2016

Complexities of Technology Integration in the Elementary Classroom Context: A Structural Equation Model Study

Heather M. Monroe-Ossi
University of North Florida

Complexities of Technology Integration in the Elementary Classroom Context: A Structural Equation Model Study

by

Heather Melissa Monroe-Ossi

A Dissertation submitted to the Department of Educational Leadership

in partial fulfillment of the requirements for the degree of

Doctor of Education

UNIVERSITY OF NORTH FLORIDA

COLLEGE OF EDUCATION AND HUMAN SERVICES

April, 2016

This dissertation titled *Complexities of Technology Integration in the Elementary Classroom Context: A Structural Equation Model Study* is approved:

Dr. Sandra Gupton, Phd

Dr. Cheryl Fountain, EdD

Dr. Janice Seabrooks-Blackmore, PhD

Dr. Sharon Cobb, PhD

Accepted for the Department of Educational Leadership, School Counseling, and Sports Management:

Dr. Christopher Janson, PhD

Accepted for the College of Education and Human Services:

Dr. Marcia Lupi, PhD

Accepted for the University:

Dr. John Kantner, PhD
Dean of the Graduate School

DEDICATION

"The good news is that the moment you decide that what you know is more important than what you have been taught to believe, you will have shifted gears in your quest for abundance.
Success comes from within, not from without."
— Ralph Waldo Emerson

This work is dedicated to my loves. There are no words that can express my gratitude.

ACKNOWLEDGMENTS

This research would not be possible without the support of my dear mentor and chairperson, Dr. Sandra Gupton. Your work ethic, leadership, intelligence, and beautiful southern bravado has impacted me in ways that have truly made me a better student, leader, and person of character. Thank you for standing by my side and fighting the good fight, picking me up when I was ready to give up, and guiding me through to the end of the journey. To the amazing women at the Florida Institute of Education – Dr. Cheryl Fountain, Dr. Katherine Kasten, and Dr. Stephanie Wehry, I thank you for showing me what courage, passion, and persistence means professionally and personally. Each of you has given me so much of your time and expertise, all of which have become life lessons that I cherish. To Dr. Sharon Cobb and Dr. Janice Seabrooks-Blackmore, I thank you for being respected members of my committee. I am particularly grateful for your individual perspectives, professionalism, and flexibility as I traveled different paths on this journey. To Dr. Francis Godwyll and Dr. Chris Janson, I am very appreciative of the role each of you played while being on my committee. I am humbled by the support each and every one of you has provided me in making this dream a reality.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Effectively integrating technology into classroom instruction presents teachers with several dilemmas about their understanding of how students learn, their approach to designing learning activities, and their conceptualization of their role as teachers (Windschitl, 2002). To maximize efforts invested into helping teachers' embed technology into classroom practice, valid and reliable instruments are necessary to identify the complex factors associated with technology integration more accurately. Using the Technological Pedagogical Content Knowledge (TPACK) model (Koehler & Mishra, 2005, 2009; Mishra & Koehler, 2006) as the conceptual model undergirding the research, this study was designed to build evidence towards establishing the validity and reliability of a measurement instrument employed to assess the technological, pedagogical, and content knowledge teachers utilize, as well as gain an understanding of how this knowledge is affected by teacher beliefs about technology use in classroom practice. Among the measurement tools reviewed, the TPACK-deep scale (Kabakci-Yurdakul et al., 2012) demonstrated the greatest potential to serve as a reliable measure of pre-service teachers' beliefs about their technology integration abilities. Thus, this scale was selected to examine in-service teachers' beliefs about how they use technology in classroom practice in the present study. A review of literature indicated that context also affects teachers' use of technology. Thus, three contextual factors were also investigated, namely leadership support for technology, teaching self-efficacy, and traditional beliefs about children.

Structural equation modeling (SEM) was selected for analyzing data gathered in this research design. This methodology was well suited because SEM offers researchers a means of assessing theoretical constructs and their relationships (Anderson & Gerbing, 1988). The

relationships among four latent factors and three latent variables were examined using measurement models to determine a final structural model.

Results from this exploratory study involving seventy-five in-service elementary school teachers in Florida (*N* = 75) suggest that the TPACK-deep scale has potential as a measure of teachers' beliefs about their technological, pedagogical, and content knowledge. Further, these findings posit that the scale could be used as a one-factor measure or, as selected in this exploratory study, as a four-factor measure of teacher efficacy in technology use. The findings yielded by the present exploratory study pertain to Design, Exertion, Ethics, and Proficiency—which are considered the four factors of the TPACK-deep scale (Kabakci-Yurdakul et al., 2012). Of particular interest were teachers' beliefs about their design abilities using technology, their exertion abilities implementing instruction with technology, and their behaviors related to ethical uses of technology, as well as teachers' beliefs about their technology integration proficiency. Furthermore, this study's findings indicate positive predictive relationships between leadership support for technology and teachers' beliefs about using technology in their classrooms. While positive predictive relationships between teachers' teaching self-efficacy and their beliefs about technology integration in classroom practice were found, no statistically significant association between teachers' beliefs about using technology and their traditional beliefs about children could be established for three (Design, Exertion, Ethics) of the four TPACK-deep factors under investigation.

CHAPTER 1: INTRODUCTION

This exploratory quantitative research study aimed to examine in-service teachers' beliefs about their abilities to integrate technology into their classroom practice. The investigation primarily relied upon the TPACK (Technological Pedagogical Content Knowledge) model (Koehler & Mishra, 2005, 2009; Mishra & Koehler, 2006), which is a conceptual framework created to identify the types of knowledge used simultaneously when integrating technology in classroom practice by both in-service and pre-service teachers. The purpose of this study was to contribute to the knowledge of TPACK measurement by exploring how an instrument previously applied to assess pre-service teachers' beliefs about their abilities to integrate technology in classroom practice would perform when applied to the data gathered from in-service elementary classroom teachers in Florida. The aim was also to investigate the relationships among in-service teachers' beliefs about their technology integration abilities and three contextual factors hypothesized to affect teachers' beliefs about their technology integration abilities. This first chapter of the dissertation presents the background of the study, specifies the problem the study aims to address, elucidates its significance, and presents an overview of the methodology used. The chapter also delineates delimitations of the study and identifies key terms used before concluding by presenting the organization of the remainder of the dissertation.

Background

In the last two decades, the rapid advancements in science and technology have resulted in significant changes in human interaction in modern urban society. This shift in modes of communication and travel has facilitated rapid global interconnectivity among individuals, organizations, and institutions. Yet, these advances have also brought complex challenges to industrial-based and agricultural-based economies that rely primarily on production. According to Katz and Miller (2010), this emerging digital age necessitates an economy focused on unleashing innovation, creativity, and critical thinking.

As the world becomes increasingly globalized, competition for available jobs will also intensify, whereby employees must focus on developing and utilizing creativity, collaboration, and critical thinking abilities. These 21st century skills are a prerequisite for success in a digitally driven economy. Developing these 21st century skills is particularly important for educational practices in the modern era, as the new generations will be the workforce of the future, when these skills will be seen as the norm. Unfortunately, in education, integration of technology used for learning, teaching, and leading has failed to keep pace with industry and other enterprises, thus limiting the technological potential of students and teachers.

Undergirding a successful progression toward global readiness is the development of new literacies, specifically digital literacies, defined by O'Brien and Scharber (2008) as "socially-situated practices supported by skills, strategies, and stances that enable representation and understanding of ideas using a range of modalities enabled by digital tools" (pp. 66-67). Understanding how current approaches to formal schooling can benefit from incorporating these literacies in classroom and leadership practice has never been more urgent. Digital literacies and rapidly changing technologies are the key determinants of who will and who will not have opportunities for success (Lankshear & Knobel, 2011).

Students of the technological era are often referred to as digital natives (Prensky, 2001). They have had access to the Internet, computer technology, and mobile devices for the majority of their lives. However, empirical evidence suggests that a digital native does not equate to a digital learner. As Hughes (2005) pointed out, while these students may have an innate ability to multitask, communicate, and collaborate with fearlessness, they do not necessarily have the aptitudes needed to transfer these skills to complex learning tasks. Thus, teachers must find ways to take advantage of the technological skills students have without accommodating the oftentimes-counterproductive accompanying habits of instant gratification and reactionary thinking. Barnes, Marateo, and Ferris (2007), concurred with this view, adding, "The challenge of evolving pedagogy to meet the needs of Net-savvy students is daunting, but educators are assisted by the fact that this generation values education. These students learn in a different way than their predecessors did, but they do want to learn" (para. 1). While the impact of technology on society has generated the need for digital literacy and 21st century skills, it is the responsibility of educators, both teachers and principals, to ensure that students become effective digital learners and develop the ability to complete complex tasks.

Yet, in order for teachers to promote the digital literacy of their students, they must first become digitally literate themselves. Today's students acquire and use information in ways that are different from those their teachers are often most familiar with. This mismatch results in a widening technology gap between the teacher and the student. The increased access to, but continued underuse or lag in use of technology in education makes it increasingly urgent to understand how teachers perceive the integration of technology in their classroom practice if they are to provide students with accountable and effective instruction in the digital era.

Pundits have said that it is easier to put a man on the moon than to reform public schools. Nowhere is this paradox more apparent than in the way teachers interact with technology. Since the mid-nineteenth century, the public school classroom has become home to a succession of innovative tools and technologies. In the 19th century, lecture was the primary teaching strategy.

Chalk, slate, books, and illustrations were tools used to augment and aid the lecturer by providing supplemental visual tools to transmit content. More recently, movies, radio, audio recorders, television, and computers have entered the classroom (Cuban, 1986; Reiser, 2001). Currently, tablets, smart boards, video streaming, mobile devices, video games, and blogs are available—albeit underused—tools that teachers can employ to enhance instruction in their classroom practice. These technologies are also the tools that students, even those as young as five years old, are using in their free time with more proficiency than many of their teachers (NAEYC, 2012).

Given the importance of digital literacy and 21st century skills in the global workplace, researchers have attempted to comprehend the complex nature of teaching and leading using technology. However, extant research related to the subject of technology integration in educational practice is fraught with problems. One of the key obstacles stems from the fact that rapid technological advances cannot be examined using traditional gold standard research methods. In line with innovation in the field of communications, educational technology tools are also advancing rapidly, and thus quickly become obsolete as newer tools continually become available. This eliminates the potential for conducting longitudinal studies, which are traditionally perceived as the best source for evidence-based practice. This hurdle is compounded by the intricate nature of changes that teacher practice is continually experiencing in order to meet various standards. These problems further undermine researchers' ability to elucidate the impact of technology on teacher and leadership practices in the digital age.

At this juncture, it is appropriate to describe briefly the conceptual model that influenced the present study and provide an overview of the measurement instrument selected to assess teachers' beliefs about their technology integration abilities in classroom practice. This conceptual framework provides direction to the present study and was the primary factor in identifying the most appropriate measurement instrument to explore more fully as a reliable measure of teachers' beliefs about their technology competencies. The conceptual model undergirding the present study is the TPACK knowledge model that defines the role of technology in classroom practice as an integrative process (Koehler & Mishra, 2005, 2009; Mishra & Koehler, 2006). The construct of TPACK as a knowledge model "allows teachers, researchers, and teacher educators to move beyond oversimplified approaches that treat technology as an add-on instead to focus again, and in a more ecological way, upon the connections among technology, content, and pedagogy as they play out in classroom contexts" (Koehler & Mishra, 2009, p. 67). This model extends Shulman's (1986) work regarding teachers' knowledge of pedagogy and content. In representing three types of teacher knowledge as overlapping circles with intersecting points, the TPACK knowledge model captures the complexity of the knowledge teachers' use when integrating technology in their classroom practice (see Figure 1). Koehler and Mishra (2009) expressed the multifaceted nature of this model:

> Teaching with technology is a difficult thing to do well. The TPACK framework suggests that content, pedagogy, technology, and teaching/learning contexts have roles to play individually and together. Teaching successfully with technology requires continually creating, maintaining, and re-establishing a dynamic equilibrium among all components. It is worth noting that a range of factors influences how this equilibrium is reached. (p. 67)

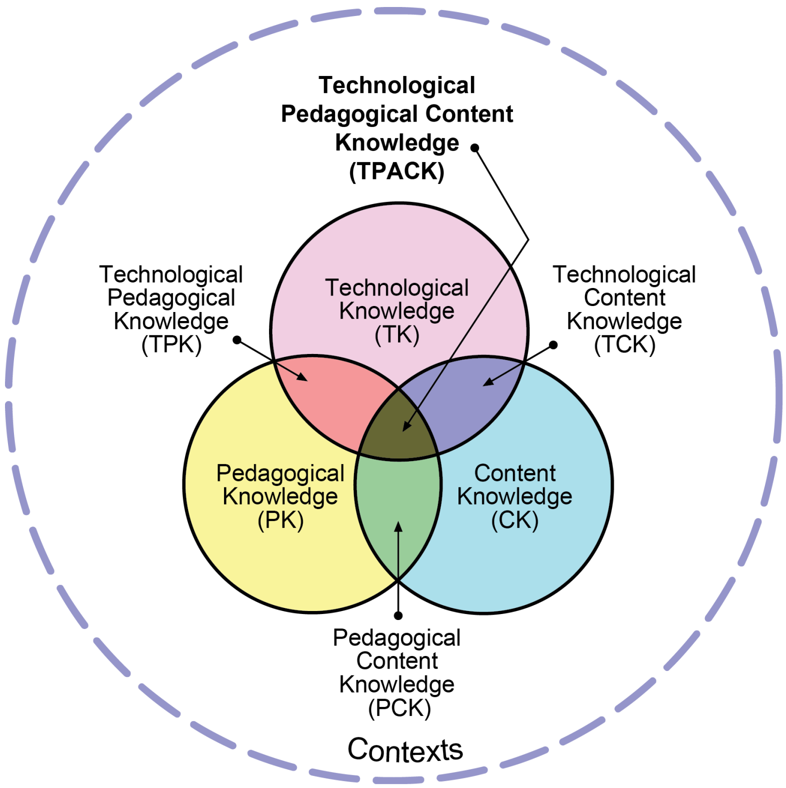

Figure 1. *TPACK Knowledge Model reproduced by permission of the publisher, © 2012 by tpack.org.*

As shown in Figure 1, the model combines three intersecting segments of technology use, pedagogy, and content for teaching effectively. It is built upon the premise that teaching with technology is a multifarious undertaking. This framework suggests that effective technology integration requires teachers to apply cognitive flexibility in each of the knowledge domains and identifies context as the circumstances and environments in which the integration occurs. In other words, it is based on the premise that specific contextual factors may support or hinder teachers in developing classroom practice that facilitates the accomplishment of student learning goals (Koehler & Mishra, 2009). Mishra and Koehler (2006) define the TPACK knowledge model:

> …is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can redress some of the problems that students face; knowledge of the students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones. (p. 1029)

As depicted in Figure 1, the model suggests that, to teach effectively, teachers must use three intersecting types of knowledge. However, measuring educators' knowledge— technological, pedagogical, and content knowledge—as well as identifying the intersections among these knowledge types, has been difficult for researchers. Extant studies have relied on different approaches to define the context in which effective technology integration occurs. Yet, fully measuring technological, pedagogical, and content knowledge is a challenge researchers continue to face. According to Abbitt (2011), measuring the TPACK components as one construct is challenging owing to the "difficulty in understanding how teacher knowledge influences actual teaching practices, as well as the overarching challenges of the efficiency, reliability, and validity of the measurement methods" (p. 288). By exploring ways to measure this complex construct more effectively, researchers and practitioners may develop strategies that better support effective technology integration in teachers' classroom practices.

