequency by Modality	54
Table 4. Age Group Frequency by Modality	54
Table 5. Subscale Internal Reliability.....	55
Table 6. Technology Knowledge Mann-Whitney U Test Results	56
Table 7. Survey Items Indicating Significant Differences between Modalities	56
Table 8. Technology Beliefs Mann-Whitney U Test Results	57
Table 9. Entire Sample Mean and Standard Deviation.....	58
Table 10. Spearman’s Correlation between Each Knowledge Subscale and KT	59
Table 11. Spearman’s Correlation between Each Belief Subscale and BT	59

List of Figures

	Page
Figure 1. Knowledge domains of the TPACK framework	3
Figure 2. Boxplots of medians per age group for PK subscale.....	60

CHAPTER ONE: INTRODUCTION

Background of the Problem

Over the past several years, researchers and educators alike have called for change in the American education system. The United States consistently falls behind other nations in reading, math, and science on international assessments (Fleischman, Hopstock, Pelczar, & Shelley, 2010). As a result, integrative science, technology, engineering, and math (STEM) education, Common Core State Standards (CCSS), and 21st century learning skills are the new focus of state and federal governments, school districts, educators, and researchers. Each of these three initiatives requires teachers and students to think critically and develop both problem-solving and higher order thinking skills (<http://www.corestandards.org/>; Sanders, 2009; Silva, 2009).

Fullan (2013) argued that American students today are bored with their education and benefit greatly from teachers who embrace the principles of constructivism, such as hands-on problem-based learning, as well as the technological tools that students use outside of school every day. Students want to be interested, be engaged, and learn cooperatively with their peers, all of which lead to increased student achievement (Fullan, 2013). According to Fullan (2013), the integration of technology will significantly ease the transition towards use of critical thinking and higher order skills in the curriculum; however, few teachers know how to integrate technology effectively in their classrooms to attain these learning goals. While school districts accept responsibility for in-service teachers' technology integration, teacher educators are responsible for preparing pre-service teachers to integrate technology when they enter the workforce. Unfortunately, teacher educators encounter the same barriers to technology integration as in-service and

pre-service teachers, such as self-efficacy, lack of technological pedagogical content knowledge (TPACK), time, budget, beliefs about technology, and cultural attitudes toward technology (Schmidt et al., 2009b; Teclehaimanot, Mentzer, & Hickman, 2011).

In the late 19th century, the field of education focused on teacher content knowledge, or teacher understanding of the subject matter taught, as a predictor of effective teaching (Shulman, 1986). By the mid-20th century, the focus shifted to favor pedagogical skills, or how teachers teach, including classroom management, assessment techniques, content delivery, and student engagement. In the late 1980s, Shulman (1986) merged those opposite perspectives into the concept of pedagogical content knowledge (PCK), believing that both content knowledge and pedagogical knowledge were similarly essential to successful teaching. In the decades that followed the introduction of PCK, technology knowledge emerged as an important third factor for successful teaching prompting the development of the technological pedagogical content knowledge (TPCK) theoretical framework (Mishra & Koehler, 2006). The TPCK framework eventually became TPACK, both for fluency in pronunciation and to place further emphasis on the relationships among content, technology, and pedagogy (Thompson & Mishra, 2007).

While Koehler, Mishra, and Cain (2013) applied the TPACK framework to both digital and analog technology, this study limited the definition of technology to digital technologies, such as computers, software, and mobile devices. Digital technologies pose distinctive difficulties for educators because they are constantly changing and can be used in a variety of ways in diverse classroom contexts (Koehler et al., 2013). The TPACK framework includes three main forms of knowledge—technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK)—as essential to move

teachers beyond mere technology use to technology integration (Mishra & Koehler, 2006). Technology integration is not the existence of technology in a classroom, but the act of teachers utilizing technology for student learning.

Mishra and Koehler (2006) placed equal importance on the relationships between TK, PK, and CK, which led to the development of the concepts of pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK; see Figure 1). It is important to note that all seven types of knowledge exist within, and may change according to, the diverse contexts in which they occur, as demonstrated by the large outer circle of Figure 1.

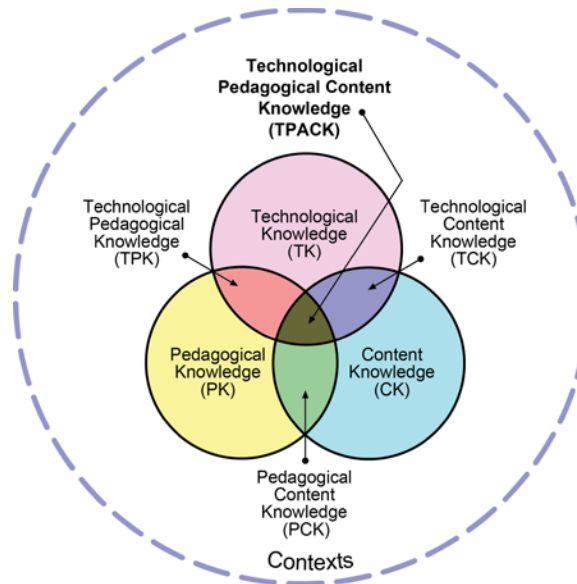


Figure 1. Knowledge domains of the TPACK framework developed by Mishra and Koehler (2006). -Reproduced by permission of the publisher, © 2012 by tpack.org

In addition to knowledge about technology, pedagogy, and content, both intrapersonal and external factors influence teacher decisions to integrate technology (Niederhauser & Perkmen, 2008, 2010; Chai, Koh, & Tsai, 2013; Koehler et al., 2013).

External factors affecting technology integration include access to new digital technologies and adequate training on how to use them (Niederhauser & Perkmen, 2008, 2010). Although increased technology access and training for teachers has greatly reduced the negative influence of external factors on technology integration, many teachers still do not integrate technology (Koehler et al., 2013; Niederhauser & Perkmen, 2010). It is far more difficult to manipulate the intrapersonal factors that influence technology integration because they involve teacher beliefs, experiences, and predispositions. This study focused on technology beliefs based on the intrapersonal factors of self-efficacy, outcome expectations, and interest, as studied by Niederhauser and Perkmen (2008, 2010).

Although national initiatives, such as 21st century skills for teaching and learning (Partnership for 21st Century Skills, 2009), ConnectED (The White House, 2013), and national technology standards for students, teachers, and administrators (ISTE, 2015b) place technology at the forefront of contemporary education, educators from preschool to higher education have been slow to adopt strategies for technology integration (Ertmer & Ottenbreit-Leftwich, 2010; Mishra & Koehler, 2006). Teacher educators must understand the technology knowledge and technology beliefs affecting pre-service teachers in order to make informed changes to undergraduate teacher preparation programs to increase technology integration in kindergarten through 12th grade (K-12) classrooms. The intent of this quantitative study was to determine if a relationship exists between instructional modality, or how students receive course and program content, and the development of undergraduate pre-service teacher technology knowledge and technology beliefs at a private university.

Statement of the Problem

The development of a theoretical framework by Mishra and Koehler (2006) provided a guideline for effective teaching based on a balance of pedagogy, content, and technology. However, technology knowledge alone is insufficient. Technology beliefs based on intrapersonal factors such as self-efficacy, outcome expectations, and interest also influence a teacher's ability to integrate instructional technology in the classroom.

With a large number of students including pre-service teachers now earning degrees online, teacher preparation programs need to determine if differences in learner outcomes exist due to the modality of instruction. If so, teacher preparation programs need to structure learning experiences to meet the needs of both online and face-to-face students. Specifically, individuals who create and maintain teacher preparation programs need to understand the relationships between instructional modality, technology knowledge, and technology beliefs in order to structure technology experiences for pre-service teachers to maximize the potential for technology integration in the field.

Purpose of the Study

The purpose of this quantitative study was to determine whether there were differences between online and face-to-face pre-service teachers in the areas of technology knowledge and technology beliefs. Additionally, this study aimed to determine which domains of technology knowledge and technology beliefs show the greatest variance between modalities. The independent variable was instructional modality, categorized as online or face-to-face. The dependent variables were technology knowledge as described by the TPACK conceptual framework and

technology beliefs, specifically technology self-efficacy, technology outcome expectations, and technology interest.

Research Question

The TPACK theoretical framework developed by Mishra and Koehler (2006) is widely used as a theoretical research base for understanding effective teaching for 21st century learners in both face-to-face and online learning environments in elementary, middle, and high schools (Chai et al., 2013). Many universities, particularly those with teacher education programs, also use the TPACK framework to structure learning environments for both faculty and pre-service teachers (Mishra & Koehler, 2006; Schmidt et al., 2009b). However, technology knowledge alone may be insufficient for determining actual technology integration in the classroom, as the concept can be difficult to measure in practice (Mishra & Koehler, 2006). Technology beliefs based on intrapersonal factors, such as self-efficacy, outcome expectations, and interest may affect classroom technology integration decisions (Niederhauser & Perkmen, 2008). Any number of factors may influence the development of technology knowledge and beliefs, including instructional modality. The following research question guided this study:

Research question: Do technology knowledge and technology beliefs vary between undergraduate pre-service teachers who receive online instruction and those who receive face-to-face instruction?

Hypotheses

One of the weaknesses of the TPACK framework is a lack of research regarding application of the framework to pre-service teachers who take their courses online. Because increasing numbers of students are choosing online coursework and an

increasing number of universities are offering online degree programs (Allen & Seaman, 2014), it is necessary to examine the technology knowledge of online pre-service teachers in order to design programs that maximize the potential for future technology integration. Online students use technology to complete their coursework and communicate with professors and classmates, but it cannot be assumed that technology use leads to increased technology knowledge or more positive technology beliefs.

In a study conducted by Schmidt et al. (2009b), face-to-face students given a TPACK survey instrument showed significant growth in technology knowledge over the course of a semester due to participation in an introductory instructional technology course. However, that only provides insight into a specific course, not the program as a whole, which may or may not integrate technology throughout each course. As demonstrated by the lack of technology integration in the field of education (Ertmer & Ottenbreit-Leftwich, 2010; Fullan, 2013; Mishra & Koehler, 2006), face-to-face instructors may be less likely to integrate instructional technology unless specifically required by the course and may focus instead on pedagogical skills.

Hypothesis #1: Online pre-service teachers will indicate higher levels of knowledge of how to integrate technology in the classroom to impact student learning than their face-to-face counterparts.

Increased exposure to and use of technology in a teacher preparation course leads to increased self-efficacy towards integrating technology in the classroom upon completion of the course (Niederhauser & Perkmen, 2010). Online learners must use technology for every course they take, regardless of the content of the course, due to the nature of the instructional modality. Face-to-face students may or may not use

technology in each course, depending on the requirements of the course and the beliefs and practices of the instructor.

Hypothesis #2: Online pre-service teachers will indicate more positive intrapersonal technology beliefs than their face-to-face counterparts.

Method Overview

This quantitative study collected data from both online and face-to-face learners at a private university based in the southwestern United States. Participants were undergraduates who had completed the majority of their teacher education coursework and were enrolled in their student teaching semester in elementary or early childhood education for the spring 2015 semester. I electronically sent the Intrapersonal Technology Integration Scale (IT IS; Niederhauser & Perkmen, 2008) and the Survey of Pre-service Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009b) to all face-to-face elementary and early childhood student teachers and all online elementary and early childhood student teachers residing in the state where the physical campus is located plus one neighboring state.

I used IBM's Statistical Package for Social Science (SPSS) to analyze the data for both descriptive statistics and statistically significant relationships. Descriptive statistics included the frequency and percent for demographic categories for all participants, as well as the mean and standard deviation for overall technology knowledge, the seven knowledge subscales, overall technology beliefs, and the three belief subscale scores. I used non-parametric Mann-Whitney U tests to determine whether statistically significant relationships existed between the online and face-to-face populations for overall technology knowledge and beliefs scores, as well as the seven knowledge subscales and

three belief subscales. Additionally, I used a Kruskal-Wallis H test to test for statistically significant differences for all scales and subscales and the four age group categories.

Definition of Terms

While TPACK is a common term among those in the field of education concerned with technology integration, many educators are unfamiliar with its meaning, and it is not used in other fields of study. Several other terms were used throughout this study that may have obvious meaning to those in the field of education, including study participants, but not to outside readers. Still other terms were used that may have common meanings to outside readers, but specific meanings when used within this study. The following terms were used operationally within this study:

Face-to-face students: students who physically attend class and are taught synchronously, less than 80% of program is completed online

In-service teachers: certified educators currently teaching in a K-12 classroom

Instructional modality: the method of course content delivery, either face-to-face or online

Intrapersonal factors: beliefs, experiences, and predispositions that influence technology integration

Online students: students who complete at least 80% of their programs online rather than attending a physical campus (Allen & Seaman, 2014)

Pre-service teachers: undergraduate students enrolled in a teacher education program

Student teaching: an experience for pre-service teachers wherein they are placed in a classroom full time teaching K-12 students under the supervision of the

classroom teacher; typically takes place at the end of the teacher education program after completion of all other coursework

Teacher education program: a university program that prepares students for certification as educators; it typically consists of a series of courses, followed by student teaching

Technology beliefs: beliefs about technology integration based on the intrapersonal factors of self-efficacy, outcome expectations, and interest

Technology integration: the knowledge and application of technology to support the teaching of subject matter content and student learning

Technology interest: pre-service teachers' liking, disliking, or being indifferent to instructional technology experiences (Niederhauser & Perkmen, 2008)

Technology knowledge: knowledge of technology, pedagogy, and content necessary for effective classroom technology integration to impact student learning as outlined in the TPACK conceptual framework (Mishra & Koehler, 2006)

Technology outcome expectations: pre-service teachers' expectations of the benefits of using technology in the classroom for instruction (Niederhauser & Perkmen, 2008)

Technology self-efficacy: pre-service teachers' confidence in using technology knowledge to facilitate student learning (Ertmer & Ottenbreit-Leftwich, 2010)

Assumptions

This study assumed that participants honestly responded to questions about their own technology knowledge and beliefs. This study also assumed that participants

completed an instructional technology course as part of their undergraduate program, during which they learned about the availability of various instructional technologies, how to use such technologies, and the benefits of implementing those technologies in the classroom. Due to the uniform curriculum throughout the education programs for both online and face-to-face learners at the university in which this study was conducted, another key assumption was that all students used the same textbook, received instruction on the same topics, and met the same course objectives.