While several measurement scales are presently used to assess the technological, pedagogical, and content knowledge of teachers, one scale in particular was selected to explore more fully in the present study. Upon reviewing measurement tools, the TPACK-deep scale (Kabakci-Yurdakul et al., 2012) emerged as the most promising instrument for reliably measuring teachers' beliefs about their technology integration abilities. Kabakci-Yurdakul et al. (2012), using data pertaining to Turkish pre-service teachers, designed the TPACK-deep scale to measure the central construct within the TPACK knowledge model. The TPACK-deep scale evolved as a result of rigorous analyses aimed at determining its item pool, construct validity, item validity, and internal consistency. These comprehensive analyses resulted in a 33-item scale with a four-factor structure. The instrument, when applied to data obtained from pre-service teachers, generated four factors related to teachers' beliefs about their competency using technology in classroom practice. The authors denoted these factors as Design, Exertion, Ethics, and Proficiency. A distinguishing attribute of the TPACK-deep scale is that the items do not have a specific content focus. This provides the opportunity for broader use. Thus, the TPACK-deep scale was selected for further examination in the present study.

Research Problem

Society needs a global-ready workforce, and educational institutions are investing substantive resources—including funding, personnel, and time—into strategies aimed at preparing students for the increasingly globalized workforce by integrating technology in the learning environment. However, actualizing this type of transformational change in schools is a "wicked problem" facing teachers as well as school principals (Grint, 2008). The persistent dilemmas of teaching have been exasperated by the necessity of a digitally driven educational environment that challenges the traditional roles of educators.

The TPACK knowledge model (Koehler & Mishra, 2005, 2009; Mishra & Koehler, 2006) is the dominant conceptual framework for effective technology integration in research. It provides researchers and practitioners with a conceptual framework that identifies the three types of knowledge educators must apply simultaneously to effectively integrate technology into their teaching practice. However, consensus is presently lacking among researchers regarding how to measure teachers' complex teaching behavior that intersects when technological, pedagogical, and content knowledge is used to successfully integrate technology into classroom practice. Additionally, extant research suggests that contextual factors are also indicative of teacher effectiveness in the application of technology in classroom practice. Examining methods that have the potential to capture these teaching complexities is necessary in order to have a better understanding of technology integration in formal schooling. Although there have been many efforts to define and measure technology integration in formal schooling, challenges remain.

Study Significance

The significance and scale of technology's impact on modern society is evidenced in the way we communicate, learn, and work. Thus, in order to keep the pace with these rapid changes, philosophical perspectives, conceptual models, and measurement instruments should be modified to illustrate the characteristics and effects of communication, learning, and working with technology in ways that reflect the today's society (Siemens, 2005). In other words, learning, teaching, and leading in the digital age can only be effective if sufficient efforts are dedicated to transforming PreK-12 public education to address the technological context of the world in which we live.

As teachers explore ways to maximize learning using technology and identify strategies that are accomplishable, they must learn how to critique and examine whether or not the technology that is chosen is well-suited for meeting the academic outcomes set for their students (Harris, 2005). Angeli and Valanides (2009) explained that technology integration requires teachers to understand the technology itself, as well as the effectiveness of that technology in supporting the teaching of subject matter in a way that enables concepts to be learned more readily. Similarly, Earle (2002) posited that "integrating technology is not about technology—it is primarily about content and effective instructional practices. Technology involves the tools with which we deliver content and implement practices in better ways" (p. 7). Integrating technology into a curriculum that promotes teaching and learning requires that teachers have knowledge of not only subject matter and pedagogy, but also technological skills, which many teachers presently lack (Earle, 2002; Koehler & Mishra, 2005, 2009; Mishra & Koehler, 2006). Effectively integrating technology into classroom instruction presents teachers with several dilemmas about their understanding of how students learn, their approach to designing learning activities, and their conceptualization of their role as teachers (Windschitl, 2002).

Owing to the vastly changing needs of a technologically driven global workforce, it is critical that PreK-12 educational institutions address the complexity of changing practice to include integration of technology in multiple contexts. Accountability in assessing the use of technology cannot be solely measured via numbers of computers in classrooms and recorded expenditures on technology. The TPACK knowledge model (Koehler & Mishra, 2005, 2009; Mishra & Koehler, 2006) provides the research community with a complex framework from which to identify the types of knowledge teachers use to integrate technology effectively in classroom instruction. Validating a measurement instrument that shows strong potential to reliably capture this complexity should provide insight relevant to the changing needs of teachers in the 21st century.

Study Purpose

The purpose of the present study was to contribute evidence to the TPACK research base by exploring a measurement tool demonstrating strong potential for reliably assessing teachers' beliefs about their abilities to integrate technology into classroom practice. Upon reviewing alternative approaches, the TPACK-deep scale emerged as the measurement tool most appropriate for assessing pre-service teachers' beliefs about their technology integration abilities. The present study extended the current body of knowledge on this model and its utility by exploring whether the TPACK-deep scale could be applied to in-service teachers. For this purpose, data was collected from a sample of in-service elementary school teachers in Florida, allowing examination of three contextual factors—leadership support for technology, teaching self-efficacy, and traditional beliefs about children—that were hypothesized to impact teachers' beliefs about their competencies related to integrating technology in their classroom practice. In meeting the study objectives, an exploratory research study approach was adopted, which is appropriate when the investigation addresses a new topic on which little or no previous research exists (Brown, 2006).

The research questions included the replication (question one) and extension (question two) of Kabakci-Yurdakul et al.'s (2012) TPACK measurement research using a quantitative research design. Structural equation models (SEM) were used to investigate the TPACK-deep scale.

Research Questions

1. In what ways do structural equation model (SEM) results from a measurement model using the TPACK-deep scale items with in-service elementary school teachers in Florida confirm an existing theoretical structure with data provided by pre-service teachers?

2. In what ways are in-service elementary school teachers' beliefs about their leadership support for technology, teaching self-efficacy, and traditional beliefs about children associated with their beliefs about their ability to use technology in their teaching practice?

To answer the two research questions, the following were hypothesized:

1. The four TPACK-deep scale latent factors—Design, Exertion, Proficiency, and Ethics—are correlated.
2. Leadership support for technology is correlated with teaching self-efficacy.
3. Leadership support for technology predicts the four TPACK-deep scale latent factors (Design, Exertion, Proficiency, and Ethics).
4. Teaching self-efficacy predicts the four TPACK-deep scale latent factors (Design, Exertion, Proficiency, and Ethics).
5. Traditional beliefs about children predict the four TPACK-deep scale latent factors (Design, Exertion, Proficiency, and Ethics).

Structural equation modeling (SEM), also known as a covariance structure model, is a multivariate technique that is used to create diagrams representing relationships among latent and observed variables (Schreiber, Nora, Stage, Barlow, & King, 2006). According to Hoyle (1995), the purpose of this assessment is to identify a model that best fits the data gathered. Thus, SEM is most useful when investigating several complex data sets simultaneously. Because it is a multivariate technique, SEM takes into "account several variables and helps measure what we cannot see based on what we can" (Hoyle, p. 104). Its application facilitates identifying observed variables (what is seen) or measured directly, as well as latent variables (what is not seen). A more thorough description of the methodology used in this exploratory study is provided in Chapter 3.

Delimitations of the Study

This exploratory study was designed to examine the validity and reliability of an instrument (TPACK-deep scale) for measuring teachers' beliefs about their technology integration abilities. The work conducted as a part of this investigation included both replication and extension of previous research, as the goal was to identify additional factors associated with teachers' beliefs about their abilities to effectively use technology in elementary classrooms in Florida. The SEM results yielded by the measurement model were used to confirm a theoretical factor structure previously used with a different population in a different country. The data required to meet the research objectives was gathered via a 65-item web-based survey and was subsequently used in SEM analyses to examine factors that may influence teachers' technology integration. Data collection occurred from August through October 2015. The study sample comprised of prekindergarten and elementary school teachers (Grade PreK–5) employed in the Florida school districts. Prior to commencing the study, 24 Florida school districts identified by public records were contacted for permission to collect data in each respective county. As 14 school districts approved the research request, the study sample comprising of 75 elementary school teachers in Florida was drawn from these sites. Given this methodological design, the results of this study are exploratory in nature. Moreover, it must be emphasized that the sample under investigation is not representative of the entire population of teachers in Florida or nationally. Hence, the results reported in this dissertation are representative solely of the prekindergarten through grade five elementary school teachers in Florida that took part in the survey.

Definition of Terms

Several terms and acronyms that are used in relation to the present study are identified below, to provide context in which they are used.

Leadership support for technology. The practice of the school principal to use interpersonal and communication skills to support teachers and staff as technology is being integrated into the teaching and learning process (Chang, Chin, & Hsu, 2008).

Teaching self-efficacy**.** Defined by Tschannen-Moran, Woolfolk Hoy, and Hoy (1998) as "teacher's belief in her or his ability to organize and execute the courses of action required to successfully accomplish a specific teaching task in a particular context" (p. 233).

Technology integration. Implementation of effective teaching practices to facilitate meaningful learning using an integrative technological, pedagogical, and content knowledge approach.

Technology tools. Tablets, desktop computers, digital cameras, laptops, interactive smart boards, document cameras, Internet resources, computer software, and Web 2.0 tools.

Technological Pedagogical Content Knowledge (TPACK). The intersection of three types of knowledge used to teach effectively with technology that includes content understanding, pedagogical abilities, and technological expertise in combining the three knowledge bases during instruction to support student learning (Koehler & Mishra, 2009).

TPACK-deep scale. A 33-item TPACK measurement instrument based on the intersection of teachers' technological, pedagogical, and content knowledge. This is the central construct of the TPACK knowledge model framework designed to measure educator beliefs about their TPACK competencies (Kabakci-Yurdakul et al., 2012).

TPACK-deep Design. Teachers' competencies in designing their instruction to maximize the student learning as they use their technology skills, pedagogy, and subject matter expertise (Kabakci-Yurdakul et al., 2012).

TPACK-deep Ethics. Teachers' competencies related to ethical technology use and teaching behaviors (Kabakci-Yurdakul et al., 2012).

TPACK-deep Exertion. Teachers' competencies in using technology for lesson implementation and as a means to measure students' learning and evaluate the effectiveness of the implementation (Kabakci-Yurdakul et al., 2012).

TPACK-deep Proficiency. Teachers' competencies related to integrating technology in classroom instruction and abilities to solve problems when technology is being used (Kabakci-Yurdakul et al., 2012).

Traditional beliefs about children. Beliefs about the nature of children, children's learning, and the role of the educator from an authoritarian, adult-centered perspective (Justice, Mashburn, Hamre, & Pianta, 2008).

Structural Equation Modeling (SEM). A multivariate statistical technique used to examine how latent variables and latent factors are associated with observed variables by creating a diagram and estimating the fit between measurement and structural models and the data (Schreiber et al., 2006).

Organization of the Study

The next chapter, Chapter 2, provides a review of pertinent literature and includes a discussion of societal influences that effect technology integration, along with an examination of educational policy and spending related to technology integration. The aim is to provide empirical evidence emphasizing the importance of technology use in education, and describe currently used models of technology integration. The sources reviewed also allow examining and contrasting the presently available technology integration measurement instruments. The literature review closes with the exploration of factors posited to influence teachers' technology use, as well as their levels of digital literacy, along with their impact on teacher practice, teachers' beliefs, and leadership support from principals. This is followed by the description of the theoretical framework that undergirds the study. Chapter 3 identifies and describes the research procedures and methods employed in the present study, while Chapter 4 reports the data analyses and results. Finally, Chapter 5 provides a summary of the present study and a discussion of the key results, before addressing study limitations and implications for future research and practice in the area of integration of technology in today's classroom.

CHAPTER 2: REVIEW OF LITERATURE

This chapter presents a review of pertinent literature on technology integration in formal schooling that serves as a foundation for the present study. Specifically, the review begins with a discussion of societal influences affecting technology integration, followed by an examination of educational policy and spending related to technology integration. The focus then shifts to literature sources elucidating the significance of technology use in educational practice and those describing models of technology integration and technology integration measurement instruments. In addition, extant studies that examine the factors influencing teachers' technology use are discussed, focusing on those related to digital literacy and the impact of change on teacher practice, teachers' beliefs, and leadership support from principals. Finally, the chapter closes by delineating the theoretical framework underpinning the present study, illustrating the connections among the major theoretical bases that provide direction to this research study.

The purpose of this exploratory study was to examine the validity of the TPACK-deep scale (Kabakci-Yurdakul et al., 2012) instrument as a tool for measuring in-service prekindergarten through grade five teachers' beliefs about their technological abilities in classroom practice. This quantitative research design included testing the TPACK-deep scale instrument and three additional subscales using the data provided by in-service teachers in Florida, which was subjected to structural equation modeling. The aim was to confirm the theoretical structure established with a different population and to examine specific contextual factors—leadership support for technology, teaching self-efficacy, and traditional beliefs about children—hypothesized to influence teachers' technology integration abilities. Using valid and reliable measurement instruments to examine the beliefs of teachers, who are on the frontline of this educational transformation, is instrumental in developing strategic improvements in teaching, learning, and leading in the digital age.

Technology Integration: Societal Influences

The need to change current educational practices to support a digitally driven society stems from two societal realities—increasing global prevalence of access to digital tools and the related changes in the skills necessary for workforce success. These societal realities suggest that principals and teachers should examine how technology can be utilized in instructional practice to improve learning, teaching, and leading in the 21st century. To remain relevant, the educational community must keep pace with technology advancements by effectively using technology in the classroom. Teachers and principals must be held accountable and effective in their ultimate mission—providing the nation's youth with education that will equip them with the skills and knowledge necessary to function in today's society.

Technology integration can be viewed as both the cause and a major means of achieving significant educational change. However, at present, a wide gulf exists between the promise of technology integration and the reality of its use in schools. This gap between aspirations and practice is magnified by the complex nature of educational change. Any kind of substantive change in public education takes time, perseverance, and exceptional leadership skill (DuFour & Marzano, 2015; Fullan, 2006; Hew & Brush, 2007). This assertion is affirmed by Cuban (1986, 1998), who claimed that the classroom structure in public schooling has undergone very little change in the last 100 years. Fullan (2006) also posited that little to no success has been achieved in the implementation of wide-scale educational change efforts in the K-12 public education arena. These challenges can be considered wicked problems challenging the traditional learning systems of public education. Wicked problems are those that cannot be easily solved, as each problem is unique because of the unique context in which it occurs and the evolving circumstances. Consequently, even the most optimal solutions for a particular context may fail to yield expected outcomes, if unable to respond to ongoing changes. In such cases, decisions are often made intuitively (Grint, 2008). As Senge, Smith, Kruschwitz, Laur, and Schley (2010) suggested;

> A real change is grounded in new ways of thinking and perceiving. . . . With nature and not machines as their inspiration, today's innovators are showing how to create a different future by learning how to see the larger system of which they are a part and to foster collaboration across every imaginable boundary. These core capabilities—seeing systems, collaborating across boundaries and creating versus problem solving—form the underpinnings, and ultimately the tool and methods, for this shift in thinking. (pp. 10–11)

The “shift in thinking” described by Senge et al. is very difficult in the PreK-12 educational landscape. This type of change must occur at multiple levels—from districts, to school buildings, to classrooms—if students are to be prepared as global citizens and ready for success in the digital era.

Technology has changed the world as we know it. It has provided society with an interactive resource that, if used effectively and responsibly, has the potential to expand communication and creative exploration. Yet, this requires a complete reconceptualization of teaching and learning that presents unprecedented challenges to traditional classroom practice. It is not surprising that the goal of transforming learning, teaching, and leading through the increased utilization of technology in formal schooling has consistently been among the most important educational reform agendas since the 1980s (Cuban, 2001; Cuban, Kirkpatrick, & Peck, 2001; Levin & Wadmany, 2008).

Students of today must be ready for work in a globalized society. Extant research has consistently shown that today's school graduates lack the skills demanded by the increasingly competitive workplace (Bernanke, 2007; Darling-Hammond, Ancess, & Ort, 2002; Spann, 2000). Presently, employees must not only possess long-standing basic knowledge and skills, such as reading comprehension, mathematics, science, economics, arts, history, and geography, but they must also have digital literacy and 21st century skills (Casner-Lotto & Barrington, 2006; Jones & Shao, 2011; Tapscott, 2009). Determining how to provide students with authentic learning opportunities that facilitate the development of these skills in formal educational settings is a complex issue for school principals and teachers, who have been plagued with educational solutions packaged in mandated interventions with little support (Levin & Wadmany, 2008). This has resulted in hesitancy among teachers at the school level to embark on yet another educational reform initiative, as very few of those that have been attempted to date have yielded desired outcomes (Cuban, 1998; Elmore, 2005; Fullan, 2006).

Educational Policy and Government Spending

The Obama administration, during President Obama's first term, identified innovation at the state-level as the core of educational reform with the Race to the Top initiative. This legislation was an invitation to stakeholders from individual states to propose ideas on strategies that could be adopted to raise educational standards in order to prepare all students for college and careers. The Race to the Top was funded by a $4.35 billion investment (part of the American Recovery and Reinvestment Act of 2009) with the goal of supporting teachers and principals in reversing the downward trend in the lowest-performing schools, as well as using data as a primary tool for informed decision-making. In 2014, the U.S. Department of Education reported that additional initiatives had been launched:

> …flagship grant programs for states under the Race to the Top banner including Race to the Top Assessment, which supports state consortia to design assessments aligned to new, higher standards; Race to the Top-Early Learning Challenge, which promotes system-building around early learning opportunities; and Race to the Top-District, which supports local ideas about how to tailor learning to the needs of individual students. (p. 10)

Established as part of the Telecommunications Act of 1996, The E-Rate program was designed by the Federal Communications Commission (FCC) to support telecommunications, information services, and broadband for classrooms. Since its inception in 1996, the E-Rate program has provided Internet access in approximately 74% of schools and 98% of libraries. However, many schools and libraries still lack the Internet bandwidth necessary to utilize new digital learning technologies, such as cloud-based software, tablets, and Wi-Fi driven devices. In 2009, the FCC developed a national broadband plan and provided suggestions for how broadband could enable improvements in formal schooling. Recommendations are now being solicited regarding how to modernize E-Rate to potentially improve the alignment and expansion of Internet broadband to better meet the needs of the public education system. At $2.25 billion designated for K-12 and higher education, the E-Rate program was the most extensively funded IT program of the 2013/2014 school year (Center for Digital Education, 2013).

President Obama's 2016 fiscal year budget for the U.S. Department of Education is set at over $70 billion, with $200 million allocated for Funding for the Education Technology State Grants program. These funds are designated for supporting exemplary models of teaching with technology. Evidently, a significant investment is being made at the federal level to ensure that America's students leave high school digitally literate and prepared to enter the workforce or post-secondary education. In a 2013 report by the Center for Digital Education (CDE), spending on educational technology in K-12 public education for the year 2013 was estimated at $9.7 billion, exceeding the value reported for 2012 by 11%. As the expenditure is projected to reach $19 billion by 2018, utilization of educational technology is clearly not hindered by funding issues, but rather suffers from problems associated with implementation by classroom teachers and principals.

At the state level, the Florida Department of Education's (FLDOE) Bureau of Standards and Instructional Support is responsible for supporting instructional technology in 68 public school districts. Florida State Statute 1000.03—Function, mission, and goals of the Florida K-20 education system—states that "Florida's K-20 education system shall maintain a system-wide technology plan based on a common set of data definitions." In 2014, the Florida Digital Classrooms Plan was passed by the state legislature, with a first year appropriation of $40 million statewide, whereby each district would receive an allocation of at least $250,000. All Florida school districts have outlined digital specifications for five component areas pertaining to student performance outcomes, digital learning and infrastructure, professional development, digital tools, and on-line assessment. The FLDOE executive summary of the Florida Digital Classrooms Plan reported that 80% of classrooms in Florida are meeting the state wireless goals. According to the FLDOE, 1.43 million student technology devices are presently available for use in classrooms. At the state level, Florida is funding technology integration in the public school system even as other initiatives are cut from the state budget.

The impact of technology has significantly changed nearly every aspect of the human experience. A digitally connected global community has emerged as a result of rapid technological advancements in the last two decades. While highly beneficial, these innovations also pose challenges to educational institutions, as educational change efforts have not kept pace with changing societal needs. Investments have been made and policies have changed, yet teaching practice still lags behind societal trends. Students, teachers, and principals are affected, both individually and collectively, by changes resulting from a digitally connected society.

Technology Integration Frameworks

Several frameworks have been advanced to explain the intricate nature of integrating technology into classroom practice. Four models are presently used to characterize teachers' technology integration, namely the Perception Goal Theory (PCT); Levels of Technology Implementation (LoTi) model; the Substitution, Augmentation, Modification and Redefinition (SAMR) model; and the Technological Pedagogical Content Knowledge (TPACK) model. Each model possesses both strengths and weaknesses in terms of its potential to identify the most optimal support for teachers in integrating technology into their classroom practice.

The PCT theoretical framework (Zhao & Cziko, 2001) suggests that, in order to understand why teachers do or do not use technology, attention must be placed upon teachers' goals. This framework suggests that three conditions must be met for teachers to effectively integrate technology:

- Teachers must believe that technology can more effectively achieve or maintain a higher-level goal than what has been used in the past ("effectiveness");

- Teachers must believe that using technology will not cause disturbances to other higher-level goals that they believe to be as more important than the one being used ("disturbances"); and
- Teachers must believe that they have the skills and resources to use technology ("control") (Zhao & Cziko, 2001, p. 27).

In contrast to the LoTi model, the PCT frame posits that beliefs—perceived ease of use and perceived usefulness—determine one's intentions when integrating technology into practice. These beliefs have been associated with the actual behaviors of teachers when utilizing technology in their classroom practice, suggesting that teachers' beliefs do not necessarily coincide with their actual classroom practice. As noted by Taylor and Todd (1995), while a teacher may report that he or she has a constructivist perspective, when observed in classroom practice, it may become evident that he or she actually uses teacher-directed instructional methods. This finding indicates that further research is necessary to understand the contextual and pedagogical perspectives that can influence teachers' willingness and ability to integrate technology into their classroom practices.

The LoTi conceptual model (Moersch, 1995) was designed to support school districts that were at the forefront of technology integration. Technology and funding allocations were balanced with instructional practices and professional learning. This model was created for school districts to gauge the effectiveness of technology integration in classrooms. The model was revised in 2009, aiming to better describe the attributes of the pedagogical continuum as teachers move to a learner-centered approach, increase their expectations for their students, and continue to learn the changing and dynamic ways of integrating technology in the classroom.

Puentedura (2010) developed the Substitution Augmentation Modification Redefinition (SAMR) model for teacher technology integration. The SAMR model highlights the use of technology in learning tasks, from the simplest to the most complex, yet inventive tasks. The SAMR model identifies Substitution and Augmentation tasks as ways to enrich learning, whereas the tasks of Modification and Redefinition pertain to the transformation of learning and achieving outcomes in entirely original ways. This model identifies a continuum of teacher use for teachers to follow as technology is implemented in classroom practice. Fabian and MacLean (2014) report that theSAMR model places an emphasis on developing teachers' abilities to infuse technology in teaching as a means of maximizing student engagement through the digital learning experience.

The TPACK knowledge model is a teacher knowledge framework that incorporates technology knowledge into a knowledge framework developed by Shulman (1986). Shulman described this knowledge as the "cognitive understanding of subject matter content and the relationships between such understanding and the instruction teachers provide for students" (p. 25) and defined it as *pedagogical content knowledge*. The TPACK framework was developed during a five-year, design-based research study of educator professional learning (Koehler & Mishra, 2009; Mishra & Koehler, 2006). The resulting model identifies three types of knowledge teachers use to effectively integrate technology into instruction (see Figure 1). These knowledge domains—comprising of content, pedagogical, and technological knowledge—when represented as a Venn diagram, intersect, forming seven distinct areas and nine boundaries (Koehler & Mishra, 2009; Mishra & Koehler, 2006). However, as the framework underpinning the TPACK knowledge model is highly complex, pertinent studies have indicated that it is very difficult to describe the intentional intersection at each of the nine boundaries in classroom practice or professional learning (Archambault & Crippen, 2009; Brantley-Dias & Ertmer, 2013). At the center of the TPACK knowledge model is the overlap of knowledge in three primary modes—Content (CK), Pedagogy (PK), and Technology (TK). The main benefit of the TPACK approach is that, rather than assessing these three types of knowledge singularly, the approach focuses on the kinds of knowledge that overlap when integrated technology in practice: Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). As described by Koehler and Mishra (2009), these intersecting constructs include:

- **Content Knowledge (CK)** – Knowledge of subject matter that is to be taught that includes the knowledge of concepts, theories, ideas, and organizational frameworks (Koehler & Mishra, 2009).
- **Pedagogical Knowledge (PK)** – Knowledge of the practices necessary for learning and teaching. These practices may include classroom management strategies, designing lessons, implementing instruction, and assessing student progress. Schulman (1986) considered this knowledge as the "how" of teaching (Koehler & Mishra, 2009).
- **Technology Knowledge (TK)** – Knowledge of technology tools and uses, pertaining to ways of working with and using technology. This knowledge also addresses the ability to adapt one's use of technology tools and resources to different contexts, such as personal and professional use, with an emphasis on how technology can impede or advance the achievement of desired outcomes (Koehler & Mishra, 2009).
- **Pedagogical Content Knowledge (PCK)** – Knowledge of how to use pedagogy to teach specific subject matter by understanding underlying and related concepts,

choosing a variety of ways to represent the subject matter, and the flexibility to change strategies in order to meet the needs of students as instruction progresses (Koehler & Mishra, 2009; Shulman, 1986).

- **Technological Content Knowledge (TCK)** – Knowledge of how technology and subject matter influence each other by understanding the content, the underlying concepts to be taught, as well as the technology that can be used to maximize students' potential to attain the desired learning goals (Koehler & Mishra, 2009).
- **Technological Pedagogical Knowledge (TPK)** – Knowledge of the ways technology can affect the learning and teaching practices that are implemented during classroom instruction (Koehler & Mishra, 2009).
- **Technological Pedagogical Content Knowledge (TPACK)** – Knowledge of teaching with technology that encompasses ways to represent content, pedagogical strategies, and the ability to adapt instruction to the diverse needs of students (Koehler & Mishra, 2009).

Each of the four models described above enhances the research base regarding technology integration in classroom practice. However, educational researchers still lack consensus regarding the most effective ways to develop teachers' abilities to integrate technology in their everyday teaching practice. The PCT model is grounded in Bandura's (1999) research on self-efficacy, which is a difficult construct in itself for practitioners outside the field of psychology to apply in their daily work. The SAMR model originated in 2010, and very little empirical research exists regarding its usefulness and impact on the quality of technology integration in classroom practice. LoTi model was designed for school district-wide implementation and has shown promise in the last 20 years. However, the LoTi model focuses on process changes that teachers go through on a continuum without addressing structural changes in the learning environment, which may be necessary for technology integration to be successful.

Given the strengths and weaknesses of the aforementioned models, the TPACK knowledge model (Mishra & Koehler, 2006; Koehler & Mishra, 2009) has emerged as the most robust model, and this view is supported by ample pertinent technology literature. Moreover, given that, of the four models presented, the TPACK knowledge model is most closely aligned with the theories that undergird the present study, it anchors its conceptual framework.

Assessing Technology Integration: Measurement Studies

Several studies examining technology integration have been conducted in the last two decades. For example, Baylor and Ritchie (2002) studied "what actions can school personnel take that most effectively lead to desired results in the integration of technology" (p. 2). The authors recruited 97 participants selected from four states and employed four data collection instruments (structured interviews with teachers and administrators, teacher self-report surveys, and school technology plan examinations). Subsequent analyses subjecting the gathered data to a regression model with seven factors revealed that teacher technology integration is predicted by teacher willingness to change and the percentage of collaborative technology use with others. While these findings are certainly encouraging, the cost incurred by collecting data for a mixed methods research study limits the practicality of replicating this study. In another study conducted at the start of the 21st century, Russell, Bebell, O'Dwyer, and O'Connor (2003) employed the Use, Support, and Effect of Instructional Technology (USEIT) model in order to investigate factors that are associated with in-service teachers' improved use of technology in their classroom practice. Using a 44-item survey, the authors obtained 2,894 responses from teachers in grades kindergarten through grade 12. The gathered data was subjected to factor analyses, which yielded six factors related to technology use, and established positive correlations among the factors. The authors thus concluded that teachers "who use technology for one purpose are, on average, likely to use technology for other purposes" (p. 306). While valuable, this study suffered from several limitations, in particular the differences in beliefs, practices, and comfort level with technology reported by experienced and less experienced teachers. For example, while young teachers have had more exposure to technology, that exposure may not necessarily coincide with their ability to use technology effectively in classroom practice.

More recently, Hsu (2010) reported difficulties regarding measuring technology integration in a study of 3,729 Taiwanese teachers of grades one through nine. The author developed a scale to measure teachers' technology integration abilities. His instrument included six subscales based upon the ISTE standards as a framework. The data collected were split randomly in half and analyzed using factor analyses (N = 1,865) and (N = 1,864). The findings yielded by Hsu's research indicated that teachers' pedagogical beliefs and ethical behaviors related to technology are important constructs to consider when measuring their technology use. The key limitation of this study is that the population under investigation comprised solely of Taiwanese teachers. Historically, technology integration in educational practice has been a priority of the Taiwanese government. This level of governmental support is not typical in public school districts in the United States, as support varies greatly among schools and counties.

Data obtained by surveying pre-service teachers was used to develop the Schmidt et al. (2009) TPACK survey that measured participants' perceptions using the TPACK knowledge model domains. The study participants were 124 education students, who completed a 75-item survey. While the study sample was small, the authors nonetheless provided preliminary evidence toward establishing the TPACK construct validity. However, more research is needed to help teachers develop effective approaches and build their technological, pedagogical, and content knowledge.

With the goal of more accurately measuring pre-service teachers' perceptions of their technology integration abilities, Kabakci-Yurdakul et al. (2012) expanded the original TPACK knowledge model. The resulting instrument, the TPACK-deep scale, is one of the most promising tools to measure TPACK, as the scale is designed to measure the specific TPACK component as one entity within the knowledge model, irrespective of a content domain. The validity and reliability of the TPACK-deep scale was tested using the data provided by 998 Turkish pre-service teachers. The results yielded suggest that the TPACK-deep scale is a promising measure of the central construct of TPACK. Thus, based upon Kabakci-Yurdakul et al.'s findings, it can be posited that the TPACK-deep scale may be of value in the assessment of in-service teachers' beliefs about their technological, pedagogical, and content knowledge.