Delimitations

One significant delimitation of this study was the population studied. All participants were enrolled at the same private university in the southwestern United States and were completing their undergraduate student teaching semester in either an elementary or early childhood placement in the spring of 2015. Future research with public universities or universities in other geographic locations, pre-service teachers at the graduate level, pre-service teachers studying emphases other than early childhood or elementary education, pre-service teachers prior to the conclusion of their coursework, or in-service teachers may yield different results.

Limitations

One limitation of this study was the use of self-reported data, which may not provide an accurate description of pre-service teachers' technology knowledge or beliefs. Another limitation of this study, due to the quantitative design, was the lack of depth of responses. Additional questions were not asked to gain further insight into initial participant responses, as this area of investigation was outside the scope of this study. Finally, as a cross-sectional survey study, causation could not be determined.

Significance of the Study

To date, many TPACK studies have measured changes in pre-service teachers from the beginning to the end of an educational technology course or some type of technology intervention (Schmidt et al., 2009b; Ozgun-Koca, Meagher, & Edwards, 2009; Chai, Koh, & Tsai., 2010). Little research exists regarding the overall TPACK of pre-service teachers as they begin their student teaching after completing all program coursework. Some programs may have a designated instructional or educational technology course, whereas others may embed technology throughout all courses or throughout methods courses. At the university in this study, the instructional technology course is a 200-level course, typically taken early in a student's program of study. While a student may increase his or her TPACK throughout a course of this type, there is currently little research to determine if he or she maintains that level of TPACK throughout the rest of his or her program. This study determined what level of TPACK pre-service teachers had as they began to teach students in the classroom.

Niederhauser and Perkmen (2008) found the relationships among technology self-efficacy, outcome expectations, and interest, to be strong influences on teacher decisions to integrate technology. While several studies have examined each of those three factors in isolation, few have addressed the relationships amongst the three as Niederhauser and Perkmen did. In addition, there is little existing research regarding how instructional modality may affect technology knowledge and technology beliefs for pre-service teachers. With an increasing number of university students, including pre-service teachers, taking courses online, it is important for teacher education programs to determine if there are differences between online and face-to-face learners in order to

structure programs to meet student needs. Specifically, it is important for teacher educators to understand the technology knowledge and technology beliefs of both online and face-to-face students in order to structure learning experiences to ensure pre-service teachers maintain or continue to develop technology knowledge and technology beliefs throughout their teacher education programs, as these factors may predict technology integration once pre-service teachers enter the field.

Summary

There are many challenges to teaching with technology that cause teachers to abandon technology integration in their classrooms (Ertmer, 1999; Koehler et al., 2013). Examining differences between technology knowledge and technology beliefs for online and face-to-face pre-service teachers may provide useful information for teacher preparation programs to structure courses in a way that maximizes the potential for future technology integration for pre-service teachers as they enter the field. Subsequent chapters of this study include a literature review, detailed methodology, study results and data analysis, and conclusions and recommendations for future research.

CHAPTER TWO: REVIEW OF THE LITERATURE

Introduction

This literature review examines the development and importance of technology integration in the field of education, as well as non-education fields. Potential benefits of classroom technology integration for students and teachers, as well as teacher barriers to technology integration, are explored. Two common barriers for teachers to classroom technology integration— technology knowledge and technology beliefs—are discussed in depth. This literature review then explores the role teacher education programs play in influencing a pre-service teachers' choice to integrate technology, as well as trends in higher education including the growth of online student populations.

Technology Integration in Non-Education Fields

Both business and healthcare industries typically refer to technology in terms of information technology (IT), or using computer hardware and software to produce and communicate data and information. Many studies report empirical evidence to support the benefits of IT in both business and healthcare. In business, IT integration has increased global competitiveness and productivity (Oliveira & Martins, 2011), as well as profitability (Mithas, Tafti, Bardhan, & Mein Goh, 2012). In healthcare, IT has improved quality of care, increased operational efficiency, reduced costs for both healthcare providers and consumers (Wanderer & Ehrenfeld, 2014), and increased patient self-engagement in healthcare decisions (Buntin, Burke, Hoaglin, & Blumenthal, 2011).

In both industries, simply having access to the technology does not guarantee use. Stakeholders, such as employees, executives, administrators, and shareholders, must understand how the technology works and its potential benefits (Mithas et al., 2012), and

staff need strong leadership and belief in the benefits of technology integration (Buntin et al., 2011). Technology integration in education is similar to both business and healthcare in terms of definition, potential benefits, and access as described in the following section; however, use of technology in education has not reached the implementation level of other industries (Vockley, 2007).

Technology Integration in Education

As defined in Chapter 1, technology integration in education is the knowledge and application of technology to support the teaching of subject matter content and student learning. Technology integration in education does not refer to the amount of technology available in a classroom; rather, technology integration is how that technology is used by both teachers and students to advance learning. Examples of technology integration are student-centered and include activities such as teachers using museum websites to take students on virtual fieldtrips, students and teachers using simulation software such as *Minecraftedu* (<http://minecraftedu.com>), students producing video portfolios of their work, students and teachers creating video games based on educational content, and students using spreadsheets to calculate math equations. Some non-examples of technology integration are teachers using PowerPoint to present information to students, teachers and students using interactive whiteboards solely for presentation rather than interaction, and students using classroom computers for free-time game playing that is not connected to learning outcomes. These non-examples are teacher-centered and do not require students to problem solve or think critically.

Potential Benefits of Technology Integration

Technology integration has the potential to increase students' 21st century skills, academic rigor, relevancy of subject matter to everyday life, and student engagement (Metri Group, 2006; Vockley, 2007). Technology integration can also increase higher-order thinking skills in students to help prepare students for the competitive global job market of the future (ISTE, 2015c). Frameworks outlining 21st century skills have been produced by the Assessment and Teaching of 21st Century Skills, the International Society for Technology in Education, and the Partnership for 21st Century Skills, which are non-governmental organizations that study both education and technology. According to the frameworks, 21st century skills include collaboration, communication, critical thinking, problem solving, and cultural competency (ISTE, 2015c; NCES, 2014; Partnership for 21st Century Skills, 2009). Another skill common to these frameworks is information communication technology (ICT) literacy, or the ability to use technology to access, evaluate, organize, create, and communicate information (Partnership for 21st Century Skills, n.d.).

Unfortunately, little empirical evidence exists to support the benefits of technology integration outlined in the 21st century skills frameworks. Some experts in the field argue that the focus on technology integration has failed to change the American education system (Cuban, 2009; Fullan, 2013) or international education systems (Shields, 2011). Both Cuban (2009) and Fullan (2013) argued that teachers have failed to change the way they teach, despite increased technology access and use, which is ultimately the reason benefits from technology integration have not been realized. Voogt, Knezek, Cox, Knezek, and ten Brummelhuis (2011) suggested several actions education

leaders can take to improve teaching and learning with the use of technology, including establishing a clear relationship between technology and 21st century skills, restructuring schools, developing technology models for pre-service and in-service teachers, and establishing essential conditions for technology investments.

Barriers to Teacher Technology Integration

The landscape of American education is changing to include standards and initiatives at a national level aimed at increasing critical thinking and problem solving skills in an effort to narrow the achievement gap between American students and students in other industrialized nations. While technology is accessible in the United States and useful for advancing these initiatives, in-service teachers, pre-service teachers, and teacher educators alike, face many barriers to technology integration. In 1994, only 5% of K-12 teachers integrated technology in the classroom (Parks & Pisapia, 1994). Seventeen years later, researchers found that only 8% of teachers integrated technology in their classrooms (Moeller & Reitzes, 2011). It is important to note these statistics reflect classroom technology integration, not teacher technology use. A 3% increase in classroom technology integration is minimal compared to the rapid growth of technology and educational technology initiatives between 1994 and 2011.

Researchers have studied barriers to technology integration and ways to overcome them since the 1990s. Ertmer (1999) categorized these barriers as extrinsic and intrinsic. Extrinsic, also considered first-order, barriers are external to the teacher and include access to resources, training to use resources, and ongoing support from administrators, coaches, and technology specialists to continue the use of those resources. Intrinsic, also

considered second-order, barriers are internal to the teacher and consist of beliefs about both teaching and technology and willingness to transform teaching practices.

Efforts to Overcome Teacher Technology Integration Barriers

Initially, researchers and educators thought removing first-order, extrinsic barriers, primarily technology access, would increase technology integration (Ertmer, 1999). In response, the federal government of the United States developed a national plan for educational technology and secured billions of dollars of funding to connect students to the Internet through initiatives such as ConnectEd and the E-Rate Program. Additionally, The International Society for Technology in Education (ISTE) first published international technology standards for students in 1998, with standards for teachers and administrators following in 2000. These initiatives have increased technology access in schools and libraries in the United States.

The National Educational Technology Plan (NETP). The NETP is a five-year action plan that details several goals for educational technology use specifically focused on learning, assessment, teaching, infrastructure, and efficiency of time, money, and staff (U. S. Department of Education Office of Educational Technology, 2010). The NETP was designed to help increase the number of college graduates and prepare all high school graduates for success in college or careers through the effective use of educational technology in the classroom. The plan also includes strategies for gaining access to technology, as well as transformative teaching and learning practices using technology. In addition, the NETP also suggests educators and education leaders use the successful technology experiences of other industries, such as business and entertainment, as learning opportunities for their own practice. ConnectEd and the E-Rate program offer

solutions for access to technology hardware and software and connections to the Internet, so schools can then focus on the goals of the NETP.

ConnectEd. The ConnectEd initiative, announced by President Obama in June 2013, included three main goals for increasing classroom technology use (The White House, 2013). The first goal of ConnectEd is to have 99% of America's students connected to the Internet via broadband and high-speed Internet in schools and libraries by 2017. The second goal is to train teachers to integrate technology in their classrooms and to provide teachers with the tools necessary to do so. The third goal is to leverage private-sector innovation by increasing the number of educational devices available for student use, expand access to broadband and digital technologies, and increase the use of educational software. In 2014, the ConnectEd initiative received \$2 billion to be paid over two years from the Federal Communications Commission (FCC), as well as over \$2 billion from private sector companies to be used to connect 20 million more students to improved broadband and innovative technologies in classrooms (The White House, 2013). ConnectEd is a multi-year initiative, which makes it difficult to determine its success at this time.

The E-Rate Program. The FCC initiated the E-Rate Program in 1997 and modernized many aspects of the program in 2010 (FCC, 2014). The E-Rate Program offered \$2.4 billion in funding in 2013 to schools and libraries to cover 20 to 90% of the cost of telecommunications and Internet services (Schaffhauser, 2013). The funding is competitive and based on poverty level and the type of population served, with preference given to urban and rural communities. Although the program was successful in helping to connect nearly all public schools and libraries in the United States to the

Internet by 2006, those connections are often too slow to support student use of current technologies. The updated program goals now focus on affordable high-speed access and streamlined program administration to increase the number of schools receiving funding (FCC, 2014). As the FCC just updated the program goals this year, it will take several years to determine if those updates improve technology integration in schools.

International technology standards. ISTE rebranded its image in 2013 and renamed the standards the ISTE Standards in 2014 (ISTE, 2015a). Various educational institutions worldwide have adopted the ISTE Standards. The ISTE Standards are “the definitive framework for successfully implementing digital strategies to positively impact learning, teaching, and leading in our technology-powered world” (ISTE, 2015a). ISTE currently produces five sets of standards; one set each for students, teachers, administrators, coaches, and computer science educators.

The NETP, ConnectEd, E-Rate Program, and ISTE Standards all address extrinsic barriers to technology integration. While the majority of schools and students do have access to the Internet now, new barriers such as the speed of connectivity have surfaced. In addition, connectivity to the Internet does not automatically mean that teachers are integrating technology in their classrooms for student learning (Ertmer, 1999). As a result, researchers then turned their focus to second-order, or internal barriers, believing those barriers had a stronger influence on teacher technology decisions (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). After completing a review of technology integration barrier studies from 1995 through 2006, Hew and Brush (2007) identified the two main categories of barriers to be technology knowledge and technology beliefs.