The importance of technology and its integration in education is best exemplified by the fact that a Google Scholar search of "scales to measure technology integration in schools" yielded over 173,000 results in 0.20 seconds. The identified articles discussed a wide variety of topics, including teacher dispositions, self-efficacy, and student attitudes. When investigating TPACK specifically, 220,000 results were found in 0.11 seconds. The TPACK knowledge model is a framework that has been widely adopted by the educational technology community and is used both as a noun (e.g., TPACK develops over time) and as an adjective (e.g., TPACK coaches). Some of the most distinguished researchers in educational technology have authored books on and have dedicated entire research journals to TPACK. Abbitt (2011) reported, "As the popularity of this framework has grown, so has the use of TPACK in research and evaluation studies in K–12 and higher education contexts” (p. 283). However, Brantley-Dias and Ertmer (2013) noted that, although more than “300 unique manuscripts, including journal publications and conference proceedings have been published on this topic” (p. 104). Thus, additional studies are warranted in hope of producing a clearer understanding of the overlapping knowledge structures that intersect in order to grasp better how TPACK is actualized in teacher practice. They argued that, “TPACK takes the concept of technology integration and packages it as a framework that is much too big (i.e., one that embodies seven distinct knowledge types) while simultaneously making it too small by dividing the “package” into so many pieces that they have become impossible to distinguish from one another” (Brantley-Dias & Ertmer, 2013, p. 104). In other words, the TPACK knowledge model has provided complex challenges to researchers in how to most effectively translate the TPACK knowledge model theories into practice.

TPACK Measurement Instruments

While ample body of research has been conducted on TPACK, most extant studies focus on its measures (Abbitt, 2011; Koehler, Shin, & Mishra, 2011; Rosenberg & Koehler, 2015). These efforts have had some success; however, in many cases, the measurement methods lack reliability and validity indicators (Cavanagh & Koehler, 2013). Schmidt et al. (2009) attempted measuring TPACK to confirm the structure of the initial TPACK knowledge model (Schmidt et al., 2009), while other authors found support for fewer components (Archambault & Barnett, 2010; Kabakci-Yurdakul et al., 2012). Rosenberg and Koehler (2015) reported a need for future research focused on investigating the complexity of teaching practice by the development of measures that include the context and addressing the alignment of the TPACK knowledge model components.

In line with this view, other literature sources included in this review suggest that the majority of TPACK measures do not include context. Table 1 provides an overview of TPACK measurement instruments that were developed from 2009 to 2013 and were reviewed as a part of the present study.

Table 1

Overview of TPACK Measurement Instruments

Scale	Items	Authors	Sample	Context Measured
TPACK Survey	75	Schmidt, et al. (2009)	124 PreK-6 pre-service teachers in the US Midwest	No
TPACK in Science Survey	31	Graham, et al. (2009)	15 US elementary school and secondary school in-service science teachers	No
TPACK Framework Survey	24	Archambault and Barnett (2010)	596 K-12 US teachers involved in online teaching	No
Pre-service Teachers' Knowledge of Teaching and Technology	75	Koh, Chai, & Tsai (2010)	1,185 Singapore pre-service teachers	No
TPACK-deep scale	33	Kabakci-Yurdakul et al. (2012)	995 Turkish pre-service teachers	No
TPACK Mathematics Survey	62	Zelkowski, Gleason, Cox, & Bismarck (2013)	315 US pre-service mathematics teachers	No
TTF TPACK Survey	24	Jamieson-Proctor, et al. (2013)	5,809 Australian students in teacher preparation programs	No

Two conclusions can be drawn from the review of the TPACK measurement studies presented in Table 1. First, the knowledge base related to TPACK measurement research can be further expanded by inclusion of in-service teachers in the assessments. Second, the TPACK research community rarely engages in studies that address contextual factors in addition to TPACK. Furthermore, the TPACK knowledge model may be reconceptualized to provide practitioners and researchers with more useful ways to identify, understand, and support the types of knowledge teachers' use when integrating technology into classroom practice, as well as the contexts that may potentially support their effective use of technology in classroom practice (Abbitt, 2011; Archambault & Barnett, 2010; Rosenberg & Koehler, 2015).

Kabakci-Yurdakul et al.'s (2012) work added to the measurement research by "developing a scale to measure TPACK as a whole entity" (p. 966) with explicit focus on the central construct of TPACK. This central construct is represented as the intersection at which all three components of the TPACK knowledge model—teachers' technological, pedagogical, and content knowledge—overlap. Analyses of the data provided by Turkish pre-service teachers indicated that the TPACK-deep scale has a four-factor structure, comprising of Design, Exertion, Ethics, and Proficiency. Kabakci-Yurdakul et al. (2012) defined the factors as competency using technology in their classroom practice. Specifically, the TPACK-deep Design factor is described as a teachers' ability to design their teaching plans to enhance the learning process by understanding the content to be addressed, as well as using their technological knowledge and their pedagogical knowledge prior to the implementation of teaching instruction. The TPACK-deep Exertion factor refers to a teacher's ability to use technology during lesson implementation, as well as when determining the effectiveness of implementation in achieving learning goals. On the other hand, the TPACK-deep Ethics factor pertains to teachers' abilities to implement instruction appropriately with an understanding of ethical issues when using technology, such as technology-based intellectual property issues, privacy and safety, and teaching professionalism. Finally, the TPACK-deep Proficiency factor refers to teachers' skillfulness in using technology tools in all phases of teaching. Kabakci-Yurdakul et al.'s (2012) work is one of a few studies identified during the search of pertinent literature for inclusion in this review in which all

TPACK components are measured as a unified construct without focus on one content area or one technology tool (e.g., science teachers who use iPad tablets). Thus, of the TPACK measurement instruments reviewed, the TPACK-deep scale is most closely aligned with the theoretical bases that undergird this study (see Figure 2).

The TPACK knowledge model affords researchers a conceptual framework to examine the three types of knowledge teachers assimilate simultaneously when integrating technology into classroom practice. However, extant studies that have examined teachers' technology use suggest presence of several contextual factors that influence teachers' use of technology in their teaching. Contextual factors related to teachers' digital literacy skills, the impact of change on teachers' practice, teachers' beliefs, and leadership support are examined more thoroughly in a review of factors that influence teachers' use of technology.

Factors that Influence Teacher Use of Technology

Today's teachers are often expected to integrate technology into their instructional practice, although many are not provided the support needed to achieve this aim. The literature sources reviewed as a part of this investigation point to the existence of contextual factors that influence teachers' technology integration abilities. These factors can be classified into four distinct groups, namely (1) those related to the challenges brought forth by the need for digital literacy, (2) those related to changing one's instructional practices, (3) those related to personal beliefs, and (4) those related to support from school principals.

Digital Literacy: Skills of the 21st Century

The term "digital literacy" is typically used to describe the level of proficiency with which one uses online communication tools and modern technology. Technology is currently imbedded in a variety of tools and devices, and is becoming omnipresent. It is widely used to not only to communicate, but also to create, navigate, and function in current society. Many children develop digital literacy skills as a natural part of their lives, similar to oral language, without realizing that they are gaining new knowledge and aptitudes (Andersen, 2002). In contrast, late adopters of technology, commonly referred to as the digital immigrants, often approach digital literacy with hesitancy, as learning new technological skills may be perceived as a complex task with questionable utility (Jones & Flannigan, 2006). Those who did not grow up with technology, such as a majority of the current teaching force, must continually adapt.

Research suggests that this is problematic. While lack of digital literacy is increasingly being perceived as a handicap (International Reading Association, 2009; Koltay, 2011), this only exacerbates challenges of attaining such skills, as it increases fear of new tools and technologies. The digital literacy problem is most evident in the field of education. Many of today's classrooms are filled with digitally competent students led by a traditional, technologically unaware, instructor. Although technology, such as Internet access and Web 2.0 tools, is available for teachers to use in their classrooms, there is limited evidence to suggest that educational organizations have implemented explicit and long-term technology plans that ensure successful technology integration in everyday teaching practices (Ertmer & Ottenbreit-Leftwich, 2010; Rakes, Fields, & Cox, 2006).

This perpetuates a controversial argument regarding the skills of digital users termed as digital natives and those of digital immigrants in the context of education. Digital natives, defined as those who have grown up with personal computers and Internet access, are today's students in all levels of education, from prekindergarten through postsecondary educational settings (Prensky, 2001; Tapscott, 1998). Digital immigrants, those exposed to technology later in life, are thought to be apprehensive and weary of it, and lack the skill set to use technology comfortably (Bennett & Maton, 2010). Because the traditional education system does not consistently develop the digital literacy and 21st century skills that young people need, it is argued that dramatic educational change is necessary. Outdated teaching techniques can alienate and disenfranchise today's technologically savvy students. This argument continues to be at the forefront of the educational technology debate, with little consensus on how to define digital natives and immigrants or how to address the changing needs of today's students (Bennett & Maton, 2010; Palfrey & Gasser, 2008). Never before has the educational system been faced with students who have such an enormous amount of technological savoir-faire; thus, relying on extant strategies and adopting evidence-based practice is no longer appropriate for addressing their educational needs (Hicks, 2011).

In recognition of the need to close the gap between students and teachers, the Partnership for 21st Century Skills was formed in 2002 as a coalition to bring teachers, business community leaders, and policy makers together to address the readiness skills of 21st century K-12 students, teachers, and leaders. Rapid changes in technology and globalization have introduced a new range of skills that students must master to compete in a vastly different economic environment than any other time in the U.S. history. These skills include the ability to use what are now known as 21st century skills (critical thinking, problem solving, and collaboration) and digital literacy to identify and solve real world issues.

Pertinent literature suggests that students' 21st century skills can be enhanced in a technology-supported learning environment. Creativity and problem solving, as well as motivation, are positively influenced when students are afforded the opportunities to use technology during the learning process (Drayton, Falk, Stroud, Hobbs, & Hammerman, 2010; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010; Weston & Bain, 2010). These are the

21st century skills necessary for entering the globalized workforce and forging a successful career. Students in the digital age must have opportunities to develop the digital literacy and 21st century skills needed for success beyond educational setting.

Although ample body of research provides evidence that technology-enhanced instruction supports students' efforts to engage in learning opportunities that promote digital literacy, problem solving, critical thinking, and collaboration, technology has not been widely adopted for these purposes in classrooms (Becker, 1991; Cuban, 1996; Lei, 2010; Martin et al., 2010; Wenglinsky, 2005). In a survey of over 3,000 students, Levin, Arafeh, Lenhart, and Rainie (2002) reported a digital disconnect between how students use technology in their personal lives and in classrooms. According to their survey responses, majority of students that took part in the study believed that teachers did not modify their instruction in acknowledgment of the primary ways in which students communicate and use the technology in their everyday lives.

Today's educators are expected to prepare students to be digitally literate and have the ability to use 21st century skills to meet the needs of the global workforce. Performance pay, standardized testing, and accountability are usually at the forefront in the education reform debate. Yet, the challenge of adapting pedagogy and content to differentiate instruction is, for many, exasperated by the difficulties of learning and using technology in daily classroom practice. In this rapidly changing global landscape, technology can no longer be viewed as a nicety or a supplemental frill for improving instruction. Digital literacy and 21st century skills are a necessity for student success.

While technology available for classroom use has the potential to provide a multitude of learning opportunities for students, its adoption can be challenging for teachers, as they must initially learn how to use the technology and then feel comfortable enough planning and implementing instruction using the technology (Ertmer, Gopalakrishnan, & Ross, 2000). In many cases, accomplishment in the integration of technology into classroom practice occurs in distinct silos at the school level. Individually motivated teachers actively embrace advances in technology and master, most often in their own time, the skills needed to blend technology tools with classroom practice (Franklin, 2005; Lowery, 2003; Watson, 2001). However, other teachers still view technology integration as too challenging.

Their apprehension and reluctance to embrace technology is understandable, as the complex nature of teaching incorporates far more than the use of technology tools to be effective. Darling-Hammond (2006) explained:

> Standards for learning are now higher than they have ever been before, as citizens and workers need greater knowledge and skill to survive and succeed. Education is increasingly important to the success of both individuals and nations, and growing evidence demonstrates that—among all educational resources—teachers' abilities are especially crucial contributors to students' learning. Furthermore, the demands on teachers are increasing. Teachers need not only to be able to keep order and provide useful information to students but also to be increasingly effective in enabling a diverse group of students to learn ever more complex material. In previous decades, they were expected to prepare only a small minority for ambitious intellectual work, whereas they are now expected to prepare virtually all students for higher order thinking and performance skills once reserved to only a few. (p. 1)

Changing Teacher Practice

For technology to become an integral part of teaching, learning, and leading in education, the dynamics of changing practice must be addressed. Several theories of change have been conceptualized to address how successful change occurs in organizations. This review of extant literature sources discussing this topic provides insight into how the process of change impacts educator practice as related to technology integration in instruction.

One of the historical theories of change, force field analysis (Lewin, 1951), describes the disequilibrium that occurs when shifting from current practice to desired practice. According to Lewin (1951), facilitating forces encouraging the change and restraining forces support the status quo. To ensure that changed behaviors are not short-lived, the integration of new values and beliefs (considered re-freezing) must occur to stabilize the equilibrium by balancing the encouraging force and the restraining force (Kritsonis, 2005). In the context of technology integration, encouraging forces referred to in Lewin's model could include Internet access, ease of communication and collaboration, and the impact of students' existing technology use and knowledge. According to Earle (2002), examples of restraining forces could include teacher skills and knowledge, lack of consistent technology support, and pedagogical hesitations. Principals can stabilize and refreeze teacher practice by incorporating a vision and mission for the integration of technology into the school culture and providing leadership support for technology use for teachers who are facing changes in their traditional way of work. Burke (2011) posited that change occurs both incrementally and radically, irrespective of whether the process involves individuals, groups, or organizations. In the context of technology integration, revolutionary change is in process. Revolutionary change, as defined by Burke (2011), is a jolt to the system that results in nothing ever being the same again. This is the kind of change required to truly integrate technology into educational institutions.

Becoming a better educator often requires complex shifts in practice, values, and beliefs. The vast majority of teachers aspire to improve student outcomes (Guskey, 2002). Although changes in teacher practice are often required by policy mandates and recertification obligations, most teachers have strong personal desire to become better at their job. To address these changes, Guskey (2002) developed the Model of Teacher Change. His model, adapted from earlier work by Kurt Lewin (1951), described a continuum of development for teacher expertise. The continuum includes change in teacher practice that results in a change in student outcomes and finally leads to changed teacher beliefs and attitudes. This shift occurs only after evidence of a positive effect on student learning becomes available. His model emphasized that change is a "gradual and difficult process for teachers" (p. 386). Guskey emphasized that most teachers feel anxiety when encouraged to try something unfamiliar. This anxiety is often magnified when changes in practice include using technology (Brzycki & Dudt, 2005). For teachers, combining content, pedagogical, and technological expertise is a much more complex endeavor than merely implementing a lesson using a technological tool.

Sandholtz, Ringstaff, and Dwyer (1997) studied teachers as technology was newly implemented. Results indicated that teacher change, related to technology integration occurs in five stages. Entry-stage teachers use electronic reading materials and lecture to support teacher-led activities. Adoption-stage teachers employ mechanical use of technology using word processers or computer-based testing software with students. Adaptation-phase teachers use integration strategies in that there is a shift in how the technology is used in the classroom that incorporates student choice, allowing them to select and use the technology tools available in the classroom for a specific purpose. Appropriation-stage teachers allow students to work with a multitude of technology tools as project-based learning opportunities are being designed. Invention-phase teachers are considered the most effective technology integrators who facilitate primarily project-learning instruction with students working at an individually-designed pace and take advantage of all technology to further students' learning and collaboration skills.

Hughes (2005) reported that teachers use different types of pedagogy when changing their teaching practice to integrate technology Results were used to classify teachers' use of technology in three components. Technology could function as "replacement", as "amplification," or as "transformation." Replacement comprises of teachers utilizing technology only as a supplement and do not change their instructional routines. Amplification incorporates a more efficient use of technology in task completion, without regard for changing the instructional task. Transformation results in significant changes to the entire instructional design of activities as well as students' and teachers' behaviors in practice.

Understanding the dynamics of change theory provides insight into the complex nature of actualizing effective technology integration in education. Change in educator practice can be examined on a continuum and is highly influenced by beliefs, knowledge, skills, and support. For many teachers, technology integration further magnifies the difficulties of effective teaching practice, as it necessitates successfully combining technological knowledge with content and pedagogical knowledge.

Teachers' Beliefs

Empirical evidence indicates that teachers use their existing beliefs and prior knowledge when adopting technology in their classrooms (Ertmer, 1999; Hew & Brush, 2007; Levin & Wadmany, 2008; Liu, 2011; Zhao & Cziko, 2001). In a longitudinal qualitative case study of three teachers, Levin and Wadmany (2008) reported that teachers' beliefs about their technology integration abilities could be described by two influencing factors: (1) the human learning factor, which emphasizes the ways that teachers view technology and the conditions under which technology is used, and (2) the knowledge of learning factor, which describes the knowledge of technology and the knowledge of changes in practice involved in technology integration. Findings reported by Levin and Wadmany (2008) suggest that educational researchers and practitioners should be mindful of the influence teachers' beliefs have on their classroom practice.

In an earlier work, Ertmer (2005) explained that, when it comes to technology integration, "most teachers—regardless of whether they are veterans or novices, have limited understanding and experience about how technology should integrate into various educational aspects to facilitate teaching and learning" (p. 67). Moersch (1995) reported that individuals possessing high levels of self-efficacy are more likely to accept change. Thus, teaching self-efficacy should be taken into account when examining factors that may affect technology integration in the classroom. Brinkerhoff (2006) studied the influence of a professional development intervention on K-8 teachers' technology skills, computer self-efficacy, and technology integration beliefs and practices. The study findings indicated that teachers who participated in the two-year academy reported a stronger sense of computer self-efficacy after taking part in the professional development program. This outcome suggests that teachers' attitudes may be an obstacle to their technology integration. Brinkerhoff (2006) also noted that teaching self-efficacy had a considerable impact on the use of technology, particularly for novice users. The relationship between teachers' sense of teaching self-efficacy and their classroom uses of technology is explored in the present study.

Pierson (2001) studied how teachers who are proficient in their technology use perceive the function of technology in their classrooms in relation to their own use as well as that by their students. The goal was to describe the relationship between technology use and teaching practices. Pierson asserted:

- Teachers' personal definition of technology integration was based upon the way technology was used in the classroom.
- Teachers taught technology in the style that suited their own personal preference.
- Teachers' individual definition of technology integration impacted the way students' were able to use and access technology.
- Teachers' at lower levels of technology or teaching abilities used differing types of assessment. (p. 419-423)

Based on the study findings, the author concluded:

> Unless a teacher views technology use as an integral part of the learning process, it will remain a peripheral ancillary to his or her teaching. True integration can only be understood as the intersection of multiple types of teacher knowledge and, therefore, is likely as rare as expertise" (Pierson, 2001, p. 427).

Pierson's findings, akin to those reported by Koehler and Mishra (2009), highlight the need for more research to support teachers as they combine content, pedagogy, and technology knowledge to develop expertise in integrating technology.

Research by Lawless and Pellegrino (2007) also described the intricate balance that is required when using technology in classroom practice:

> Technology can make it quicker or easier to teach the same things in routine ways, or it can make it possible to adopt new and arguably better approaches to instruction and/or change the content or context of learning. Decisions about when to use technology, what

technology to use, and for what purposes cannot be made in isolation of theories and research on learning, instruction, and assessment. (p. 580)

Several researchers have investigated the relationship between teachers' beliefs and their approaches to learning (Dexter & Anderson, 2002; Ertmer, 2005; Ertmer, Ottenbreit-Leftwich, Sadik, Sendururc, & Sendururc, 2011). Following their qualitative study of exemplary in-service teachers, Ertmer et al. (2011) reported that teachers with a student-centered approach to teaching implemented more student-driven learning activities in their classroom practice. Wozney, Venkatesh, and Abrami's (2006) research of teachers' perceptions of their technology integration practices suggested that, while teachers' beliefs may be student-centered, their teaching practices in classrooms tend to be more traditional. In a longitudinal study of classroom quality, Justice et al. (2008) revealed that teacher's progressive or traditional beliefs about children influenced the quality of teacher and child interactions. More specifically, the authors reported that teachers who held a student-centered or progressive perspective about children provided instruction of higher quality. On the other hand, teachers that held more traditional beliefs about children were more proficient in explicit instruction methods.

Extant research suggests that a traditional pedagogy in which knowledge is transmitted to students should be replaced by a student-centered pedagogy that emphasizes student learning, allowing students to construct their own understandings (Bonk & Cunningham, 1998; Weimer, 2002). Hadley and Sheighold (1993) posited that the ability to facilitate student-centered learning requires deeper teacher expertise and skill that extends beyond traditional, adult-centered instruction. Yet, if teachers are to create technology-rich, student-centered classrooms that facilitate 21st century learning, they must have support from others (Ertmer & Ottenbreit-Leftwich, 2010).

Empirical evidence indicates that student-centered instruction is difficult to achieve in practice because many teachers still use traditional, adult-centered teaching methods. This difficulty creates tension, as teachers feel pressured to meet the changing expectations placed upon them to teach not only subject matter but also higher-order thinking skills. According to Pedersen and Min (2003), complex shifts in control are required for teachers to feel comfortable allowing their students to navigate their own learning using the technological tools available in today's classroom, and this poses a serious dilemma for many teachers. The tension between teacher and student control over the activities carried out during the teaching and learning process raises questions regarding how approaches to learning and pedagogical beliefs may ultimately affect teachers' use of technology in their classrooms.

Evidence demonstrates that teachers' beliefs can and do influence the instructional strategies they use when attempting to integrate technology into classroom instruction (Ertmer, 2005; Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010; Niederhauser & Stoddart, 2001). Hence, the relationship between teachers' beliefs and their technology integration abilities warrants further exploration. Measuring teachers' beliefs and examining how teachers' self-efficacy may potentially influences teachers' technology integration abilities in classroom practice is very important for gaining a better understanding of the factors related effective technology use in educational settings.

Leadership Support

An ample body of research evidence confirms that teachers may not have the necessary leadership support to effectively use technology in their classroom practice (Chen, Looi, & Chen, 2009; Hew & Brush, 2007; Inan & Lowther, 2010; Lawless & Pellegrino, 2007; Yalin, Karadeniz, & Sahin, 2007; Zhao, 2007). However, as Chang (2012) noted, "Schools striving to excel in the information age need leaders that are well versed in the potential and pitfalls of information and communication technology" (p. 328). School principals play a critical role in the improvement of technology use in educator practice (Anderson & Dexter, 2005; Chang et al., 2008). Yet, despite this evident link, most studies in this field limited their focus on teachers' perceptions of technology use and integration, while omitting the principals' perceptions of their roles in this process. This gap in research should be addressed, as extant studies indicate that, by providing effective motivation, direction, and supervision, the school principal often serves as the primary source of support for technology integration at the school and classroom levels (Hughes, McLeod, Dikkers, Brahier, & Whiteside, 2005).

Several studies have examined principal leadership required for effective technology integration. In one of the early studies preceding the digital era, MacNeil and Delafield (1998) reported the following findings:

- Barriers to technology implementation in the classrooms included time, mechanical infrastructure, lack of professional development.
- Technology integration will not have significant impact if funding, training, and leadership are not addressed at multiple levels including the district, the school, and the classroom levels.
- In order to promote technology integration in classroom practice, the principal must provide supportive conditions for teachers.

In a more recent study, Dawson and Rakes (2003) investigated whether technology training received by principals was associated with the implementation of technology in classrooms. Their findings indicated that, "the principal's involvement in infusing technology into the school is indispensable" (pp. 45-46). The authors further noted that principals who are more educated about technology have higher technology integration at the classroom level. In conclusion, Dawson and Rakes (2003) highlighted the need for researchers to further explore the role of the principal in technology integration from teachers' perspective.

Flanagan and Jacobson (2003) studied the effect of technology integration on the traditional roles and responsibilities of the school principal. Their findings indicated that the role of the principal has altered due to the need to integrate technology in schools, as they must now lead faculty and staff in the process of change, motivating them to incorporate technology into the teaching and learning strategies. These different roles include the principal being identified as a technology leader and allocating the time and resources necessary to support teachers as the technology is implemented. Additionally, school principals are charged with inspiring teachers and setting the expectations and directions for how technology will be integrated in the curriculum. Similar to teachers, principals are experiencing a shift in the expectations of their roles. Thus, professional development for principals is critical if they are to develop the innovative skills and attitudes required to support technology integration at the classroom level (Flanigan & Jacobsen, 2003).

Anderson and Dexter (2005) studied leadership attributes that made a difference in successful technology-related programs. The data required to meet the study objectives were collected from 488 principals and 467 technology coordinators from a national sample of public, private, and parochial schools. The three measures, Net Use, Technology Integration, and Student Tool-Use, were used to develop one survey. Upon analyzing the gathered data, the authors reported, "elementary schools were significantly lower than middle and high schools on the overall indicator of technology leadership" (p. 76). In addition, they confirmed that principal's technology leadership played an essential role in positive technology outcomes at the school level.

Kozloski (2006) researched the leadership role of the school principal in technology integration in Pennsylvania. The data collection instruments employed included surveys ($N = 94$) and in-depth interviews ($N = 16$). Interviews with principals allowed Kozloski to identify overarching themes regarding methods and strategies to facilitate technology integration related to principals' technology leadership. The results of this thematic analysis suggest that principals would promote teachers' use of technology by modeling the use of technology in their leadership practice, promoting the use of technology using small manageable steps. These research studies indicate that principals play an influential role in technology integration at the classroom level. Principals who are effective technology leaders are able to identify and articulate a vision, provide an appropriate model, offer individualized support, and have high expectations for technology use (Afshari, Bakar, Luan, Samah, & Fooi, 2009; ISTE, 2009; Leithwood, 1994).

Educational policy, investments in technological tools, and the needs of the 21st century workforce affect students, teachers, and principals in many ways. Students thrive when presented with authentic learning tasks using familiar technological tools. Teachers who are technologically, pedagogically, and content savvy use technology in ways that enhance their classroom practice. Educational leaders who set a vision, communicate expectations, and provide teachers with support to make different expectations attainable are effective leaders in the technological age. This in-depth examination of the factors that influence teachers' technology integration abilities confirms the urgency of the present study and amplifies the need for empirical research regarding how to measure the complex factors that are associated with technology integration in schools.

Summary and Theoretical Framework

This review of literature yielded a measurement instrument that showed promise as a scale to measure teachers' beliefs about their abilities to integrate technology in their classroom practice. For that reason, TPACK-deep scale was selected for further examination to test Kabakci-Yurdakul et al.'s (2012) assertions and build evidence towards establishing the validity and reliability of a TPACK measurement instrument for use with in-service elementary school teachers. Furthermore, Figure 2 presents the theoretical framework, adapted by the researcher from the TPACK knowledge framework (Koehler & Mishra, 2009; Mishra & Koehler, 2006) that undergirds this study's research design.

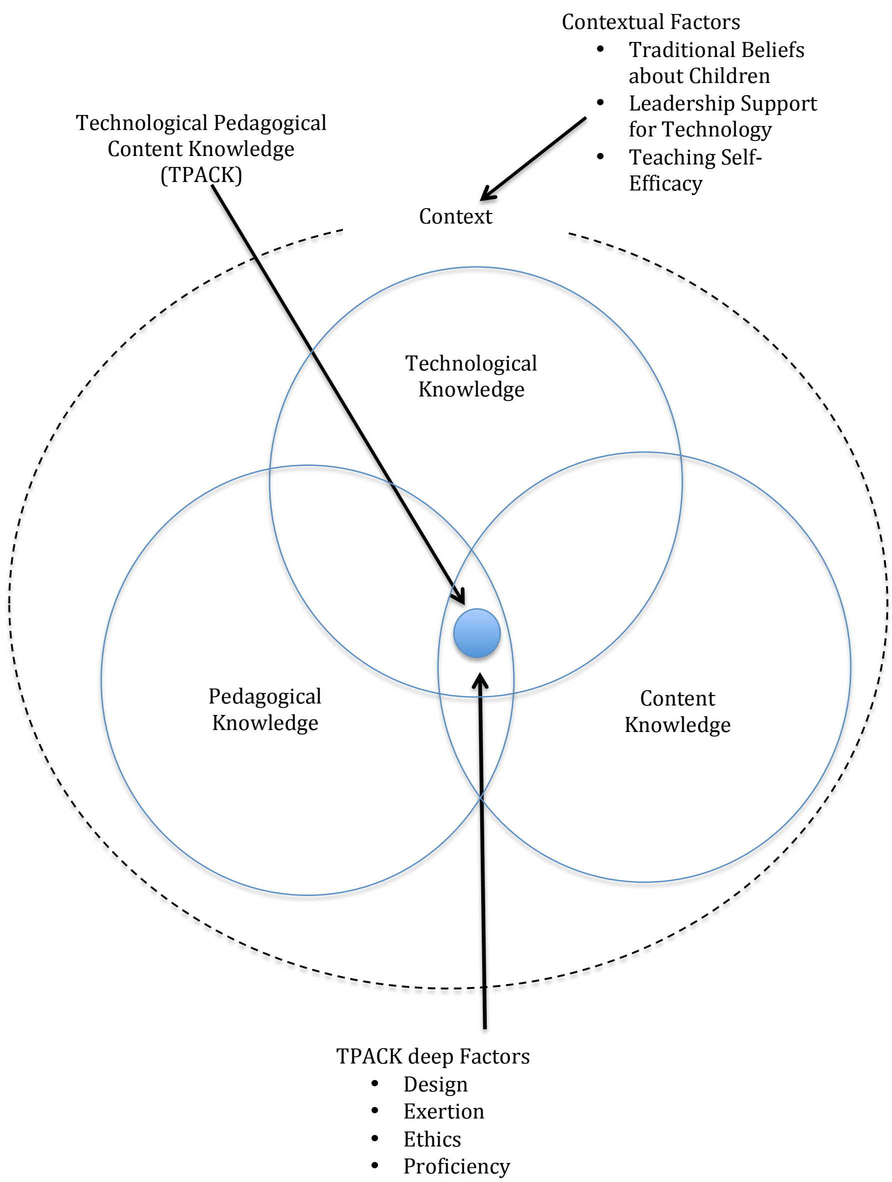

Figure 2. Theoretical framework for this research study.

Furthermore, this review of literature has focused on studies addressing technology integration in education. As was revealed, schools must overcome a variety of challenges when integrating technology in classroom instruction. Advances in technology have influenced society as a whole, and has had profound effect on the educational practice. These advances are evidenced in current educational spending and educational policy. Teachers in the 21st century are faced with significant changes in expectations for success in a digitally connected economy, which add to the persistent dilemmas of teaching. In recognition of these struggles, researchers and practitioners continue to invest efforts into identifying strategies that can close the gap among technological innovation, current practice, and effective practice. Capturing the complexity of this issue using theoretical models and measurement scales has proved to be a substantial problem for educational researchers and warrants further exploration.