Technology Knowledge

The pendulum of American education swings back and forth from one trend to another, and often back again. Standards for teacher effectiveness are not immune to these shifts. From the 19th to the 21st century, views of teacher effectiveness shifted from a focus on content, to a focus on pedagogy, to a focus on technology. Research over the past several decades suggests the relationships among content, pedagogy, and technology form the knowledge base teachers must have to integrate technology for effective teaching in the 21st century (Chai et al., 2013; Mishra & Koehler, 2006; Niess, 2005; Voogt, Fisser, Pareja Roblin, Tondeur, & Van Braak, 2013). The evolution from distinct forms of content and pedagogical knowledge to integrated views of content, pedagogical, and technological knowledge is necessary for understanding contemporary perspectives on the importance of technology integration for teacher effectiveness.

Development of PCK

In 19th century America, teacher evaluations focused solely on content knowledge (CK) as the indicator of teacher quality. If a person had a deep understanding of the subject matter, that person was considered a good teacher. Teacher certification examinations reflected this perspective. By the 1980s, the pendulum swung in the opposite direction. CK was no longer the defining mark of a good teacher; instead, it was pedagogical knowledge (PK). PK included how well someone could plan lessons, manage classroom behaviors, understand cultural differences, and differentiate instruction. Shulman (1986) referred to the lack of focus on CK as the “missing paradigm” (p. 6) and suggested that there would be serious consequences for teachers and students if researchers and administrators continued to ignore CK when determining

teacher quality. Without strong CK, teachers could leave out important information, or worse, misinform students.

Shulman (1986) presented the theory of pedagogical content knowledge (PCK) to bridge the gap between PK and CK. PCK is an understanding of the content, as well as how to present that content in a pedagogically sound way. Shulman (1987) argued that teacher education programs must infuse PCK throughout coursework by specifically relating content to pedagogy, rather than focusing solely on general pedagogical skills. He also suggested that teacher examinations should also include questions related to both PK and CK in order to reflect PCK. Various scholars have extended Shulman's (1986, 1987) initial work on PCK since the concept was introduced, particularly as it relates to science education (Geddis, Onslow, Benyon, & Oesch, 1993; Halim & Meerah, 2002; Loughran, Mulhall, & Berry, 2004; Park & Oliver, 2008). Shulman's (1986) concept of PCK remains important to understanding effective teaching; however, by the end of the 20th century, technology also became an essential element of teaching and learning.

Evolution of TPACK

The increase in availability of digital technologies throughout the beginning of the 21st century has led to yet another conceptualization of teacher knowledge, one that includes technology. As new technologies emerge, education faces yet another shift that requires the integration of digital technologies to support student learning in content areas. However, many teachers lack the knowledge and skills needed to effectively integrate technology to teach 21st century learners (Niess, 2005). Therefore, scholars began investigating the relationship between technology and PCK (Chai et al., 2013; Niess, 2005; Voogt et al., 2013). Pierson (2001) first used the term technological

pedagogical content knowledge in 2001, but Koehler and Mishra (2005) popularized the acronym “TPCK” in 2005, now known as TPACK.

Based on Shulman’s conception of PCK, TPACK is defined as the dynamic relationship between PK, CK, and technology, not the existence of each knowledge type in isolation (Koehler & Mishra, 2005; Niess, 2005; Pierson, 2001). The concept of TPACK provides a means for understanding a teacher’s ability to go beyond the mere existence of technology in the classroom to actually integrating technology for instruction (Mishra & Koehler, 2006). Mishra and Koehler (2006) developed a TPACK conceptual framework grounded in Shulman’s (1986) theory of PCK, which continues to be widely used to understand the knowledge base of teachers who effectively integrate technology.

TPACK Conceptual Framework

Theoretically, TPACK is an extension of PCK (Cox & Graham, 2009), a separate and unique type of knowledge (Angeli & Valanides, 2009) and reflects an understanding of the interactions among content knowledge, pedagogical knowledge, and technology knowledge, which contributes to meaningful technology integration (Koehler et al., 2013). The TPACK conceptual framework as developed by Mishra and Koehler (2006) is widely accepted in the literature of contemporary researchers (Chai et al., 2013; Voogt et al., 2013). The framework consists of a triple Venn diagram demonstrating the seven knowledge domains within a large outer-ring representing context (see Figure 1), representing not only the knowledge teachers need in order to integrate technology effectively, but also how teachers use that knowledge within the dynamic context of their unique classrooms (Koehler et al., 2013). The conceptual framework contains seven domains of knowledge, which include content knowledge, pedagogical knowledge,

pedagogical content knowledge, technology knowledge, technological content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge.

Content knowledge (CK). Content knowledge refers to knowledge of the actual content students must learn, whether it is elementary math, high school calculus, or middle school vocal music. Teachers must possess a deep understanding of the specific content knowledge for their own disciplines (Mishra & Koehler, 2006), as well as an understanding of how one's own content knowledge differs from teachers of other content areas (Schmidt et al., 2009b).

Pedagogical knowledge (PK). Pedagogical knowledge is knowledge of how to teach effectively, including lesson plan development, management techniques, student engagement strategies, and measurement of student progress. PK requires teachers to understand their students' thought processes, as well as how cognitive, social, and developmental theories apply to specific classroom contexts (Mishra & Koehler, 2006).

Pedagogical content knowledge (PCK). Based on the concept originally developed by Shulman (1986), pedagogical content knowledge refers to the blending of CK and PK. Teachers with high levels of PCK are able to use their CK and PK to develop rich, content-specific, learning experiences for their students. These teachers understand what students already know and are able to anticipate any misconceptions or resulting misunderstandings students may have about the content.

Technology knowledge (TK). Technology knowledge includes knowledge of both low-tech and high-tech technologies. Low-tech technologies are simple, such as a whiteboard. High-tech technologies are more complex, such as an interactive whiteboard

and the software to support it. TK also includes the ability to operate various technologies, install and remove computer programs, and learn how to use emerging technologies (Mishra & Koehler, 2006).

Technological content knowledge (TCK). Technological content knowledge refers to the relationship between technology and content. Technology has the ability to change the nature of learning by allowing students to see new and varied representations of the same material (Schmidt et al., 2009b). Teachers must understand how to choose technology based on the specific content they expect students to learn.

Technological pedagogical knowledge (TPK). Technological pedagogical knowledge is an understanding of how technology supports teaching, regardless of the content area. TPK includes the ability of teachers to determine which technology is appropriate for a given task and knowledge of how that technology can change teaching.

Technological pedagogical content knowledge (TPACK). Technological pedagogical content knowledge refers to a teacher's ability to teach content using appropriate pedagogical techniques and technology resources. TPACK is essential for successful classroom technology integration (Mishra & Koehler, 2006).

TPACK Research

Many researchers have studied various aspects of TPACK since the term became popular in 2005 (Chai et al., 2013; Voogt et al., 2013). Studies have focused on the application of TPACK to various content areas, measurement of TPACK, and the development of TPACK in pre- and in-service teachers. Results have indicated TPACK is complex, content and context dependent, and difficult to measure.

TPACK in content areas. The majority of TPACK studies in specific content areas have focused on math and science, followed by social studies. Very few studies have been conducted to examine TPACK in language arts or literature, and even fewer in specialized areas like economics and the arts (Chai et al., 2013). The majority of studies regarding content and TPACK have focused on teacher development of TPACK in content-specific situations, rather than student learning. In addition, regardless of the specific content studied, results have supported general pedagogical best practices that are applicable in all content areas, rather than content-specific strategies.

One common theme that emerged from content-specific studies of TPACK is that pedagogy must drive technology decisions, rather than technology driving pedagogical decisions. The teaching structure of giving, prompting, and modeling proposed by Hammond and Manfra (2009) emphasized the importance of selecting a technology based on pedagogical goals, rather than selecting pedagogical goals based on a specific technology. Although their research focused on social studies content, the results support the basic best practice for all teachers of selecting technology based on pedagogical goals regardless of content area. Similarly, Harris et al. (2010) proposed using learning activity types, which are curriculum-based lists of activities used to help build lesson plans, to integrate content and TPACK. Harris et al. (2010) developed preliminary taxonomies of pedagogically based activity types in a variety of K-6 and secondary content areas aligned to appropriate educational technologies in order to promote seamless technology integration. An example of a learning activity type for mathematics is estimation. For this learning activity type, students use supportive technologies to estimate mathematical values ("Math Learning Activity Types," 2011). Suggested technologies to accomplish

this pedagogical goal are scientific and graphing calculators, spreadsheets, and student clicker response systems ("Math Learning Activity Types," 2011). Harris et al. (2010) recommended planning curriculum units using these learning activities, then selecting technologies appropriate for the learning activities, rather than discovering an interesting technology and forcing it to fit within the curriculum.

Many teachers have not experienced being a student in technology-integrated classrooms, making it difficult for them to teach with technology. As a result, teachers tend to use technology in teacher-centered ways, such as demonstrating how a technology is used, modeling how to complete activities using a technology, and providing content examples using technology (Hammond & Manfra, 2009; Niess et al., 2009). Niess et al. (2009) described five stages teachers go through as they develop TPACK in mathematics education. The five developmental stages, based on Rogers' (1995) five-stage model describing a person's adoption of innovations, are recognizing, accepting, adapting, exploring, and advancing (Niess et al., 2009). Niess et al. (2009) provided examples of activities in mathematics classrooms for each stage, but the stages themselves were applicable to multiple disciplines.

Regardless of the particular content studied, research suggests the development of teacher TPACK is necessary for effective technology integration. Researchers have studied many different content areas and contexts to explain how both pre-service and in-service teachers develop technology knowledge based on the TPACK framework. Due to the important influence of context on the TPACK framework components as shown in Figure 1, it has been challenging to develop a universal instrument to measure TPACK using all seven knowledge domains.

Measuring TPACK. The majority of instruments developed for measuring teacher technology knowledge using the TPACK framework are self-reported surveys specific to certain grade levels and content areas. Additionally, most instruments are directed towards pre-service teachers and measure changes in TPACK due to some type of intervention (Chai et al., 2013; Voogt et al., 2013). Relatively few instruments measure TPACK based on observations of teacher behavior (Harris, Grandgenett, & Hofer, 2010) or teacher completion of tasks (Angeli & Valanides, 2009; Bowers & Stephens, 2011; Kramarski & Michalsky, 2010). Most studies do not explicitly state the instructional modality utilized by participants; however, online teachers (Archambault & Barnett, 2010) and in-service teachers completing a hybrid (both online and face-to-face) educational technology course (Shin et al., 2009) have been studied.

Schmidt et al. (2009b) developed one of the first, most widely adapted, survey instruments. However, they designed the instrument as a self-reported survey for elementary and early childhood pre-service teachers to be completed after a course intervention, making it context-specific (Schmidt et al., 2009b). Most self-reported surveys used various Likert scales based on the seven TPACK knowledge domains used by Schmidt et al. (2009b); however, factor analyses of the instruments produced varying results. Although these discrepancies in factor analyses support the interrelated constructs of content, pedagogy, and technology, they may also suggest that teachers and researchers do not share a common understanding of the differences between the seven knowledge domains (Chai et al., 2013).

While the TPACK framework provides a model for discussing and measuring the seven knowledge domains necessary for technology integration and effective teaching, it

is limited to knowledge only and does not describe technology beliefs. Technology beliefs, including self-efficacy, outcome expectations, and interest in technology also strongly influence a teacher's decision to integrate technology in the classroom.

Technology Beliefs

Pre- and in-service teachers face both internal and external barriers to technology integration. External barriers, also considered first-order barriers or barriers that do not affect teachers' underlying beliefs, include access to technology, time to plan and prepare for technology integration, and training and support to use technology (Ertmer, 1999). Conversely, internal barriers are second-order barriers, which are intrapersonal and include beliefs about pedagogy, beliefs about technology, and willingness to change teaching practices (Ertmer, 1999). Knowledge of both types of barriers is necessary for understanding teacher decisions to integrate technology in the classroom.

With increased availability and affordability of technology, most external barriers have been eliminated in the United States and are no longer considered valid reasons for lack of classroom technology integration (Ertmer, 1999; Ertmer et al., 2012; Niederhauser & Perkmen, 2008, 2010). However, internal barriers are often difficult to change because they are highly personal and influenced by experience (Ertmer, 1999; Ertmer et al., 2012; Niederhauser & Perkmen, 2008). Historically, research about technology beliefs focused primarily on self-efficacy (SE); however, outcome expectations (OE) have received more attention in recent years as a possible motivating factor for teachers to integrate technology (Niederhauser & Perkmen, 2010). Self-efficacy only means that a teacher feels confident that they can integrate technology, but Niederhauser and Perkmen (2010) argue that development of OE leads to teachers feeling

that they should integrate technology. Teachers who were highly effective at technology integration cited the internal barriers of their colleagues as the largest barrier to integration in their schools, while their own knowledge and beliefs were their biggest advantage for successful technology integration (Ertmer et al., 2012).

Social Cognitive Career Theory

Social Cognitive Career Theory (SCCT), based on Bandura's (1986) work on social cognitive theory, focuses on the relationships among personal attributes, environmental factors, and overt behaviors, and how those interactions affect career choices and career development for individuals in a variety of fields (Lent, Brown, & Hackett, 2002). One important component of SCCT is interest development, which is influenced by self-efficacy and outcome expectations. As people have personal experiences with certain careers, they will develop an interest in those careers. For example, a person who has positive personal experiences visiting the doctor may develop an interest in becoming a doctor. That interest will grow if people believe they can perform well in a certain career and achieve expected outcomes (Lent et al., 2002). Conversely, if people are not exposed to a certain career, do not believe they can perform well in that career, or do not believe they will achieve certain outcomes, they will not develop an interest in that career. This principle has also been applied to teacher technology use in the classroom.

SCCT and Classroom Technology Integration

Neiderhauser and Perkmen (2008) applied SCCT specifically to classroom technology integration. Their work focused primarily on self-efficacy, outcome expectations, and interest in technology, which are all internal, or intrapersonal,

influences on technology integration. Niederhauser and Perkmen (2008) used SCCT to develop an instrument to examine the influence of those three key factors on classroom technology integration. They found all three factors mediated external factors and clearly influenced whether teachers chose to integrate technology or not, indicating a need for understanding teachers' self-efficacy, outcome expectations, and interest in technology in order to increase classroom technology integration.

Similar to the effect of the relationships among content, pedagogy, and technology on the knowledge needed to integrate technology, the relationships among self-efficacy, outcome expectations, and interest affect teacher beliefs about technology integration. The work of Niederhauser and Perkmen (2008) indicates self-efficacy (SE) and outcome expectations (OE) strongly influence interest (INT) as individuals tend to develop interest in areas that they feel self-efficacious and have positive OE. To measure teachers' degree of interest in instructional technology Niederhauser and Perkmen (2008) developed survey questions to determine if teachers liked, disliked, or were indifferent to instructional technology experiences. They also developed survey items to measure teacher confidence in using instructional technology in the classroom and teacher expectations of the benefits of using technology in the classroom for instruction. Their findings indicate if teachers feel confident integrating technology in their classrooms and have high expectations for the eventual outcomes, they will be more interested in integrating technology in the future.

To integrate technology effectively, teachers must have knowledge of technology, pedagogy, and content, and the relationships among the three (Koehler et al., 2013). Technology SE, OE, and INT also influence a teacher's decision to integrate technology

in the classroom (Ertmer, 1999; Ertmer et al., 2012; Niederhauser & Perkmen, 2008, 2010). Teacher educators and teacher preparation programs play an important role in the development of intrapersonal factors, as well as technology knowledge, for pre-service teachers (Chai et al., 2013). To date, TPACK research has focused on face-to-face post-secondary pre-service teachers and K-12 online teachers. However, the growing population of online learners in post-secondary teacher preparation programs warrants investigation to ensure they are developing the technology knowledge and beliefs necessary for classroom technology integration. To bring technology integration into practice, teacher education programs must positively influence both online and face-to-face pre-service teachers' technology knowledge and beliefs. In order to do so, universities must first understand influences on the technology knowledge and technology beliefs of both online and face-to-face pre-service teachers.

Instructional Modality and Teacher Education

Pre-service teachers develop knowledge and beliefs throughout their teacher preparation programs, but those programs are changing as many universities now offer courses and programs online. A recent report on online education in the United States defined online learning as courses with 80% or more of content delivered online, while traditional learning has less than 80% of content delivered online (Allen & Seaman, 2014). The same report stated the proportion of higher education students taking at least one online course was 33.5% in 2013, an all-time high (Allen & Seaman, 2014, p. 4). However, the federal government and accreditation bodies such as the National Council for Accreditation of Teacher Education (now the Council for the Accreditation of Educator Preparation) are still concerned about the quality of online versus traditional

education and how to evaluate that quality (Boston, Ice, & Gibson, 2011). Less than one-third of the chief academic officers surveyed in the Allen and Seaman report felt there would no longer be concerns over the quality of online courses compared to those offered in a traditional environment, and 26% of them felt online learning outcomes were inferior to face-to-face instruction (Allen & Seaman, 2014, p. 5). The report also revealed that many universities now rely on online programs to support the university financially; however, student retention in online courses is of increasing concern.

Online learners are typically different from face-to-face learners in several ways. Online learners tend to be adults who work, have families, and need the flexibility in schedule that online programs offer (Cercone, 2008; Tyler-Smith, 2006). Online learners also tend to have lower persistence and program completion rates than their face-to-face counterparts, due to a variety of factors, including time, instructor support, course design, and technical problems (Tyler-Smith, 2006). In addition, online learning requires students to be more self-directed, self-motivated, and responsible for their own learning (Cercone, 2008; Means, Toyama, Murphy, Bakia, & Jones, 2009; Raine et al., 2011; Tyler-Smith, 2006). While researchers typically agree about the differences between characteristics of online and face-to-face learners, there is less agreement about whether differences in learner outcomes or student achievement exist.

Research on differences between online and face-to-face learning outcomes is inconclusive, with some studies favoring online education, others favoring face-to-face delivery, and still others reporting no significant difference between the two (Means et al., 2009). In addition, research studies comparing online and face-to-face instruction have focused on several different factors, including student achievement, student

preferences, student engagement, and student motivation (Means et al., 2009). Due to the large number of factors affecting online and face-to-face student performance, it is difficult to say with certainty what role the modality of instruction plays in student outcomes. Few studies have been successful at isolating and analyzing instructional modality as a potential cause for differences in learning outcomes.

Although 100% of teacher preparation programs, both online and face-to-face, include educational technology concepts, how those concepts are presented can vary greatly (Gronseth et al., 2011). The majority of both online and face-to-face programs include a separate educational technology course, while others integrate educational technology concepts throughout their pedagogical methods courses or in other areas. However, little data exists to determine if a separate educational technology course is more effective than embedding technology concepts in other courses. In addition, education technology courses vary greatly from one university to another, with differences in content, instructor ability, authentic learning experiences, and field experiences (Gronseth et al., 2011). Not only is there little conclusive data about how best to incorporate educational technology in teacher preparation programs, but there is even less research regarding differences in technology knowledge or technology beliefs between online and face-to-face learners.

Summary

Despite the success of technology integration in various fields such as business, healthcare, and entertainment, the field of education has been slow to adopt technology integration strategies for student learning. The federal government supports several multi-billion dollar initiatives; international technology standards have been adopted

across the United States, and several scholars have explained the potential benefits of technology integration for students. Yet teachers are still slow to change their practices.

Two categories of factors that affect teacher technology integration are lack of technology knowledge and technology beliefs (Hew & Brush, 2007). The TPACK conceptual framework describes the knowledge teachers need to integrate technology successfully, but has not been used to compare the technology knowledge of online and face-to-face pre-service teachers. Teacher beliefs about technology are intrinsic, or intrapersonal, making them difficult to change once formed. Relationships among self-efficacy, outcome expectations, and interest are crucial to teacher experiences with and beliefs about technology, yet the relationship of all three factors to technology use has not received a great deal of attention in the literature.

Differences in characteristics between online and face-to-face learners have been well documented, but there is little research about differences in development of knowledge and beliefs in pre-service teachers, particularly in the area of technology integration. The following chapter details the methodology used for this study, the purpose of which was to determine if differences in technology knowledge and beliefs exist between two instructional modalities.

CHAPTER THREE: METHODOLOGY

Introduction

The purpose of this study was to determine whether there was a difference between online and face-to-face pre-service teachers in the areas of technology knowledge and technology beliefs. The findings of this study are of value to universities that offer both online and face-to-face teacher education programs, individuals who create content for teacher education programs, and teacher educators who teach in those programs, as they attempt to maximize the potential for pre-service teachers to effectively integrate technology into their instructional activities once they begin teaching.

Research Questions and Hypotheses

The central research question guiding this study was, “Do technology knowledge and technology beliefs vary between undergraduate pre-service teachers who receive online instruction and those who receive face-to-face instruction?” This research question was further investigated by the following sub-questions:

1. Are there statistically significant differences in technology integration knowledge between pre-service teachers who have completed their program of study in a face-to-face or an online setting?
2. Is there a statistically significant difference in technology beliefs between pre-service teachers who have completed their program of study in a face-to-face or an online setting?

The following hypotheses were investigated:

1. Online pre-service teachers will indicate higher levels of knowledge of how to integrate technology in the classroom to impact student learning than their face-to-face counterparts.
2. Online pre-service teachers will indicate more positive technology beliefs than their face-to-face counterparts.

Method

This study used a quantitative, non-experimental, cross-sectional survey design to compare the technology knowledge and beliefs of online and face-to-face undergraduate pre-service teachers. Quantitative data was collected using two valid and reliable surveys administered concurrently. Technology knowledge was measured using the Survey of Preservice Teachers' Knowledge of Teaching and Technology, which is based on the TPACK conceptual framework (Schmidt et al., 2009b). Technology beliefs were measured using the Intrapersonal Technology Integration Scale (ITIS; Niederhauser & Perkmen, 2008). Additional demographic data regarding respondent age, gender, and instructional modality (face-to-face or online) was also collected. Experimental research design is used to determine cause and effect between independent and dependent variables (Creswell, 2011). This study did not attempt to identify a causal relationship between instructional modality and technology knowledge and beliefs, so a non-experimental design was used. A cross-sectional survey design allows the researcher to collect data at a specific point in time to measure attitudes, beliefs, and practices of two or more educational groups (Creswell, 2011). This study used an educational survey to collect information about technology beliefs and technology knowledge at one point in

time during pre-service teachers' education programs, so the cross-sectional survey design was appropriate.

Participants

The population for this study consisted of online and face-to-face undergraduate pre-service teachers at a private university in the southwestern United States. Upon enrollment, all students choose to take their entire program of study either online or face-to-face. There is no option for a hybrid program that combines instructional modalities. Each course is worth four credit hours for both online and face-to-face students. All face-to-face students complete their programs of study based on a traditional nine-month academic calendar, consisting of two 15-week semesters. Face-to-face students typically take 12 to 18 credit hours per semester, and have the option of taking summer courses. Online students typically complete their program year-round, taking two courses at a time with each course lasting eight weeks.

The university has a centralized curriculum throughout the education programs meaning all students use the same textbooks, study the same topics and objectives, and complete the same benchmark assignments for each course, regardless of instructional modality. Both online and face-to-face students use the same learning management system (LMS) to complete coursework. Online students use the LMS to access lectures and assignment descriptions, participate in class discussions, contact instructors, communicate with peers, submit assignments, and access grades and instructor feedback. Face-to-face students observe lectures and participate in class discussions when they attend class. Face-to-face students use the LMS to access assignment descriptions, submit assignments, and access grades and instructor feedback.

For any given course, students likely do not experience the same instructors. Instructors are designated as full-time online, online adjunct, full-time face-to-face, or face-to-face adjunct. Instructors are assigned to courses based on their qualifications and certifications, and seldom cross over between modalities.

The available population of undergraduate face-to-face pre-service teachers was 134. The available population of undergraduate online pre-service teachers was 1257. The sample population of face-to-face students consisted of undergraduate pre-service teachers placed for student teaching in the spring 2015 semester in either elementary or early childhood settings, which was 75 students. The sample population of online students consisted of undergraduate pre-service teachers placed for student teaching in the spring 2015 semester in either elementary or early childhood settings, who resided in the same state where the face-to-face campus is located, as well as one neighboring state. The online sample was 76 students.

Instrumentation

Two separate published survey instruments were presented concurrently to participants via the online survey tool Survey Gizmo (<http://www.surveygizmo.com>). The Survey of Preservice Teachers' Knowledge of Teaching and Technology developed by Schmidt et al. (2009b) was used to measure pre-service teachers' technology knowledge. The ITIS developed by Niderhauser and Perkmen (2008) was used to measure pre-service teachers' intrapersonal technology beliefs. Written permission was obtained from the author of the ITIS prior to use (Appendix A). As indicated on the survey instrument (Schmidt et al., 2009b), information was emailed regarding the population and use of the survey to Dr. Schmidt (Appendix A).

Technology Knowledge

Schmidt and her colleagues developed the Survey of Preservice Teachers' Knowledge of Teaching and Technology to measure pre-service teachers' self-assessment of the knowledge needed for classroom technology integration (Schmidt et al., 2009b). Survey items 1 through 46 require participants to choose from *strongly disagree* to *strongly agree* to respond to Likert-type items grouped into subscales based on the seven knowledge domains of the TPACK framework developed by Mishra and Koehler (2006). Examples of items from each of the seven subscales are:

- I can learn technology easily. (TK)
- I have sufficient knowledge about (mathematics, social studies, science, and literacy). (CK)
- I can adapt my teaching style to different learners. (PK)
- I can select effective teaching approaches to guide student thinking and learning in mathematics/social studies/science/literacy. (PCK)
- I know about technologies that I can use for understanding and doing mathematics/social studies/science/literacy. (TCK)
- I can choose technologies that enhance students' learning for a lesson. (TPK)
- I can teach lessons that appropriately combine mathematics/social studies/science/literacy, technologies and teaching approaches. (TPACK)

Survey items are scored by assigning a value of 1 to responses of *strongly disagree* to a score of 5 for *strongly agree*, then averaging scores within each knowledge subscale to produce one score per subscale, and averaging all responses to produce one total score (Schmidt et al., 2009a). The original survey developed by Schmidt et al.