Three contextual factors—beliefs about children, teaching efficacy, and leadership support—have been identified as most influential on teachers' technology integration abilities. The present study is designed to contribute to TPACK research by exploring the measurement of this integrative knowledge.

The research design and methodology for the present study are described in the following chapter, Chapter 3, whereas Chapter 4 presents the data analyses performed as a part of this investigation and the results yielded. Chapter 5 concludes this dissertation with a summary of the study, a discussion of results, and some suggestions for practice and future research in this field.

CHAPTER 3: PROCEDURES AND METHODS

Chapter 3 provides a more thorough description of this research design and methodology. This chapter also includes a context for the site selection, a description of the population, the sample, and the sampling method. The four instruments used in the present study are described. The hypothesized measurement model and path analyses as well as a rationale for why this method was selected are discussed. Also incorporated in this chapter are the methods used for collecting and analyzing the data, research validity, ethical considerations and, finally, a summary.

Research Design

The present study is influenced by the TPACK knowledge model, which is widely accepted by the research community as the transformative knowledge resulting from the integration of technology knowledge, pedagogical knowledge, and content knowledge that teachers use to maximize student learning in their teaching practice (Archambault & Crippen, 2009; Doering, Veletsianos, Scharber, & Miller, 2009; Mishra & Koehler, 2006; Kabakci-Yurdakul et al., 2012; Koehler & Mishra, 2009; Schmidt, et al., 2009;). This exploratory study was designed to add to the measurement research regarding the assessment of teachers' beliefs about their TPACK abilities. The purpose of the present study was to explore TPACK measurement by examining an established theoretical factor structure in a different context and extending previous TPACK-deep scale research to incorporate teaching self-efficacy, traditional beliefs about children, and leadership support for technology as factors associated with technology integration. Structural equation modeling (SEM) was used to analyze the hypothesized measurement model using survey responses of prekindergarten through grade five in-service teachers in Florida. The research questions included the replication (Question 1) and extension (Question 2) of Kabakci-Yurdakul et al.'s (2012) research using structural equation modeling (SEM) to capture the complexity of effectively learning, teaching, and leading with technology.

1. In what ways do structural equation model (SEM) results from a measurement model using the TPACK-deep scale items with in-service elementary school teachers in Florida confirm an existing theoretical structure with data provided by pre-service teachers?
2. In what ways are in-service elementary school teachers' beliefs about their leadership support for technology, teaching self-efficacy, and traditional beliefs about children associated with their beliefs about their ability to use technology in their teaching practice?

Several psychometric studies of teacher perceptions of technology integration used only quantitative means. Qualitative case studies regarding technology integration are also prominent in the literature (see Chapter 2). However, limited consensus exists regarding how to measure the most prominent framework used for technology integration—TPACK, the integrated knowledge of technology, pedagogy, and content to support student learning (Abbitt, 2011; Archambault & Barnett, 2010; Brantley-Dias & Ertmer, 2013; Doering, et al., 2009; Koehler & Mishra, 2005; Koehler & Mishra, 2009; Kabakci-Yurdakul et al., 2012; Mishra & Koehler, 2006).

Structural Equation Modeling

SEM is a multivariate analyses method that can be used to develop a measurement model that looks at the relationships among observed and latent variables. The goal of SEM is to determine a model that best fits the data (Hoyle, 1995) and account for measurement error. Latent variables, such as teacher beliefs, are unobserved variables. Observed variables, often referred to as observed or measured variables, are responses to items. Researchers are often interested in measuring latent variables using observed variables. This can be achieved using statistical techniques such as factor analysis and SEM (Schumacker & Lomax, 2004). These statistical techniques can be used to “reduce the number of observed variables into a smaller number of latent variables by examining the covariance among the observed variables” (Schreiber, et al., 2006, p. 323). SEM, as compared to Confirmatory factor analysis (CFA), expands the possibility of relationships among latent variables and can include a measurement model as well as structural path models.

Diagrams are essential to the SEM process because they “allow the researcher to display the hypothesized set of relations among variables – the model” (Ullman, 2006, p. 36). Ovals or circles in SEM diagrams represent latent variables. Observed variables are represented in rectangles. Lines specify relations between variables. The lack of a line connecting variables indicates there is no hypothesized relationship. Lines have either one or two arrows. A line with one arrow represents a hypothesized direct relationship between two variables. A line with an arrow at both ends specifies a correlation between the two variables. Figure 3 presents the hypothesized TPACK-deep measurement model and path analyses for this study.

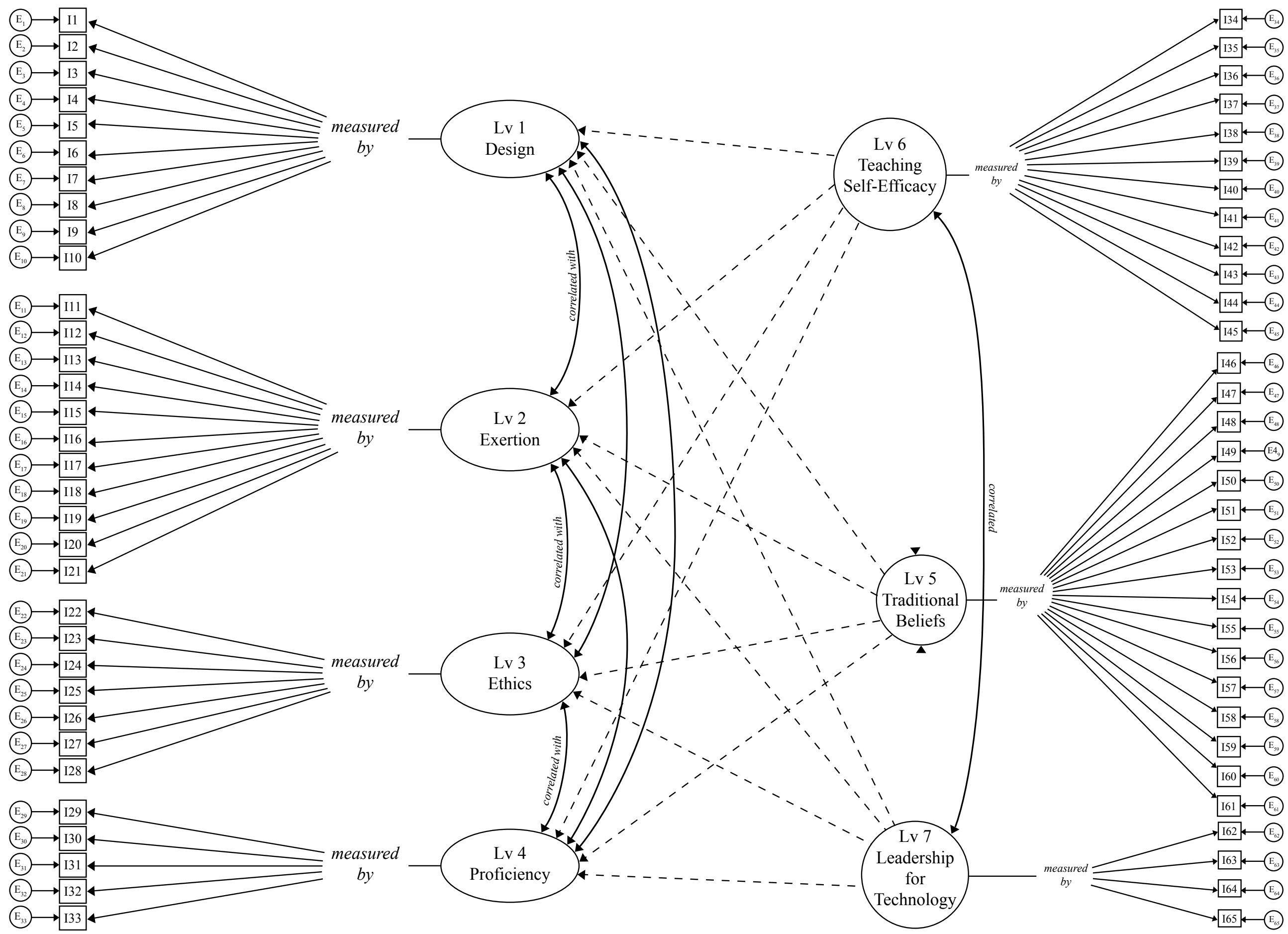

Figure 3. Hypothesized measurement model and path analyses. *Note.* Lv1 (Design latent factor), Lv2 (Exertion latent factor), Lv3 (Ethics latent factor), Lv4 (Proficiency latent factor), Lv5 (Traditional Beliefs about Children latent variable), Lv6 (Teaching Self-Efficacy latent variable), Lv7 (Technology Leadership Support for Technology latent variable). Dashed lines indicate hypothesized predictive associations and solid lines indicate hypothesized correlational associations.

Figure 3 also shows the hypothesized associations among the four TPACK-deep latent factors (Design, Exertion, Ethics, and Proficiency) and the three contextual latent variables (teaching self-efficacy, leadership support for technology, and traditional beliefs about children are the latent variables. The measurement model is used to describe the relationships among observed variables and the latent variables or factors (Ullman, 2006). The 65 observed variables of these four latent factors and three latent variable form the hypothesized measurement model and path analyses for this study.

SEMs enable a researcher to “use multiple observed variables to better understand their area of scientific inquiry . . . . permit complex phenomena to be statistically modeled and tested” (Schumacker & Lomax, 2004, p. 5). Additionally, testing validity and reliability are acknowledged SEM uses because these models explicitly account for measurement error in the statistical analyses of data. Other types of analyses frequently address measurement error and statistical analyses of data separately (Schumacker & Lomax, 2004), which some researchers find issue with in quantitative research. The hypothesized SEM model and path analyses (see Figure 3) included four latent factors and three latent variables and the following hypotheses were determined:

1. The four TPACK-deep scale latent factors—Design, Exertion, Proficiency, and Ethics—are correlated.
2. Leadership support for technology is correlated with teaching self-efficacy.
3. Leadership support for technology predicts the four TPACK-deep scale latent factors (Design, Exertion, Proficiency, and Ethics).
4. Teaching self-efficacy predicts the four TPACK-deep scale latent factors (Design, Exertion, Proficiency, and Ethics).

5. Traditional beliefs about children predict the four TPACK-deep scale latent factors (Design, Exertion, Proficiency, and Ethics).

The measurement model and path analyses presented in Figure 3 describe the complexity of factors that are hypothesized to impact teachers' beliefs about their technological, pedagogical, content knowledge abilities. SEM offers researchers a process for assessing theoretical constructs and their relationships (Anderson & Gerbing, 1988). Because the goal of this study was to examine the associations among four latent factors and three latent variables, SEM methodology was a well-suited research design for this investigation.

Site Selection

Of the 68 public school districts in Florida, 24 districts were selected by the researcher to contact. Selection was made using s.1011.62(12)(b), Florida Statutes (F.S.) that states each District School Board shall submit to the Department of Education a Digital Classrooms Plan (DCP) adopted by the district. Twenty-four districts had reported to the Florida Department of Education a Calculated Student to Device Ratio of 2.99 in at least three prekindergarten through grade five schools by the 2014 Fall Gap Analysis School Technology data. A 2.99 to one ratio indicates that these schools provided students access some technology tools.

Table 2

Florida Public School Districts Identified and Approved for Participation

Possible Florida Public School Districts			
Alachua	*Clay	Hernando	*Marion
*Bay	Dade	*Hendry	*Monroe
*Bradford	*Duval	*Hillsborough	Okaloosa
Brevard	Escambia	*Lake	*Polk
Broward	Flagler	*Leon	*Putnam
Charlotte	Gadsden	*Levy	*Volusia

Note. *Districts who approved the research request to conduct the present study.

Of the 24 school districts contacted, 14 districts gave approval to contact individual elementary school principals to then seek approval to request the voluntary participation of their elementary school teachers in this study. Table 2 also identifies the 14 school districts that approved the initial research request and are noted by an asterisk. Following district approval, 180 school principals were contacted for permission to invite teacher participation. Of these, 42 elementary school principals approved the request to contact individual teachers' for voluntary participation in the study.

Description of the Population and Sample

The participants in this study included elementary school teachers teaching in rural, suburban, and urban school districts in Florida. Florida has 68 public school districts, 24 of which were identified for potential participation in this study. Their suitability for inclusion in the study was determined by the ratio of technology devices to students that were reported as available in at least three of the district's elementary schools using public record data from the Florida Department of Education. District selection was purposive to ensure that the population under investigation had access to technology that could be used in classroom practice. This resulted in inviting 1,747 teachers in fourteen Florida public school districts, of whom seventy-five ($N = 75$) participated in this exploratory study.

The non-random sample of prekindergarten through grade five teachers in Florida who were identified as employees at schools in school districts that reported a technology device to student ratio of 2.99:1 increased the likelihood that respondents had technology tools in their classrooms. This sampling method is considered purposive. Cook, Campbell, and Day (1979) recommended purposive sampling methods for deliberate heterogeneous sampling when the activity is "typical of the kinds of outcomes of interest" (p. 354).

Determining sample size in SEM is a consistent challenge for researchers (Bollen, 1989; MacCallum, Widaman, Zhang, & Hong, 1999; Muthén & Muthén, 2002). Muthén and Muthén's recommendations for determining goodness of fit when conducting a small study ($N < 100$) was used to determine the appropriate fit boundaries for the measurement model in the present exploratory study.

Instrumentation.

Guided by the TPACK-deep scale (Kabakci-Yurdakul et al., 2012) results, four latent factors were examined in this research study to test the four-factor structure with a different population in a different country. The purpose of the Kabckci-Yurdakul et al. study was to develop a scale to measure the central construct of the TPACK knowledge model (Koehler & Mishra, 2009; Mishra & Koehler, 2006), which represents the overlapping intersection of teachers' technological, pedagogical, and content knowledge. Validity and reliability studies were conducted using 995 Turkish pre-service teachers. The sample was split into two subsamples randomly ($N_1 = 498$, $N_2 = 497$). Researchers used Exploratory factor analysis (EFA) and Confirmatory factor analysis (CFA) to test the factor scales. Kabckci Yurdakul et al.'s (2012) final TPACK-deep scale included 33 items and four factors. The four factors were identified as Design, Exertion, Ethics, and Proficiency. The Cronbach's alpha coefficient for the entire scale was .95 and the values of Cronbach's alpha coefficient for individual factors ranged from .85 to .92. CFA confirmed a four-factor scale.

Teachers' beliefs about children were assessed in the current study using 11 items from the Ideas About Raising Children (originally adapted from Schaefer & Edgerton, 1985). This scale was used in Justice, Mashburn, Hamre, and Pianta's (2008) study to examine the contribution of teacher characteristics to the quality of language and literacy instruction

(N = 135). Their research used the beliefs scale to “discriminate between traditional- or relatively adult-centered perspectives on interactions with children and more modern or progressive child-centered perspectives” (p. 7). The Cronbach’s alpha coefficient was reported at .78. For the purposes of this exploratory study, the traditional scale was used to assess the teacher’s traditional beliefs about children by measuring the amount of agreement with traditional caregiving ideas.

The Teacher Sense of Efficacy Scale (TSES; Tschannen-Moran & Woolfolk Hoy, 2001) included 12 items to examine how in-service teachers’ self-efficacy was associated with their TPACK. The TSES is a “measure of peoples’ evaluations of their own likely success in teaching” (Duffin, French & Patrick, 2012). The reliability for the 12-item scale in one factor, Efficacy, was .90.