(2009b) included several additional questions used to understand individual students and their teacher education program experiences, but those items were not used because they did not align to the purposes of this study.

The Survey of Preservice Teachers' Knowledge of Teaching and Technology is both valid and reliable. Researchers first administered a 75-item version of the survey to 124 pre-service teachers participating in an educational technology course at a university in the midwestern United States (Schmidt et al., 2009b). Researchers then used Cronbach's alpha reliability to assess the internal consistency of each of the seven TPACK knowledge subscales. Researchers then deleted 29 items from the survey that affected the reliability and construct validity of the knowledge subscales, resulting in a survey of 46 items with strong internal consistency reliability, meaning the survey and the subscales measure the intended constructs. Table 1 displays the alpha reliability coefficients for each of the seven TPACK knowledge subscales. The range of these coefficients is considered good to excellent (George & Mallery, 2003).

Table 1

Internal Consistency of Revised TPACK Instrument

	Internal Consistency (alpha)
Technology Knowledge	.82
Content Knowledge-Mathematics	.85
Content Knowledge-Social Studies	.84
Content Knowledge-Science	.82
Content Knowledge-Literacy	.75
Pedagogical Knowledge	.84
Pedagogical Content Knowledge	.85
Technological Content Knowledge	.80
Technological Pedagogical Knowledge	.86
Technological Pedagogical Content Knowledge	.92

Technology Beliefs

The ITIS (Niederhauser & Perkmen, 2008) was used to measure technology beliefs, specifically in the intrapersonal subscales of SE, OE, and INT. The ITIS (Niederhauser & Perkmen, 2008) consists of 21 Likert-type items that ask participants to choose from response options ranging from *strongly disagree* to *strongly agree* to self-report their intrapersonal technology beliefs regarding SE, OE, and INT. Survey items are scored by assigning a value to each response—*strongly disagree* = 1 to *strongly agree* = 5—then averaging response scores per subscale. The SE subscale contains six questions that measure participants' confidence using technology in the classroom. The OE subscale contains nine questions that measure participants' expected benefits from using technology in the classroom, and the INT subscale contains six questions that

measure participants' interest in using technology in the classroom (Niederhauser & Perkmen, 2008). Examples of survey items from each subscale are:

- I feel confident that I can teach relevant subject matter with appropriate use of instructional technology. (SE)
- Effectively using instructional technology in the classroom will increase my sense of accomplishment. (OE)
- I am interested in working with instructional technology tools. (INT)

The ITIS is both valid and reliable. Researchers adapted items for the ITIS from published valid and reliable survey instruments and conducted a pilot test with 28 pre-service teachers in the same instructional technology course (Niederhauser & Perkmen, 2008). Researchers then used pilot survey participants' feedback, as well as feedback from three SCCT experts who "agreed that items were consistent with the constructs they were intended to measure" (p. 104), to make minor revisions to survey items (Niederhauser & Perkmen, 2008).

Researchers used Cronbach's alpha reliability to assess the internal consistency of each of the three subscales of SE, OE, and INT, and the entire scale, to ensure each measured the intended construct. The range of these coefficients is considered good to excellent (George & Mallery, 2003). Table 2 displays the alpha reliability coefficients for the entire instrument with the three subscales combined into a single score and for each of the three intrapersonal beliefs subscales.

Table 2

ITIS Internal Consistency

	Internal Consistency (alpha)
Entire instrument	.96
SE	.90
OE	.93
INT	.89

Demographic Information

Participants provided demographic data including gender, age, and instructional modality. Gender and age data was used to describe the participants. Additionally, nonparametric tests were run to determine if any differences existed between age groups in technology knowledge and beliefs. No statistical tests were run based on gender due to the uneven distribution between the number of males and the number of females who responded. Instructional modality data was used to categorize participants as either online or face-to-face learners in order to compare the technology knowledge and technology beliefs of the two groups. The following questions and response options were used to collect this information:

- What is your gender? Male, Female
- What age group do you belong to? 19-24, 25-34, 35-54, 54+
- An online student is one who completes at least 80% of program online. A face-to-face student is one who completes less than 80% of their program online. Given that information, how have you completed your program?
Online, Face-to-face

Variables

The independent variable for this study was instructional modality. Participants self-selected either online or face-to-face as their instructional modality as part of the online survey. This variable was chosen due to the lack of conclusive evidence in the literature regarding learning outcome differences between online and face-to-face learners. Data from this study adds to the current body of research providing evidence that learning outcomes either do or do not differ between face-to-face and online pre-service teachers. Given the lack of conclusive research on this topic, either finding is valuable to teacher education programs as they continue to develop programs of study that are offered both face-to-face and online.

The two dependent variables for this study were technology knowledge and technology beliefs. These variables were chosen because they are the two most significant barriers to classroom technology integration (Hew & Brush, 2007). Technology knowledge was determined using participants' overall average score on the Survey of Preservice Teachers' Knowledge of Teaching and Technology, as well as the average score for each of the seven knowledge subscales (Schmidt et al., 2009a). Technology beliefs, categorized as SE, OE, and INT, were measured using participants' overall average score on the ITIS, as well as the average score on each of the three subscales of the ITIS (Niederhauser & Perkmen, 2008). Once calculated, the overall scores as well as the seven technology knowledge and three technology beliefs scores were analyzed to determine if statistically significant differences existed between the two instructional modality categories of the independent variable.

Data Collection Procedure

The College of Education's Director of Clinical Practice provided student information after approval was obtained from the university to contact students for data collection (Appendix F). Students in the identified sample population received an email during the first eight-week session of the student teaching semester. Emails were sent to the email addresses provided by the Director of Clinical Practice. Only one email was returned as undeliverable. An alternate email address could not be located, so that student was removed from the mailing list. The email message contained the invitation to participate in the study (Appendix B), which included information about myself, the purpose of the study, the risks associated with participation, length of time to complete the survey, information about entering for the drawing for a \$100 Amazon gift card, contact information for any questions, and the link to the Notice of Informed Consent and the survey itself. The survey link was active for three weeks. If a participant experienced technical difficulties while attempting to access the survey, the website directed them to contact Survey Gizmo support at <http://surveygizmov4.helpgizmo.com/help>.

Survey Gizmo directed participants who clicked on the survey link to the electronic Notice of Informed Consent (Appendix C). Participants either chose "Take Survey" or "I do not wish to participate at this time." Clicking "Take Survey" indicated their consent to participate in the study, and they were then automatically directed to the web-based survey instrument (Appendix D). After completing the survey, participants were given the option of submitting their email address to be entered into a drawing for a gift card. Clicking "I do not wish to participate at this time" discontinued participation in the study. The researcher was the only individual with access to the data. The upgraded

account of Survey Gizmo required a unique username and password and did not capture IP addresses or other personal information from participants.

One week after the initial email message, a reminder email was sent to the entire sample population (Appendix E). The same reminder email was also sent two weeks after the initial email message. Reminder emails were sent to all email addresses that had not been submitted for entry to the incentive drawing because there was no other way to track who had completed the survey in order to keep responses anonymous.

Data Analysis

All survey responses were coded automatically in Survey Gizmo in the following manner: *strongly disagree=1, disagree=2, neither agree nor disagree=3, agree=4, and strongly agree=5*. All survey responses were then entered into SPSS for analysis. In addition, scores were averaged for all technology knowledge questions and all technology belief questions to produce an overall score for each category. Scores were also averaged for each of the seven knowledge subscales and three belief subscales. After coding all data, SPSS was used to sort the data in ascending order for each variable. This allowed for cleaning the data by providing easy identification of any out of place, unusual, or missing numbers (Creswell, 2011). Although it is preferable to collect as many responses as possible for data analysis, participants with missing data were eliminated.

After cleaning and accounting for missing data, SPSS was used to perform descriptive statistical analysis. Frequency and percent were calculated for the categorical variables of gender and age both for the entire population and separately for the online and face-to-face populations. Data regarding gender and age were used to describe characteristics of the entire population, as well as characteristics of the online and face-

to-face populations. The mean and standard deviation were calculated both for the entire population and separately for the online and face-to-face populations for overall scores of technology knowledge and technology beliefs, as well as for each of the seven subscales of knowledge and three subscales of technology beliefs. This data was used to compare the online and face-to-face populations to each other and to the entire population, and to determine statistically significant differences between the two populations.

Due to somewhat small sample sizes and the resulting non-normal distribution of data with several outliers, non-parametric statistical tests were chosen for data analysis in SPSS. The non-parametric alternative to the independent samples *t*-test is the Mann-Whitney U test, which analyzes differences for a categorical independent variable and continuous dependent variables, but does not assume a normal distribution of data (Creswell, 2011). The Mann-Whitney U test was used to determine if there were statistically significant differences between the online and face-to-face populations for each of the overall averaged scores for technology knowledge and technology beliefs, as well as each of the seven knowledge subscale scores and the three technology beliefs subscale scores. In addition, the Mann-Whitney U test was used to determine if any statistically significant differences existed between modalities for each individual survey item. A significance level less than 0.05 indicated a statistically significant difference between the groups. This significance level means that 5% of observed differences are due to chance and is typically used with a smaller sample size, such as the one that resulted for this study.

Additionally, although not the focus of this research study, non-parametric Spearman's correlations were run to determine if any relationships existed among any of

the subscales and scales of the survey instrument. The nonparametric Kruskal-Wallis H test was also run to determine if any differences existed between age groups for any of the scales and subscales.

Ethical Considerations

There was minimal risk for participants of this study, as it did not require any risk beyond that experienced in normal life. This risk was stated in both the invitation to participate (Appendix B) and the Notice of Informed Consent (Appendix C). Both documents also clearly stated that participants could choose not to take the survey or to discontinue the survey at any time. IRB approval was obtained from both Creighton University and the participants' university prior to data collection (Appendix F).

No personal information was collected from participants to ensure their anonymity. If participants chose to provide their email addresses to be entered into the gift card drawing, that information was entered on a separate survey page that was not linked to their survey responses. An upgraded account was purchased through Survey Gizmo to further protect participant data. This account did not collect IP addresses from participants or any other identifiable information. The account required a unique username and password for access. The account was kept active for approximately six months to allow for dissertation completion. At that time, all data was deleted from the online survey account, and the account was closed.

Summary

To investigate potential differences in technology knowledge and technology beliefs between online and face-to-face pre-service teachers, a quantitative survey design was used. Participants were both online and face-to-face pre-service teachers enrolled in

either elementary or early childhood student teaching at a university in the southwestern United States. A technology knowledge survey was paired with a technology beliefs survey to create one survey to present to participants. Survey responses were collected electronically via Survey Gizmo after IRB approval was obtained from both Creighton University and the university in which the participants were enrolled. After reading the Notice of Informed Consent, participants were free to choose whether to complete the survey and to discontinue participation at any time. After all data was collected, SPSS software was used to clean and analyze the responses. Chapter 4 presents the results of the data analysis procedures.

CHAPTER FOUR: FINDINGS

Introduction

As stated in Chapter 1, this study investigated the technology knowledge and beliefs of online and face-to-face pre-service teachers. The research question that guided this study was “Do technology knowledge and technology beliefs vary between undergraduate pre-service teachers who receive online instruction and those who receive face-to-face instruction?” The two hypotheses investigated were 1) online pre-service teachers will indicate higher levels of knowledge of how to integrate technology in the classroom to impact student learning than their face-to-face counterparts; and 2) online pre-service teachers will indicate more positive intrapersonal technology beliefs than their face-to-face counterparts.

Throughout this chapter, many abbreviations are used to denote the instruments used and their subscales. Overall knowledge, as measured by the average score of all items on the Survey of Preservice Teachers’ Knowledge of Teaching and Technology (Schmidt et al., 2009) is abbreviated as KT for Knowledge Total. Overall beliefs, as measured by the average score of all items on the Intrapersonal Technology Integration Scale (IT IS; Niederhauser & Perkmen, 2008) are abbreviated as BT for Beliefs Total.

As defined in Chapter 1 the abbreviations for the subscales are:

- TK – Technological Knowledge
- CK – Content Knowledge
- PK – Pedagogical Knowledge
- PCK – Pedagogical Content Knowledge
- TCK – Technological Content Knowledge

- TPK – Technological Pedagogical Knowledge
- TPACK – Technological Pedagogical Content Knowledge
- INT – Interest
- SE – Self-Efficacy
- OE – Outcome Expectations

Methodology

The Survey of Preservice Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009) and the ITIS (Niederhauser & Perkmen, 2008) were presented to participants concurrently via the online survey tool Survey Gizmo. All face-to-face undergraduate elementary and early childhood student teachers, as well as all online undergraduate elementary and early childhood student teachers from two southwestern states, were emailed an invitation to participate in the study that included a link to the survey. All participants were emailed two more times at one-week intervals with reminders to complete the survey. After the survey closed, 12 partial responses were discarded. The data from Survey Gizmo was then exported to an Excel file, and then imported into SPSS for analysis.

SPSS was used to run a variety of statistical analyses to determine if relationships existed between the online and face-to-face groups. Non-parametric tests were used due to the non-normal distribution of data and the presence of several outliers. The non-parametric tests chosen included the Mann-Whitney U test to determine if differences existed between the two groups of modalities, the Kruskal-Wallis H test to determine if differences existed between the four age group categories, and Spearman's correlation to determine if relationships existed among the scales and subscales.