Four items from Chang, et al.’s (2008) Elementary School Principals’ Technology Leadership Questionnaire were used to examine teachers’ perceptions of principals’ technology leadership in relationship their to interpersonal and communication skills and TPACK. Chang et al.’s purpose for their scale was to investigate Taiwanese teachers’ perceptions of elementary schools principals’ technology leadership. The four items used in this study addressed one factor (Interpersonal and Communication skills). The Cronbach’s alpha coefficient for this factor was reported as .96 and was the strongest factor related to technology leadership of the four factors in their study.

The survey distributed to participants included four scales to examine how teachers’ beliefs about their technology abilities were associated with their beliefs about leadership support for technology, teaching self-efficacy, and traditional beliefs about children. Demographic data was also collected. In addition to the 65 items described previously, respondents were asked gender, age, school size, school district, and highest level of education.

Data Sources and Data Collection Procedures

Following approval by the Institutional Review Board at the University of North Florida, the identified school districts (see Table 2) were contacted to participate in this study and were provided a copy of the Institutional Review Board Memorandum, a school district research request letter, a principal research request letter, a sample of the teacher informed consent form, and a copy of the teacher survey (see Appendix A−E). Upon approval by each school district, principals were contacted for permission to recruit teachers at their respective schools. Once the relevant school principal's approval was obtained, each teacher was sent a link to the web-based survey that included a statement of consent to participate in this research study (see Appendix E). Electronic surveys were distributed to participants from August through October 2015 using the Qualtrics Research Suite, the university's web-based survey platform. In 13 of the 14 school districts that approved the research request to conduct the present study, participants were contacted twice to encourage participation. However, in the remaining school district, only the initial communication with the potential candidates was permitted. Because the data was anonymously reported, participants were contacted with a reminder even if they had completed the web-based survey.

For this exploratory research study, participants were recruited using two forms of communication. School districts were initially contacted by mail, following the individual district's research request protocol. School principals were contacted by mail and email three times requesting approval to recruit teachers for participation in this study. Teachers were recruited for participation by an online invitation and link to a web-based survey that included a brief statement regarding how their participation would be of benefit to the research regarding technology integration. Teachers were informed that their participation was voluntary and no compensation would be offered for survey completion. The intent of this communication was to assure participants of their rights as a subject in human research, while utilizing a cost-effective method to obtain data from a large sample of Florida in-service elementary school teachers.

Data Analysis

The analysis of survey data was completed using Mplus 7.4® (Muthén & Muthén, 2014) and SPSS 22® (SPSS, 2014). More specifically, descriptive analyses were computed using SPSS 22® (SPSS, 2014), whereas statistical analyses were performed via Mplus 7.4® (Muthén & Muthén, 2014). Several stages of analysis were conducted. First, “estimation of unknown parameters (e.g., factor loadings) based on observed covariance/correlation” (Kelloway, 1998, p. 14) was used to find the solution to the measurement models. Next, Mplus 7.4® was used to estimate model parameters by comparing the covariance matrix with the observed covariance matrix repeatedly until adequate similarity was achieved (Hoyle, 1995). In the final stage, the goal was to determine the fit of the model using negative variance, root mean square error of approximation (RMSEA), the Tucker-Lewis Fit Index (TLI), the weighted root squared residual (WRSR), and the comparative fit index (CFI).

Research Validity

Byrne (2013) explained that, when conducting SEM analyses, a model is being fit to the data, and the weights and other latent variable variances and/or latent variable covariates associated with that model are being estimated. Whether or not a model can be identified is a critical aspect of the analysis. A model is identified when, given the model and the data, a single set of weights and other model parameters can be computed (Byrne, 2013), producing valid results. The subscales selected for this study included 65 items found reliable when tested against data pertaining to different populations. Klem (2000) noted, “Data for an SEM program consist of a covariance or correlation matrix. Two assumptions that underlie SEM programs are (a) that the variables on which the matrix coefficients are based are intervally scaled and (b) that the variables have a multivariate normal distribution” (p. 7). Sample size in SEM is also an important consideration. The sample size required for obtaining reliability of findings is dependent on how complex the model is, the scope of the coefficients, the number of measured variables associated with the factors, and the multivariate normality of the variable distributions. Thus, complex models require a greater number of cases. Schumacker and Lomax (2004) indicated that the input matrix should be based approximately on 100−150 cases. The anticipated number of respondents for this study was 300; however, 75 in-service elementary school teachers in Florida participated in this exploratory study ($N = 75$).

Ethical Issues

The materials used in this study included a web-based survey of 65 items and six demographic questions. This study did not involve any foreseeable risk or undue costs to the participants because the survey items addressed activities that are common in educational settings and pose no risk or excessive cost to participants. One cost to participants was the time required to complete the web-based survey, which was approximately 15 minutes. A benefit of participating in this study was the opportunity to voice their perceptions regarding the complexities of effectively integrating technology in the elementary school classrooms. Participants did not receive any compensation for participation in this study. Data were kept anonymous and will be destroyed after five years. Only researchers working on this study have access to the data.

Summary

This research study was designed to explore contextual factors associated with technology integration by investigating the validity of the TPACK-deep instrument to measure Florida in-service prekindergarten through grade five teachers' beliefs about their ability to integrate technology in elementary school classrooms. This research design included testing the TPACK-deep scale and three additional subscales using a 65-item web-based survey distributed to in-service teachers in Florida. The data gathered was analyzed to confirm a proposed theoretical structure and examine how teaching leadership support for technology, self-efficacy, and traditional beliefs about children may influence teachers' perceptions of their technology integration abilities.

The study design presented in this chapter identified participants, instrumentation, procedures, and methods for collecting and analyzing the data. Ethical considerations were also described. Chapter 4 details the data analyses and SEM results. Chapter 5 provides a summary of the present study, discussion of the findings, implications for practice, and suggestions for future research in this field.

CHAPTER 4 – DATA ANALYSIS AND RESULTS

This exploratory study tested a hypothesized structural model to confirm a factor structure found with data collected from a different population. The current study also examined the associations among the TPACK-deep scale factors and contextual factors that were hypothesized to influence Florida prekindergarten through grade five teachers' use of technology. Results include the descriptive and structural equation analyses used to answer the research questions and the hypothesized associations among the four latent factors and the three latent variables.

Data Preparation

Data were exported from the web-based survey database, Qualtrics Research Suite into an Excel workbook. Excel files were formatted for use in SPSS 22® (SPSS, 2014) and then Mplus 7.4® (Muthén & Muthén, 2014). Data were analyzed as ordered categorical data variables in the model and estimation.

Missing Data

The analyses of missing data indicated some surveys were incomplete. The missing data were presumed to happen at random by respondents. Seventy-five surveys were completed. Seventeen surveys contained missing data. Twenty-two items were not answered from the total of 17 surveys. Missing data were inputted using Mplus 7.4® (Muthén & Muthén, 2014). The full information maximum likelihood (FIML) was used to estimate a model in which some of the variables had missing values. A latent variable model was created for the four scales to maintain the sample size ($N = 75$), which permitted inputting all missing survey data. Missing data by questionnaire item number is displayed in Table 3.

Table 3

Missing Data Analysis

Questionnaire Item	*n*	Missing
Q8	74	1
Q9	74	1
Q12	74	1
Q14	73	2
Q19	73	2
Q24	74	1
Q26	74	1
Q32	74	1
Q35	74	1
Q37	74	1
Q38	74	1
Q39	74	1
Q41	74	1
Q44	74	1
Q48	74	1
Q49	74	1
Q50	73	2
Q51	74	1
Q56	74	1

Descriptive Analyses

Descriptive statistics were calculated using SPSS 22® (SPSS, 2014). Descriptive statistics were computed on age, school size, and gender status to describe the characteristics of the present study' population sample. Scale reliability analyses were used to determine internal consistency reliability by estimating coefficient alphas for each of the four selected scales using data from this study. Findings for these analyses are detailed in the following sections.

Study Participants

Data were collected from in-service Florida elementary school teachers employed in 14 public school districts at 42 elementary schools ($N = 75$). The participant gender was reported as

96% female and 4% male. The age of respondents ranged from 23 to 66 years old. Sixty-seven percent of respondents reported that the size of their elementary school was large (more than 500 students), 31% reported that the size of their elementary school was medium (100 to 500 students), and 3% of respondents reported that the size of their elementary school was small (less than 100 students). Table 4 reports the gender, age, and school size characteristics of the study participants. Additionally, all participants reported a bachelor's degree or above as their highest level of education.

Table 4

Gender, Age, and School Size Characteristics of Study Participants (N = 75)

Characteristic		*n*	%
Gender			
	Female	72	96.0
	Male	3	4.0
Age			
	Not reported	2	2.2
	23-33 years	8	10.4
	34-44 years	24	30.6
	45-55 years	25	32.0
	56-66 years	16	20.6
School Size			
	Small (under 100 students)	2	2.7
	Medium (100 to 500 students)	23	30.0
	Large (over 500 students)	50	66.7

Scale Reliability Analyses

To determine scale reliability, Cronbach's alpha values were estimated for the four study scales. The TPACK-deep scale, leadership support for technology scale, teaching self-efficacy scale, and the scale of traditional beliefs about children were analyzed using SPSS 22® (SPSS, 2014). Results confirmed the internal consistency for the sample under investigation in the present study. Acceptable values were obtained for the four scales as displayed in Table 5.

Table 5

Internal Consistency Reliability Estimates of Selected Scales for Study Data

Scale	Alpha
Technological Pedagogical Content Knowledge (TPACK-deep)	.957
Design	.920
Exertion	.883
Ethics	.836
Proficiency	.811
Leadership Support for Technology	.876
Teaching Self-Efficacy	.914
Traditional Beliefs	.831

Structural Equation Analyses

Mplus 7.4® (Muthén & Muthén, 2014) was used to compute the structural equation analyses and to examine the associations among the TPACK-deep factors (Design, Exertion, Ethics, and Proficiency) and the contextual factors (leadership support for technology, teaching self-efficacy, and traditional beliefs about children) to better understand what influences elementary teachers' efficacy about technology use in their teaching practice. The hypothesized structural model was tested by the development of multiple measurement models. To answer the research questions and research hypotheses, simultaneous regression and correlation equations and measurement models were used to analyze the data. The resulting path coefficients were compared to examine the association among the TPACK-deep latent factors and the previously identified contextual factors. The following sections detail the findings for the TPACK-deep measurement models.

TPACK-deep scale

The first stage of data analyses included using the data to examine the measurement of the TPACK-deep factors of Design, Exertion, Ethics, and Proficiency. Mplus 7.4® (Muthén & Muthén, 2014) computes estimate polychoric correlations when variables are ordered-categorical, both are dichotomous, or one is ordered-categorical and the other is dichotomous.

Table 6 details the polychoric correlation matrix among the design TPACK-deep factors. All polychoric correlations were statistically different than zero with $p < .001$. Design scale items (Q7 - Q16) demonstrated correlations ranging from .443 to .819. The highest polychoric correlation was found between Q15 (I can use technology to appropriately design materials for an effective teaching and learning process) and Q16 (I can organize the educational environment appropriately to use technology) with an estimated value of .819.

Table 6

Polychoric Correlation Matrix for the TPACK-deep Design Items

	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15
Q8	.719								
Q9	.676	.758							
Q10	.658	.815	.707						
Q11	.572	.678	.443	.647	.				
Q12	.710	.648	.864	.725	576	.			
Q13	.703	.709	.613	.793	.571	.675			
Q14	.599	.692	.510	.608	.789	.696	.566		
Q15	.749	.711	.644	.793	.592	.807	.771	.778	
Q16	.698	.657	.661	.787	.512	.708	.636	.681	.819

The TPACK-deep factor Exertion items (Q17 - Q27 and Q29) were also highly correlated (see Table 7), ranging from .174 to .932. The highest polychoric correlation was between Q26 (I can use technology to update my knowledge and skills) and Q27 (I can update my technological knowledge for the teaching process) with an estimated value of .932.

Table 7

Polychoric Correlation Matrix for the TPACK-deep Exertion Items

	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27
Q18	.597										
Q19	.431	.692									
Q20	.393	.686	.462								
Q21	.306	.573	.426	.637							
Q22	.464	.752	.725	.548	.549						
Q23	.339	.663	.373	.368	.316	.604					
Q24	.400	.621	.418	.363	.397	.620	.627				
Q25	.291	.620	.639	.618	.746	.523	.380	.522			
Q26	.294	.486	.569	.441	.515	.729	.541	.475	.496		
Q27	.338	.713	.612	.558	.685	.755	.536	.458	.622	.932	
Q29	.335	.491	.428	.324	.210	.337	.183	.193	.325	.174	.220

The polychoric correlations among TPACK-deep Ethics items (Q30 - Q33 and Q35) and TPACK-deep Proficiency items (Q36 - Q39) presented in Table 8 ranged from .389 to .830. The highest polychoric correlation between Ethics items was Q30 (I can behave ethically in acquiring and using special/private information-which will be used in a teaching area) and Q32 (I can follow the teaching profession's code of Ethics in online educational environments) with an estimated value of .792. Proficiency items that were highly correlated include Q38 (I can become a leader in spreading the use of technological innovations in my teaching community) and Q39 (I can cooperate with other teachers regarding the use of technology to solve problems encountered in the process of presenting content) with an estimated value of .799.

Table 8

Polychoric Correlation Matrix for the TPACK-deep Ethics and Proficiency Items

	Q30	Q31	Q32	Q33	Q35	Q36	Q37	Q38
Q31	.657							
Q32	.792	.668						
Q33	.607	.683	.653					
Q35	.435	.539	.584	.714				
Q36	.389	.406	.541	.668	.830			
Q37	.476	.568	.485	.753	.764	.663		
Q38	.425	.510	.602	.696	.700	.759	.630	
Q39	.472	.554	.633	.598	.588	.559	.502	.799

Polychoric correlations among all TPACK-deep items (Q7 - Q27, Q29 - Q33, Q35 - Q39) using the four-factor structure indicate the highest correlation among the different factors is between Q8 (Design, I can use technology to determine students' needs relative to a content area in the pre-teaching process) and Q19 (Exertion, I can apply instructional approaches and methods to differentiate instruction using technology with an estimated value of .808). The four latent factors (Design, Exertion, Ethics, and Proficiency) were formed using 33-items from the web-based survey.

The robust weighted least squares means and variance adjusted (WLSM) estimation method was used to estimate models. Goodness of fit indices were used for all models, and often fit was improved by allowing correlations among the errors of some of the scale items. Table 9 presents the fit indices and the ranges that indicate good fit.

Table 9

Goodness of Fit Indices

Index	Good Fit Boundaries
Negative variance	No
RMSEA	< .05 (Hu & Bentler; 1999; Yu & Muthén , 2002)
CFI	> .95 (Kline, 2015)
TLI	> .90; (Hu & Bentler, 1999; Yu & Muthén , 2002)
WRMR	< 1.0 (Yu & Muthén , 2002)

After confirming the one- and four-factor models, the confirmatory factor analysis (CFA) was used to identify factor loadings for the TPACK-deep items. Two items (Q28 and Q34) were removed to improve the model fit as they had negative variance estimates.