Data Analyses

After importing the Excel file into SPSS, the data was checked for missing values and none were found. Additionally, boxplots were generated for each dependent variable and each subscale to check for outliers. Outliers were discovered for several measures, including CK, PCK, TPACK, INT, SE, OE, and BT. To account for outliers the non-parametric Mann-Whitney U Test was chosen for further analysis because it is less sensitive to outliers than an independent-samples *t*-test ("Mann-Whitney U," 2013).

Results

The link to the online survey tool was emailed to 76 online and 75 face-to-face undergraduate pre-service teachers attending the same university. One face-to-face email was undeliverable and an alternate could not be located, which brought the total face-to-face emails down to 74. Of the 150 emails sent 89 participants accessed the survey. Twelve survey responses were incomplete and therefore discarded. Four participants chose not to complete the survey after accessing it. Overall, 73 complete surveys were collected, which was a response rate of 49%. Of the completed surveys, 32 were online learners, which was 44% of the total completed, and 41 were face-to-face learners, which was 56% of the total completed. As shown in Tables 3 and 4, the majority of participants were females aged 19 to 24.

Table 3

Gender Frequency by Modality

Gender	Online	Face-to-face	Total
Female	31	40	71
Male	1	1	2
Total	32	41	73

Table 4

Age Group Frequency by Modality

Age Group	Online	Face-to-face	Total
19-24	3	39	42
25-34	15	2	17
35-54	11	0	11
55+	3	0	3
Total	32	41	73

Reliability

SPSS was used to calculate reliability for each scale and subscale separately to determine if the items in each scale measured the intended construct. The survey items from the Survey of Preservice Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009a) that measured technology knowledge were internally consistent, with a Cronbach's alpha of .928 for 46 items. The survey items from the ITIS (Niederhauser & Perkmen, 2008) that measured technology beliefs were also internally

consistent, with a Cronbach's alpha of .915 for 21 items. As shown in Table 5, each subscale was also internally consistent.

Table 5

Subscale Internal Reliability

Subscale	Cronbach's Alpha	N
TK	.855	6
CK	.785	12
PK	.875	7
PCK	.776	4
TCK	.790	4
TPK	.929	9
TPACK	.852	4
INT	.824	6
SE	.878	6
OE	.906	9

Hypothesis One

The first hypothesis investigated was that online pre-service teachers would indicate higher levels of knowledge of how to integrate technology in the classroom to impact student learning than their face-to-face counterparts. Distributions of scores for TK, CK, PK, PCK, TCK, TPK, TPACK, and KT were similar based on visual inspection of histograms generated in SPSS. SPSS was used to run the Mann-Whitney U test to analyze the data for a significant difference in overall technology knowledge, as well as the seven TPACK subscales, between online and face-to-face learners. Table 6 displays the results of those Mann-Whitney U tests. Based on the common significance level of $p \leq .05$, no statistically significant differences existed.

Table 6

Technology Knowledge Mann-Whitney U Test Results

Scale	Mann-Whitney <i>U</i>	<i>p</i> -value
TK	562.5	.296
CK	682	.772
PK	757	.258
PCK	738	.346
TCK	690	.697
TPK	664	.929
TPACK	608	.558
KT	698	.640

Because there were no statistically significant differences on the overall knowledge scale and associated subscales, a Mann-Whitney U test was also run for each of the 46 survey items related to knowledge. Three individual survey items were statistically significantly different between the two modalities at the $p \leq .05$ level, as displayed in Table 7.

Table 7

Survey Items Indicating Significant Differences between Modalities

Subscale	Question	<i>p</i> -value
TK	I know about a lot of different technologies.	.039
PCK	I can select effective teaching approaches to guide student learning and thinking in science.	.027
PCK	I can select effective teaching approaches to guide student learning and thinking in social studies.	.035

Hypothesis Two

The second hypothesis investigated was that online pre-service teachers would indicate more positive technology beliefs than their face-to-face counterparts. Distributions of scores for INT, SE, OE, and BT were similar based on visual inspection of histograms generated in SPSS. SPSS was used to run the Mann-Whitney U test to analyze the data for a significant difference in overall technology beliefs, as well as the three subscales, between online and face-to-face learners. Table 8 displays the results of the Mann-Whitney U test. Based on the common significance level of $p \leq .05$, no statistically significant differences existed. Due to the lack of differences on the scales and subscales, the Mann-Whitney U test was also run for each of the 21 individual survey items in the beliefs scale. The test results did not indicate statistically significant differences between modality for any item.

Table 8

Technology Beliefs Mann-Whitney U Test Results

Scale	Mann Whitney <i>U</i>	<i>p</i> -value
INT	686.0	.737
SE	689.5	.707
OE	618.5	.676
BT	680.0	.789

Additional Analyses

Due to the lack of a statistically significant difference between online and face-to-face learners for either of the dependent variables and associated subscales, participants

were grouped together and analyzed as such. Table 9 displays the mean and standard deviation for the entire sample, with N=73 for each scale and the associated subscales.

Table 9

Entire Sample Mean and Standard Deviation

Scale	Mean	Standard Deviation
TK	3.76	0.64
CK	3.87	0.42
PK	4.33	0.46
PCK	4.12	0.55
TCK	4.14	0.55
TPK	4.23	0.55
TPACK	4.14	0.47
KT	4.06	0.35
INT	3.75	0.63
SE	4.08	0.54
OE	3.86	0.59
BT	3.89	0.47

To test for statistically significant relationships among the scales, Spearman's correlations were run in SPSS for several sets of scales. Table 10 displays the correlation coefficients and *p*-values for relationships between each of the seven knowledge subscales and knowledge total. Similarly, Table 11 displays the correlation coefficients and *p*-values for relationships between each of the three belief subscales and beliefs total. All subscales had a moderately strong, positive, statistically significant relationship with the corresponding overall scale for both technology knowledge and beliefs, with a significance level of $p \leq .05$.

Table 10

Spearman's Correlation between Each Knowledge Subscale and KT

Scale	Correlation Coefficient
TK	.597*
CK	.626*
PK	.680*
PCK	.722*
TCK	.761*
TPK	.792*
TPACK	.669*

* $p \leq .01$ for a two-sided test

Table 11

Spearman's Correlation between Each Belief Subscale and BT

Scale	Correlation Coefficient
INT	.737*
SE	.759*
OE	.901*

* $p \leq .01$ for a two-sided test

Additionally, KT and BT had a positive, moderately strong, statistically significant relationship, $r_s = .553, p \leq .01$. Two knowledge subscales, TPK ($r_s = .662, p \leq .01$) and TPACK ($r_s = .614, p \leq .01$), had positive, moderately strong, statistically significant relationships with BT. The belief subscale SE had a positive, moderately strong, statistically significant relationship with KT ($r_s = .715, p \leq .01$).

Because 97% of participants were female, there were no further tests for any relationships based on gender. The Kruskal-Wallis H test was run to determine if there were differences in any of the scales or subscales between the four age groups of 19-24, 25-34, 35-54, and 55+. The results of the test indicated a statistically significant difference in medians between groups for the PK subscale, $H(3) = 8.555$, $p = .036$; however, there were no statistically significant pairwise comparisons. As seen in Figure 2, the median for the 55+ age group is lower than the other age groups as are the minimum and maximum values; however, only three participants indicated their age to be within the 55+ age group.

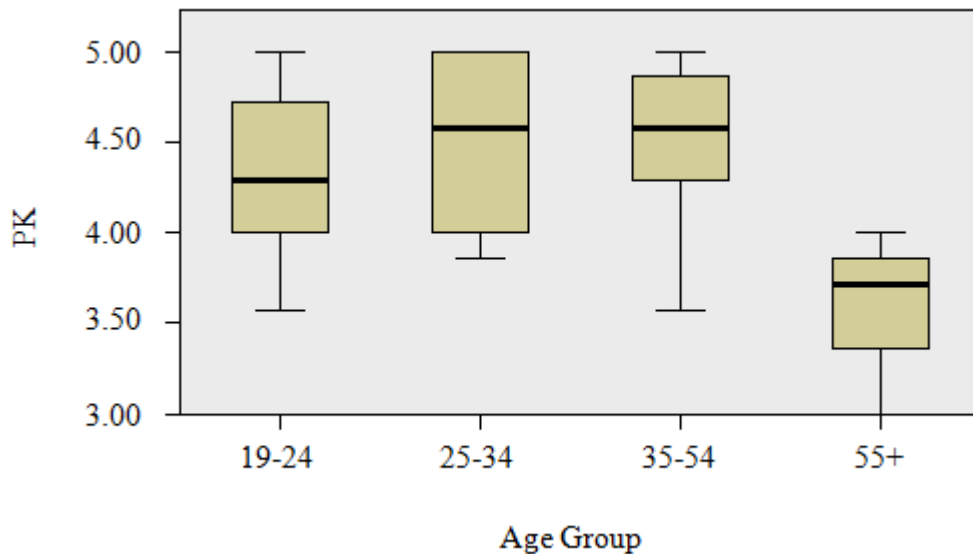


Figure 2. Boxplots of medians per age group for PK subscale.

Summary

After emailing requests to participate in the survey and collecting complete responses from 73 participants, data was exported to SPSS for analysis. Non-parametric tests were chosen because the data were not normally distributed and contained several

outliers. SPSS was used to run the Mann-Whitney U test to determine if there was a statistically significant difference in responses between online and face-to-face learners for two scales, 10 subscales, and each of the 67 individual survey items. After discovering the groups responded similarly, SPSS was used to run Spearman's correlation tests on various scales to determine if any relationships existed among the scales for the whole sample. The Kruskal-Wallis H test was also run to determine if any differences existed between the four age groups for all scales and subscales. Results of the statistical analyses indicated no statistically significant differences between online and face-to-face pre-service teachers for technology knowledge or technology beliefs. However, three individual survey items were found to be statistically significantly different between the two modalities, and several relationships among the scales and subscales were discovered, including a possibly significant difference among age groups for one subscale. These results are discussed further in Chapter 5.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

Introduction

The purpose of this study was to determine if differences in technology knowledge and technology beliefs existed between online and face-to-face pre-service teachers. Although many teachers have technology present in their classrooms, they still do not integrate technology for student learning. Lack of technology knowledge and negative beliefs about technology contribute to the lack of technology integration in United States classrooms (Hew & Brush, 2007). Additionally, many universities are now offering programs, including teacher preparation, in both online and face-to-face modalities. Current research regarding potential differences between learning outcomes of online and face-to-face learners is narrow and inconclusive; there are just as many studies that claim learning differences exist between modalities as there are that claim there are no differences. This study aimed to examine potential differences in technology knowledge and beliefs of online and face-to-face pre-service teachers in an effort to identify areas of improvement for teacher education programs to produce graduates who are willing and able to integrate technology in the 21st century classroom.

This chapter summarizes the research study and provides conclusions based on the results provided in Chapter 4. Implications for practice, suggestions for further research, and a summary of conclusions are also discussed. As referenced in Chapter 4, the abbreviations used throughout this chapter are defined as:

- TK – Technological Knowledge
- CK – Content Knowledge
- PK – Pedagogical Knowledge

- PCK – Pedagogical Content Knowledge
- TCK – Technological Content Knowledge
- TPK – Technological Pedagogical Knowledge
- TPACK – Technological Pedagogical Content Knowledge
- INT – Interest
- SE – Self-Efficacy
- OE – Outcome Expectations

Summary of Study

The purpose of this study was to determine if differences existed between online and face-to-face pre-service teachers in technology knowledge and technology beliefs. The research question that guided the study was, “Do technology knowledge and technology beliefs vary between undergraduate pre-service teachers who receive online instruction and those who receive face-to-face instruction?” To investigate the research question, I emailed both online and face-to-face students enrolled in student teaching at a southwestern university with a request to complete the survey instrument. The survey consisted of a survey to measure technology knowledge as well as a survey to measure technology beliefs presented concurrently. After collecting data for three weeks, I exported the data from Survey Gizmo and imported it into SPSS for analysis.

Analysis in SPSS showed the majority of participants to be females aged 19-24. I did not find any statistically significant differences for technology knowledge or technology beliefs between the online and face-to-face groups using the non-parametric Mann-Whitney U test with all scales and subscales. However, I did discover statistically significant differences between modalities for three individual survey items using the

Mann-Whitney U test. Due to the lack of variance in the two groups, I combined them into one sample for further analysis. After completing the non-parametric Spearman's correlation test in SPSS, I discovered statistically significant positive relationships among some of the survey subscales and overall scales. I also discovered a statistically significant difference among age groups on the PK subscale by running the non-parametric Kruskal-Wallis H test.

Conclusions about Modality and PCK

The two hypotheses I investigated were 1) online pre-service teachers will indicate higher levels of knowledge of how to integrate technology in the classroom to impact student learning than their face-to-face counterparts, and 2) online pre-service teachers will indicate more positive technology beliefs than their face-to-face counterparts. The results of this study do not support either hypothesis. Although not the expected result, the lack of a significant difference between online and face-to-face learners in the scales and subscales measuring technology knowledge and beliefs adds to the body of literature that reports no significant difference between the two modalities. Several factors may have influence the outcomes of this study.

One factor that may have influenced study outcomes was participants' predispositions for technology use, regardless of modality. Despite the mirrored curriculum use for both the online and face-to-face pre-service teachers, it was not within the parameters of this study to determine if modality was truly a differentiating factor between the two groups. Pre-service teachers who chose to respond to the survey may have done so because they already had higher levels of technology knowledge and positive technology beliefs, thus providing results of students who are already more

likely to use technology regardless of modality. The web-based survey format may have caused those who lack technology knowledge or have negative technology beliefs to be predisposed to decline the invitation to participate.

Another factor that may have influenced the outcome of this study is the required use of technology for participants from both modalities. The university where the participants were enrolled requires all students to use the same learning management system (LMS) regardless of modality. Online learners use the LMS to read lectures, participate in discussions with peers, communicate with professors, submit assignments, and view feedback. Face-to-face learners also use the LMS to communicate with professors and classmates outside of class hours, submit assignments, and view feedback. In addition, due to rapid growth at the university, during the 2014-2015 school year many face-to-face learners were strongly encouraged to take as many as two online courses per semester due to a lack of classroom space. Because of the heavy use of the LMS and increased numbers of online courses, face-to-face and online learners may have experienced comparable levels of technology use for learning throughout the latter portion of their program. Research with online students who rely on an LMS and face-to-face students who do not heavily use an LMS and/or do not take any online courses may provide different results.

Despite the factors that may have influenced study outcomes, responses were statistically significantly different between the online and face-to-face groups for three individual survey items which were all part of the technology knowledge scale. Of the three items, one was part of the TK subscale, and the other two were part of the PCK subscale. Although the TK subscale only had a moderately strong relationship to KT,

PCK had one of the strongest positive relationships to KT of all the subscales. Shulman (1986) initially argued that PCK was most important for effective teaching. These results support Shulman's findings, and indicate PCK may still influence a teacher's technology integration decisions.

Based on the results of this study as well as Shulman's (1986) recommendations, teacher education programs should include coursework and experiences that develop pre-service teachers' PCK since it may positively influence their decisions to integrate technology in their classrooms in the future. In addition, since two of the four PCK items illustrated statistically different outcomes between the two modalities, the development of PCK should be an area of focus for teacher educators and anyone who writes curriculum for teacher education programs that are offered both online and face-to-face. Rather than focusing on content or pedagogy separately, pre-service teachers need explicit instruction and experiences that demonstrate the importance of the relationship between content and pedagogy.

Conclusions about Knowledge and Beliefs Scales

Spearman's correlations resulted in statistically significant, moderately positive relationships between a few of the subscales and the overall knowledge and beliefs scales, as well as between overall knowledge and overall beliefs, when all 73 survey responses were analyzed together. Although the relationship between overall knowledge and overall beliefs was only moderately strong, it does indicate a relationship between increased technology knowledge and more positive technology beliefs.

Outcome Expectations (OE)

The OE subscale had an especially strong, positive, statistically significant relationship with BT. That result supports the deeper investigation of OE rather than SE as a significant contributing factor to overall positive beliefs about technology integration, which then leads to increased classroom technology integration. This outcome suggests the importance of focusing on technology skills to increase SE, teacher educators and those who write curriculum for teacher education programs should include explicit opportunities for students to recognize the benefits of integrating technology in their classrooms throughout their program. This intentional development of OE could lead students to feel they *should* integrate technology, providing motivation to actually do so once they are in the field.

Self-Efficacy (SE)

While all subscales related positively to the corresponding overall scales, several subscales also related positively to the opposite overall scale. For example, the SE subscale, which was part of the larger beliefs scale, had a positive, moderately strong, statistically significant relationship with KT nearly equal in strength to the relationship between SE and BT. As stated previously, most existing research on technology beliefs focused on SE. Based on the results of the relationship between SE and KT for this study, the focus on SE is warranted and should continue. Study results clearly indicate an increase in SE may lead to an increase in both KT and BT, which may ultimately result in increased technology integration in the classroom.

Study results provide important guidance for teacher education curricula. Teacher educators should focus on increasing pre-service teachers' SE by providing opportunities

to learn, practice, and successfully implement various technology skills, which could increase their technology knowledge and lead to more positive beliefs. Even though SE is positively related to both KT and BT, teacher educators should not focus on SE alone. Outcome expectations are of equal importance given the strength of the relationship between OE and BT.

Technology and Pedagogy

The two knowledge subscales of TPK and TPACK had positive, moderately strong, statistically significant relationships with BT. The commonalities between those two subscales are pedagogy and technology. These study results indicate that an understanding of the relationship between pedagogy and technology may positively influence a teacher's technology beliefs, which could lead to increased technology integration. Based on these study results, teacher educators should purposefully provide opportunities for pre-service teachers to increase their understanding of how technology supports teaching (TPK), and how to teach content using appropriate pedagogical techniques and technology resources (TPACK). Increases in knowledge in these two areas may positively influence technology beliefs, and in turn, technology integration.

Implications for Practice

It is no longer sufficient to focus on knowledge and beliefs separately. Those two barriers to technology integration are intertwined and strongly influence one another. Teacher educators and curriculum writers must shift their view from technology knowledge and beliefs as silos to an integrated model in order to change the technology integration behaviors of pre-service teachers.

Based on the statistically significant correlations produced by this study, teacher educators need to focus efforts in the classroom on self-efficacy with technology skills, outcome expectations, and the relationship between pedagogy and technology. Those subscales were all positively related to both KT and BT. More positive SE and OE, and increased knowledge of the relationship between pedagogy and technology could increase the likelihood that pre-service teachers will integrate technology in their future classrooms by increasing their technology knowledge and beliefs.

Conversely, the subscale of INT had only a moderately strong relationship to BT and did not have a statistically significant relationship to KT. That result indicates INT has less influence on BT than either SE or OE, and INT has no influence on KT. As SE and OE develop, pre-service teachers should develop INT, so it is unnecessary for teacher educators to focus specifically on INT based on the results of this study.

Based on the outcomes of this study, I recommend the following constructs, which were shown to have relationships with technology knowledge and technology beliefs in this study, be included in the learning experiences provided by teacher educators and teacher education programs:

- pedagogical content knowledge
- technology outcome expectations
- technology self-efficacy
- the relationship between pedagogy and technology

Additionally, I recommend that teacher education programs integrate educational technology concepts throughout all teacher preparation courses, rather than as a separate course. The results of this study indicate relationships among pedagogy, content,

technology knowledge, and technology beliefs, meaning they should not be taught in isolation. As curriculum is rewritten to integrate technology throughout teacher preparation courses, the ISTE Standards (ISTE, 2015b) must be explicitly and thoughtfully aligned to coursework in the curriculum regardless of content area. Teacher educators must effectively model the integration of technology, pedagogy, and content since they directly influence those they teach, and curricular and programmatic decisions should support that effort.

Suggestions for Further Research

Although this particular study did not yield significant differences between online and face-to-face pre-service teachers in overall technology knowledge and beliefs, the lack of research on this topic alone warrants further investigation. As stated previously, the face-to-face pre-service teachers in this study attended a university that relies heavily on technology regardless of modality. Future studies with face-to-face students who had taken few to no online courses may produce different results. In addition, the web-based presentation of the survey used in this study may have appealed more to students who already have higher levels of technology knowledge and more positive technology beliefs. Mailing physical surveys may also provide different results as some pre-service teachers who lack technology knowledge and have negative beliefs may be more inclined to respond. Replicating the study with graduate rather than undergraduate pre-service teachers, at public rather than private universities, and universities in other areas of the United States may also produce different outcomes.

Only two males completed the survey for this study compared to 71 females. Differences may exist between genders for technology knowledge and beliefs, but a

much larger population is needed to test for that. Currently, there are far more women than men enrolled in teacher education programs (National Education Association, 2014), which may make it difficult to compare the two groups. Age may also play a role in technology differences. There were statistically significant differences between age groups for the PK subscale in this study, indicating a need for further study.

Unfortunately, the distribution of participants by age group for this study was uneven rendering the statistical differences inconclusive. Future research with more participants in the 35-54 and 55+ age groups could provide different results, particularly since online students tend to belong to these age groups.

In addition, further research regarding the OE, SE, TPK, and TPACK of pre-service and practicing teachers is needed. The data from this study indicated strong, positive relationships between those subscales and both overall scales. More research is needed with a larger population to determine if those results are generalizable.

Other considerations are income, race/ethnicity, and community type (urban, suburban, or rural). These demographic variables were shown to have a relationship with computer use (Pew Research Center, 2014). Studying a larger online population of pre-service teachers located across the United States could indicate differences in technology knowledge and beliefs based on income, race/ethnicity, and/or community type.

Summary

“Even if every [external] barrier were removed, teachers would not automatically use technology to achieve the kind of meaningful outcomes advocated” (Ertmer, 1999, p. 51). Programs aimed at increasing technology access in all schools and libraries have removed technology access as an external barrier to teacher technology integration, but

teachers are still not using technology effectively in their classrooms. Lack of technology knowledge and negative beliefs about technology continues to prevent teachers from integrating technology in classrooms in the United States, which puts students at a disadvantage when competing for resources and jobs globally. Teacher educators have the opportunity to influence the technology knowledge and beliefs of pre-service teachers by modeling appropriate technology use and providing exposure to positive technology experiences. If teacher educators can provide learning experiences that encourage pre-service teachers to believe both in their ability to use technology in the classroom, as well as the importance of doing so, teacher educators could increase the likelihood that students in K-12 classrooms across the United States will be exposed to technology-rich instruction. This technology-rich instruction will provide K-12 students with the 21st Century skills needed to compete in today's global marketplace.

I surveyed both online and face-to-face pre-service teachers to determine if differences in technology knowledge and beliefs existed in the two populations. I ran several non-parametric tests in SPSS to test for relationships between the two modalities. While I did not discover a statistically significant difference between online and face-to-face pre-service teachers' technology knowledge and beliefs, the results of the analysis on individual survey items indicated that teacher educators and those who write curriculum for teacher education programs might need to consider the construct of PCK when differentiating instruction for online and face-to-face students. There was a statistically significant difference between online and face-to-face students on the outcomes of 50% of the items for the PCK subscale.

Additionally, more research is needed regarding the TPACK subscales and technology beliefs subscales to better understand how they influence pre-service teachers technology integration decisions. The results of this study indicated that teacher educators should focus on SE, OE, and the relationship between technology and pedagogy to increase the potential for technology integration in future teachers. The constructs of SE, OE, TPK, and TPACK were each positively related to both technology knowledge and technology beliefs. As long as pre-service and practicing teachers continue to lack the knowledge, confidence, interest, and motivation to integrate technology in the classroom, United States' students will continue to be at a disadvantage when entering the global workforce.

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Appendix A

Permission to Use Survey Instruments


← REPLY ←← REPLY ALL → FORWARD ⋮

 Dale Niederhauser <dsniederhauser@mail.wvu.edu> mark as unread
Tue 8/26/2014 1:39 PM

To: Abby Brown;

- Flag for follow up. Start by Tuesday, August 26, 2014. Due by Tuesday, August 26, 2014.
- You replied on 8/26/2014 1:45 PM.

📎 1 attachment ◀ ▶

 Intrape~.d
docx

You are welcome to use the scale. Sounds like an interesting project. Attached is a version of the scale for your use with some information on factor loadings. Best of luck with your research.

Dale S. Niederhauser
Professor and Chair

Curriculum & Instruction/Literacy Studies
West Virginia University
Morgantown, WV 26506
304-293-4446

Survey of Preservice Teachers' Knowledge of Teaching and Technology Usage Terms (Schmidt et al., 2009b): "Researchers are free to use the TPACK survey, provided they contact Dr. Denise Schmidt (dschmidt@iastate.edu) with a description of their intended usage (research questions, population, etc.), and the site locations for their research. The goal is to maintain a database of how the survey is being used, and keep track of any translations of the survey that exist."

From: Abby Brown Sent: Fri 8/22/2014 11:56 AM
To: 'dschmidt@iastate.edu'
Cc:
Subject: Request for permission to use survey

Good morning, Dr. Schmidt! I am writing to request permission to use the Survey of Preservice Teachers Knowledge of Teaching and Technology for my doctoral dissertation research at Creighton University. I will be studying both online and face-to-face preservice teachers who are student teaching. The participants will be undergraduate elementary and early childhood majors from Grand Canyon University in Phoenix, Arizona. My research question is "Do technology knowledge and technology beliefs vary between undergraduate pre-service teachers who receive online instruction and those who receive face-to-face instruction?" Your survey would be used to understand the technology knowledge portion of my research, and I will be using a different instrument for technology beliefs. I plan to use items 1-46 from your instrument.

Thank you,

Abby Brown, M.Ed.
Assistant Professor
College of Education
Grand Canyon University
(602) 639 - 6745

*Appendix B***Email Invitation to Participate**

Dear [Participant]:

I am a doctoral candidate in Creighton University's Interdisciplinary Leadership doctoral program, and am writing to invite you to participate in my dissertation research study. The purpose of the study is to compare the technology knowledge and technology beliefs of online and face-to-face undergraduate pre-service teachers. The data obtained will be useful for universities to differentiate learning experiences for online and face-to-face learners to maximize the potential for pre-service teachers to integrate technology in their K-12 classrooms once they enter the field.

The survey is web-based and should take approximately 15 minutes to complete. The Notice of Informed Consent and survey can be accessed at [URL of survey] until [date]. Although you will not be compensated for your time, you may submit your email address to be entered for a drawing to win a \$100 Amazon gift card.

Your responses are anonymous. Should you choose to provide an email address to be entered in the gift card drawing, your email address will not be associated with your survey responses, and will be kept confidential. No internet protocol (IP) addresses will be saved. Your responses will not affect your grades in any way.

There are no known risks to participants in this study, and your participation is voluntary. You are free to withdraw from the study at any time.

You are free to take the survey whenever it is convenient for you by clicking on this link [URL of survey]. After submitting the survey, a window will appear where you can enter your email address if you wish to be entered into the gift card drawing.

If you have any questions about the survey, please contact me via the information below. Your participation is greatly valued and appreciated.

Thank you!
Abby Brown, Principal Investigator
Abby.brown@gcu.edu
602-639-6745

*Appendix C***Electronic Notice of Informed Consent**

Protocol Title: Development of Technology Knowledge and Beliefs: Does Instructional Modality Matter?

Protocol Number:

Principal Investigator's Name and Department:

Abby Brown, Creighton University, EdDc

Principal Investigator's Address and Telephone Number:

3300 W Camelback Road, Phoenix, AZ 85017

602-639-6745

Introduction

This research aims to identify differences in technology knowledge and beliefs of online and face-to-face pre-service teachers.

Study Purpose and Procedures

The purpose of the study is to compare the technology knowledge and technology beliefs of online and face-to-face undergraduate pre-service teachers. The data obtained will be useful for universities to differentiate learning experiences for online and face-to-face learners to maximize the potential for pre-service teachers to integrate technology in their K-12 classrooms once they enter the field.

The study consists of a web-based survey that should take approximately 15 minutes to complete. The survey consists of questions about your knowledge and beliefs related to classroom technology integration.

Benefits of Participating in the Study

While there are no direct benefits to you as a student, the study will provide useful data for improving the technology experiences of both online and face-to-face pre-service teachers during their teacher education programs so they are more prepared to integrate technology once they enter the classroom.

Risks of Participating in the Study

The risk to participants in this study is minimal. No more risk than is encountered in everyday life is expected.

Confidentiality

I will do everything I can to keep your records confidential. However, it cannot be guaranteed. Your responses to survey questions are anonymous, and no identifying information, including IP addresses, will be captured.

I may present the research findings at professional meetings or publish the results of this research study in relevant journals. However, I will always keep your name, address, or other identifying information private.

Disclosure of Appropriate Alternatives

There are no alternatives; however, participation is voluntary and you may withdraw from the study at any time.

Compensation for Participation

You may choose to submit your email address to enter a drawing for a \$100 Amazon gift card.

Contact Information

Should you have any questions regarding this research, please contact me directly.

Abby Brown

Abby.brown@gcu.edu

602-639-6745

The Creighton University Institutional Review Board (IRB) offers you an opportunity (anonymously if you so choose) to discuss problems, concerns, and questions; obtain information; or offer input about this project with an IRB administrator who is not associated with this particular research project. You may call or write to the Institutional Review Board at (402) 280-2126; address the letter to the Institutional Review Board, Creighton University, 2500 California Plaza, Omaha, NE 68178 or by email at irb@creighton.edu.

We would appreciate your feedback on your experience as a research participant at Creighton University; please fill out our survey at <http://www.creighton.edu/participantsurvey>

Bill of Rights for Research Participants

As a participant in a research study, you have the right:

- 1. To have enough time to decide whether or not to be in the research study, and to make that decision without any pressure from the people who are conducting the research.**
- 2. To refuse to be in the study at all, or to stop participating at any time after you begin the study.**
- 3. To be told what the study is trying to find out, what will happen to you, and what you will be asked to do if you are in the study.**
- 4. To be told about the reasonably foreseeable risks of being in the study.**
- 5. To be told about the possible benefits of being in the study.**
- 6. To be told whether there are any costs associated with being in the study and whether you will be compensated for participating in the study.**

7. **To be told who will have access to information collected about you and how your confidentiality will be protected.**
8. **To be told whom to contact with questions about the research, about research-related injury, and about your rights as a research subject.**
9. **If the study involves treatment or therapy:**
 - a. **To be told about the other non-research treatment choices you have.**
 - b. **To be told where treatment is available should you have a research-related injury, and who will pay for research-related treatment.**

You are free to refuse to participate in this research project or to withdraw your consent and discontinue participation in the project at any time without penalty.

By selecting “Take Survey” below, you agree to participate in the project as described above. If you do not wish to participate in the project described above, please select “I do not wish to participate at this time.”

[Take Survey]

[I do not wish to participate at this time]

*Appendix D***Survey Instrument****Demographic Information****2) What is your gender?**

- Male
- Female

3) What age group do you belong to?

- 19-24
- 25-34
- 35-54
- 55+

4) An online student is one who completes at least 80% of their program online. A face-to-face student is one who completes less than 80% of their program online. Given that information, how have you completed your program?

- Online
- Face-to-face

Technology Knowledge

Strongly disagree Disagree Neither agree or disagree Agree Strongly agree

- 5) I know how to solve my own technical problems.
- 6) I can learn technology easily.
- 7) I keep up with important new technologies.
- 8) I frequently play around with technology.
- 9) I know about a lot of different technologies.
- 10) I have the technical skills I need to use technology.
- 11) I have sufficient knowledge about mathematics.
- 12) I can use a mathematical way of thinking.
- 13) I have various ways and strategies of developing my understanding of mathematics.
- 14) I have sufficient knowledge about social studies.
- 15) I can use a historical way of thinking.
- 16) I have various ways and strategies of developing my understanding of social studies.
- 17) I have sufficient knowledge about science.
- 18) I can use a scientific way of thinking.
- 19) I have various ways and strategies of developing my understanding of science.
- 20) I have sufficient knowledge about literacy.
- 21) I can use a literary way of thinking.
- 22) I have various ways and strategies of developing my understanding of literacy.
- 23) I know how to assess student performance in a classroom.
- 24) I can adapt my teaching based-upon what students currently understand or do not understand.
- 25) I can adapt my teaching style to different learners.

- 26) I can assess student learning in multiple ways.
- 27) I can use a wide range of teaching approaches in a classroom setting.
- 28) I am familiar with common student understandings and misconceptions.
- 29) I know how to organize and maintain classroom management.
- 30) I can select effective teaching approaches to guide student thinking and learning in mathematics.
- 31) I can select effective teaching approaches to guide student thinking and learning in literacy.
- 32) I can select effective teaching approaches to guide student thinking and learning in science.
- 33) I can select effective teaching approaches to guide student thinking and learning in social studies.
- 34) I know about technologies that I can use for understanding and doing mathematics.
- 35) I know about technologies that I can use for understanding and doing literacy.
- 36) I know about technologies that I can use for understanding and doing science.
- 37) I know about technologies that I can use for understanding and doing social studies.
- 38) I can choose technologies that enhance the teaching approaches for a lesson.
- 39) I can choose technologies that enhance students' learning for a lesson.
- 40) My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.
- 41) I am thinking critically about how to use technology in my classroom.
- 42) I can adapt the use of the technologies that I am learning about to different teaching activities.
- 43) I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.
- 44) I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.
- 45) I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.
- 46) I can choose technologies that enhance the content for a lesson.
- 47) I can teach lessons that appropriately combine mathematics, technologies and teaching approaches.
- 48) I can teach lessons that appropriately combine literacy, technologies and teaching approaches.
- 49) I can teach lessons that appropriately combine science, technologies and teaching approaches.
- 50) I can teach lessons that appropriately combine social studies, technologies and teaching approaches.

Technology Beliefs

Strongly disagree Disagree Neither agree or disagree Agree Strongly agree

- 51) I feel confident that I have the necessary skills to use instructional technology for instruction.
- 52) Using instructional technology in the classroom will make it easier for me to teach.

- 53) I have an interest in reading articles or books about instructional technology.
- 54) Using instructional technology in the classroom will increase my effectiveness as a teacher.
- 55) I am interested in working with instructional technology tools.
- 56) Using instructional technology in the classroom will make my teaching more exciting.
- 57) I feel confident that I can effectively use instructional technology in my teaching.
- 58) Effectively using instructional technology in the classroom will increase my sense of accomplishment.
- 59) Using instructional technology in the classroom will make my teaching more satisfying.
- 60) I feel confident that I can regularly incorporate appropriate instructional technologies into my lessons to enhance student learning.
- 61) Effectively using instructional technology in the classroom will increase my colleagues' respect of my teaching ability.
- 62) My colleagues will see me as competent if I effectively use instructional technology in the classroom.
- 63) I feel confident that I can select appropriate instructional technology for instruction based on curriculum standards-based pedagogy.
- 64) I have an interest in working on a project involving instructional technology concepts.
- 65) Using instructional technology in the classroom will increase my productivity.
- 66) I feel confident that I can teach relevant subject matter with appropriate use of instructional technology.
- 67) I am interested in learning about new educational software.
- 68) I feel confident that I can help students when they have difficulty with instructional technology.
- 69) I have an interest in listening to a famous instructional technologist speaking about effective use of instructional technology in the classroom.
- 70) Effectively using instructional technology in the classroom will increase my status among my colleagues.
- 71) I have an interest in attending instructional technology workshops during my teaching career.

*Appendix E***Email Reminder to Participants**

Dear [Participant]:

A week ago you should have received an email invitation to participate in my research study that is part of my doctoral program at Creighton University. If you already completed the survey, I thank you very much for your time, and you can disregard the remainder of this email. If you have not taken the time to complete the survey, I ask that you reconsider. The survey is web-based and takes only 15 minutes to complete.

The Notice of Informed Consent and survey can be accessed at [URL of survey] until [date]. Although you will not be compensated for your time, you may submit your email address to be entered for a drawing to win a \$100 Amazon gift card.

Your responses are anonymous. Should you choose to provide an email address to be entered in the gift card drawing, your email address will not be associated with your survey responses, and will be kept confidential. No internet protocol (IP) addresses will be saved. Your responses will not affect your grades in any way.

There are no known risks to participants in this study, and your participation is voluntary. You are free to withdraw from the study at any time.

You are free to take the survey whenever it is convenient for you by clicking on this link [URL of survey]. After submitting the survey, a window will appear where you can enter your email address if you wish to be entered into the gift card drawing.

If you have any questions about the survey, please contact me via the information below. Your participation is greatly valued and appreciated.

Thank you!
Abby Brown, Principal Investigator
Abby.brown@gcu.edu
602-639-6745

*Appendix F***IRB Approval**

**GRAND CANYON
UNIVERSITY™**

3300 West Camelback Road, Phoenix Arizona 85017 602.639.7500 Toll Free 800.800.9776 www.gcu.edu

DATE: December 9, 2014

TO: Abby Brown

FROM: Grand Canyon University Institutional Review Board

STUDY TITLE: [658308-1] Development of Technology Knowledge and Beliefs: Does Instructional Modality Matter?

IRB REFERENCE #:

SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF EXEMPT STATUS

DECISION DATE: December 9, 2014

REVIEW CATEGORY: Exemption category # 7.2

Thank you for your submission of New Project materials for this research study. Grand Canyon University Institutional Review Board has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations.

We will put a copy of this correspondence on file in our office.

If you have any questions, please contact Stephanie Henkel at 602-639-8010 or stephanie.henkel@gcu.edu. Please include your study title and reference number in all correspondence with this office.

cc:



Social Behavioral Institutional Review Board
2500 California Plaza • Omaha, Nebraska 68178
phone: 402.280.2126 • fax: 402.280.4766 • email: irb@creighton.edu

DATE: December 10, 2014

TO: Abby Brown
FROM: Creighton University IRB-02 Social Behavioral

PROJECT TITLE: [654194-1] Development of Technology Knowledge and Beliefs: Does Instructional Modality Matter?

SUBMISSION TYPE: New Project

ACTION: DETERMINATION OF EXEMPT STATUS
DECISION DATE: December 10, 2014

REVIEW CATEGORY: Exemption category # 2/3

Thank you for your submission of New Project materials for this project. The following items were reviewed in this submission:

- Application Form - Application for Determination of Exempt Status (UPDATED: 12/9/2014)
- Consent Form - Information letter (UPDATED: 12/9/2014)
- Letter - Email Reminder to Participate (UPDATED: 12/9/2014)
- Letter - Email Invitation to Participate (UPDATED: 12/9/2014)
- Other - Site IRB Approval (UPDATED: 12/9/2014)
- Other - Site Authorization Letter (UPDATED: 12/9/2014)
- Proposal - Dissertation Proposal (UPDATED: 12/9/2014)
- Questionnaire/Survey - Survey Instrument (UPDATED: 12/9/2014)

An IRB administrator has determined this project is EXEMPT FROM IRB REVIEW according to federal regulations. All changes to approved research must be submitted to the IRB to access if the project continues to be exempt. We will retain a copy of this correspondence within our records.

If you have any questions, please contact Christine Scheuring at 402-280-3364 or christinescheuring@creighton.edu. Please include your project title and reference number in all correspondence with this committee.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within Creighton University IRB-02 Social Behavioral's records.