Next, a measurement model was developed to control for measurement error in the TPACK-deep scores. Fit measure indices for the one-factor model and the four-factor model are presented in Table 10. The comparative fit index (CFI), Tucker-Lewis fit index (TLI), root mean square error of approximation (RMSEA), and the weighted root mean square residual (WRMR) were used to evaluate model fit while path coefficients were assessed. The fit measure indices for both models were acceptable. However, the four-factor model was selected for this exploratory study to further examine Design, Proficiency, Ethics, and Exertion. Four latent factors (Design, Exertion, Ethics, and Proficiency) were confirmed for TPACK-deep using the measure's items. Modification to improve the four-factor model fit included allowing the correlation of the errors of Q14 and Q11, the errors of Q25 and Q21, the errors of Q27 and Q26, the errors of Q30 and Q32, and the errors of Q35 and Q36 to improve the model fit. The modification resulted a good fit using four factors.

Table 10

Fit Index Measures for One- and Four-Factor Analyses (CFA)

Index	1 factor model	4 factor model
Negative variance	No	No
RMSEA	.064	.057
CFI	.971	.978
TLI	.969	.975
WRMR	.908	.846

Note. Goodness of fit boundaries for indices are found in Table 9.

Table 11 displays the standardized model results for the four-factor TPACK-deep measurement model. Items (Q), the corresponding defining factor, and their statistical significance in measuring TPACK-deep are included. All items were statistically significant ($a = .05$, $Wald > 1.96$) and, therefore, considered measures of TPACK-deep (Schumaker & Lomax, 2004, p. 177).

Table 11

Four-Factor TPACK-deep Measurement Model

Factor	Estimate (*SD*)	*Wald*
Design by		
Q7	0.790 (.049)	16.277
Q8	0.863 (.042)	20.736
Q9	0.808 (.052)	15.525
Q10	0.932 (.029)	31.897
Q11	0.669 (.051)	13.231
Q12	0.835 (.046)	18.141
Q13	0.855 (.032)	26.802
Q14	0.736 (.054)	13.685
Q15	0.923 (.029)	31.420
Q16	0.852 (.033)	25.745
Exertion by		
Q17	0.629 (.057)	11.021
Q18	0.845 (.044)	19.116
Q19	0.796 (.052)	15.166
Q20	0.671 (.057)	11.808
Q21	0.603 (.074)	8.149
Q22	0.867 (.041)	21.415
Q23	0.696 (.063)	11.077
Q24	0.768 (.050)	15.305
Q25	0.707 (.060)	11.869
Q26	0.737 (.061)	12.179
Q27	0.803 (.046)	17.527
Q29	0.414 (.104)	3.974
Ethics by		
Q30	0.675 (.071)	9.524
Q31	0.813 (.071)	19.861
Q32	0.729 (.059)	12.383
Q33	0.870 (.037)	23.375
Q35	0.806 (.053)	15.253
Proficiency by		
Q36	0.747 (.051)	14.564
Q37	0.830 (.054)	15.280
Q38	0.873 (.033)	26.489
Q39	0.884 (.038)	23.305

Note. Estimated standard error is displayed in parentheses; $a = .05$, $Wald > 1.96$.

The four-factor correlation matrix (Table 12) displays the Pearson product-moment correlations among the four TPACK-deep latent factors. All correlations are statistically significant (*p* < .001). Exertion is correlated with Design (*r* = .914). Ethics is correlated with Design (*r* = .826) and with Exertion (*r* = .876). Proficiency is correlated with Design (*r* = .829), Exertion (*r* = .792), and Ethics (*r* = .896).

Table 12

TPACK-deep Factor Correlation Matrix

TPACK-deep Factors	Exertion		Ethics		Proficiency	
	Estimate (*SD*)	*Wald*	Estimate (*SD*)	*Wald*	Estimate (*SD*)	*Wald*
Design	0.914 (.028)	32.994	0.826 (.037)	22.578	0.829 (.042)	19.554
Exertion	--	--	0.876 (.038)	23.039	0.792 (.056)	14.069
Ethics	--	--	--	--	0.896 (.041)	21.907

Note. Estimated standard error is in parentheses; *a* = .05, *Wald* > 1.96.

Figure 4 illustrates the TPACK-deep measurement model. All path coefficients were statistically significant at *p* < .10. The four TPACK latent factors were highly correlated. The highest correlation among TPACK-deep latent factors was between Design and Exertion (*r* = .914). Ethics and Design were correlated at (*r* = .826), as were Proficiency and Design (*r* = .829). Ethics was also correlated with Exertion (*r* = .876). Proficiency and Ethics were correlated at (*r* = .896). The smallest correlation found was between Proficiency and Exertion (*r* = .792). All of these results confirmed that the model could equally be a one-factor model. Fit statistics' for the final measurement and structural models for the four TPACK-deep factors and the three contextual factors presented in the following sections represent the order in which the TPACK-deep latent factors were regressed on the contextual variables (covariates) for analyses.

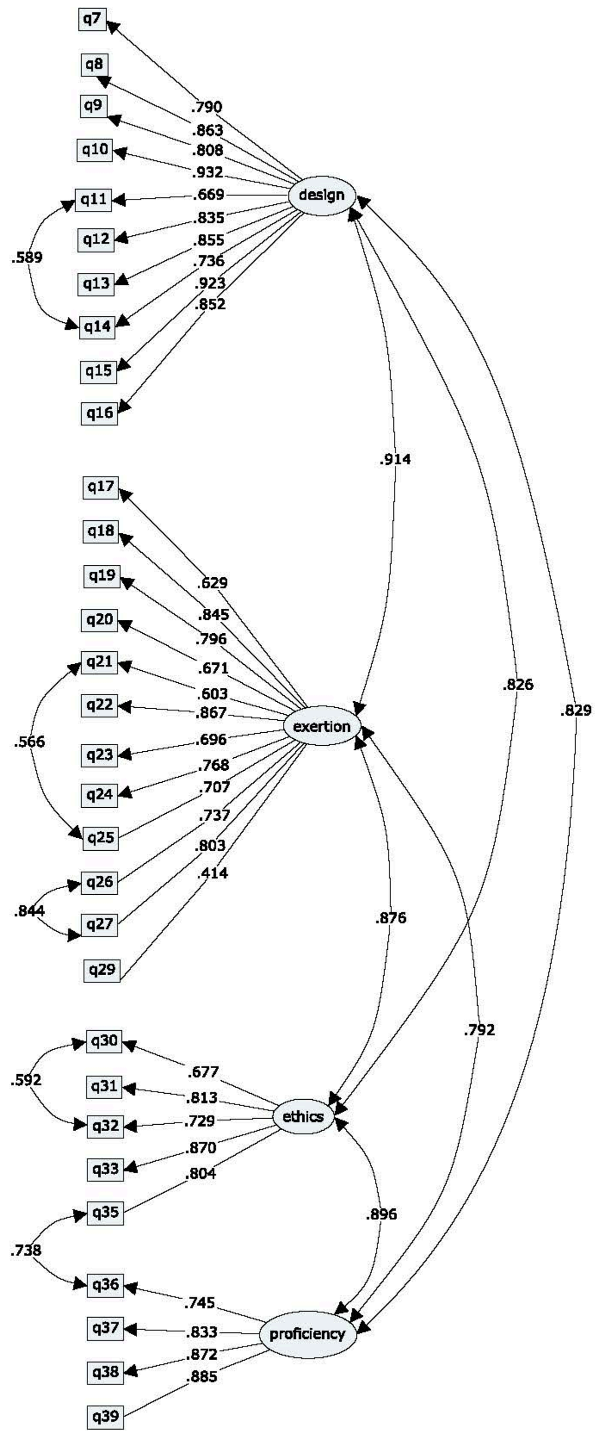

Figure 4. *TPACK-deep final measurement model.*

Contextual Factors

Next, path analyses were designed to examine the relationship among the four TPACK-deep latent factors of Design, Exertion, Ethics, and Proficiency and three contextual factors (traditional beliefs about children, leadership support for technology, and teaching self-efficacy). Data were gathered using 11 items of the web-based survey to measure teachers' traditional beliefs about children. Leadership support for technology data were measured using four items of the web-based survey. Teaching self-efficacy was measured using 11 items of the web-based survey. An analysis of each contextual variable and its association with the four TPACK-deep latent factors are discussed in the order in which the TPACK-deep latent factors were regressed on the latent variables to form the final measurement model.

Traditional Beliefs about Children

Teachers' traditional beliefs about children were measured using items adapted from the Ideas about Raising Children scale (Justice, et al., 2008). For this exploratory study, 11 items were used to assess traditional beliefs. Polychoric correlations (see Table 13) among traditional items ranged from .047 to .772. The highest correlation was between Q61 (Teachers should discipline all children the same) and Q68 (In order to be fair, a teacher must treat all children alike) with an estimated value of .772. The lowest correlation was between Q60 (Children should be treated the same regardless of differences among them) and Q71 (Children must be carefully trained early in life or their natural impulses will make them unmanageable) with an estimated value of .047.

Table 13

Polychoric Correlation Matrix for the Traditional Beliefs Items

	Q59	Q60	Q61	Q62	Q63	Q64	Q66	Q67	Q68	Q69
Q60	.398									
Q61	.519	.620								
Q62	.468	.593	.550							
Q63	.180	.088	.382	.112						
Q64	.360	.323	.522	.489	.459					
Q66	.356	.420	.508	.509	.187	.310				
Q67	.308	.288	.311	.368	.317	.253	.337			
Q68	.479	.554	.772	.573	.099	.521	.470	.317		
Q69	.504	.590	.558	.493	.141	.442	.545	.280	.675	
Q71	.264	.047	.198	.202	.079	.405	.196	.168	.192	.345

Fit index measures for the TPACK-deep latent factor regression on the traditional beliefs latent variable are presented in Table 14. Goodness of fit was determined as each model was tested. Items did not have negative variance. The RMSEA, CFI, TLI and the WRMR indicate the final model was well suited for this exploratory study.

Table 14

Fit Index Measures for Regression Analyses of the TPACK-deep Latent Factors on the Traditional Beliefs Latent Variable

Index	TPACK-deep with Traditional Beliefs
Negative variance	No
RMSEA	.044
CFI	.974
TLI	.973
WRMR	.920

Note. Goodness of fit boundaries for indices are found in Table 9.

The standardized model results for the TPACK-deep latent factor regression on the traditional beliefs latent variable are presented in Table 15. Table 15 displays items (Q), the corresponding defining factor, and their statistical significance using the Wald statistic. With the addition of traditional beliefs, all measurement model items were statistically significant, *Wald* > 1.96. (Schumaker & Lomax, 2004, p. 177).

Table 15

Traditional Beliefs Latent Variable Measurement Model

Item	Estimate (*SD*)	*Wald*
Q59	0.615 (.068)	9.032
Q60	0.684 (.068)	10.043
Q61	0.859 (.038)	22.657
Q62	0.712 (.061)	11.658
Q63	0.318 (.087)	3.659
Q64	0.624 (.086)	7.250
Q66	0.616 (.071)	8.644
Q67	0.427 (.096)	4.465
Q68	0.857 (.037)	22.940
Q69	0.764 (.053)	14.455
Q71	0.313 (.111)	2.820

Note. Estimated standard error is in parentheses; $a = .05$, *Wald* > 1.96.

Pearson product-moment correlations among the four TPACK-deep latent factors and the path coefficients when they are regressed on the traditional beliefs latent variable did not produce a correlation between the TPACK-deep latent factors and the traditional beliefs latent variable.

An analysis of the four TPACK-deep latent factors regression on the traditional beliefs latent variable indicates that teachers' traditional beliefs did not predict TPACK Design ($p = .804$), Ethics ($p = .651$), Proficiency ($p = .244$), or Exertion ($p = .335$) with statistical significance. The SEM model displaying the TPACK-deep latent factors regressed on traditional beliefs latent variable is displayed in Figure 5.

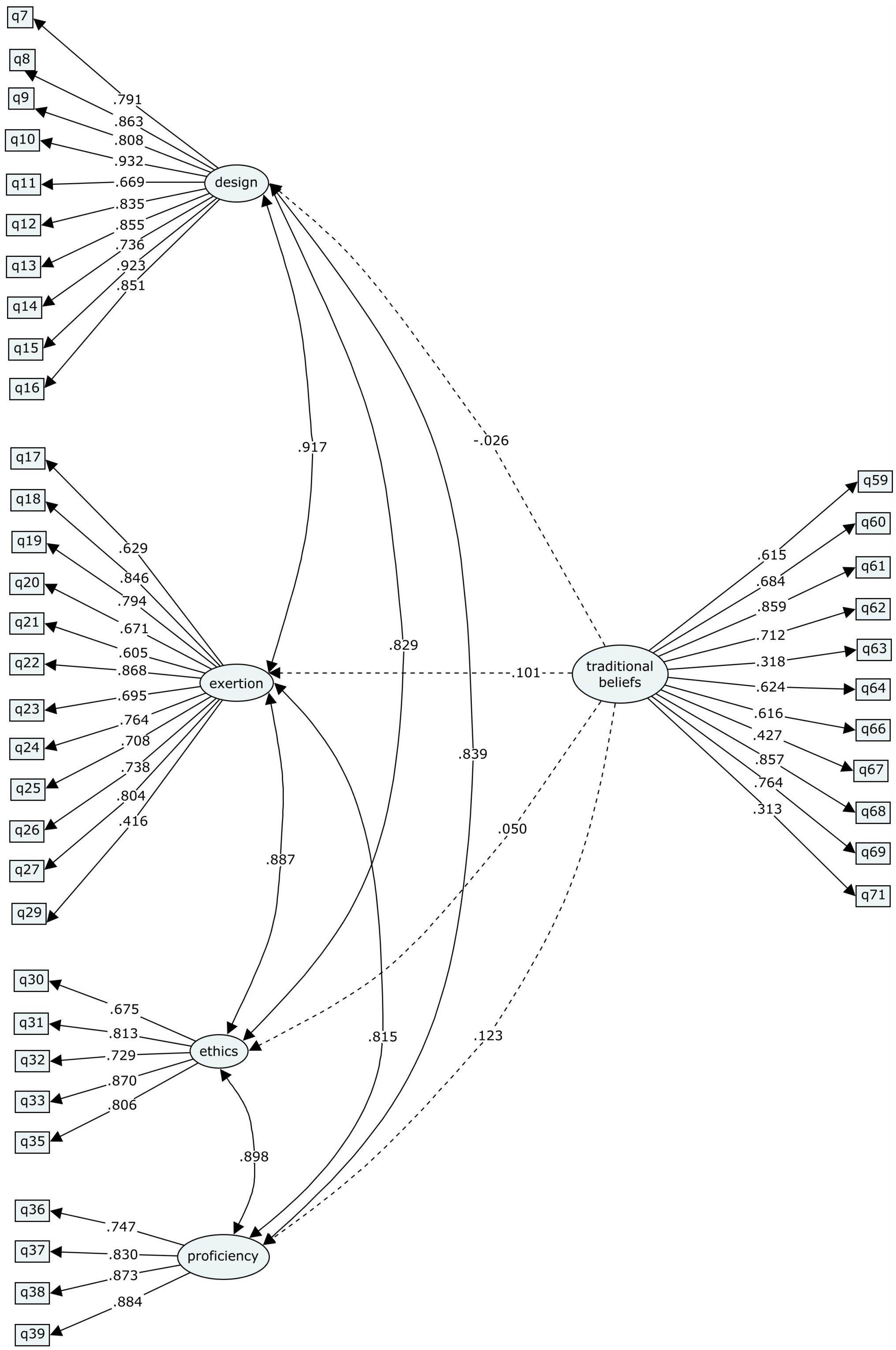

Figure 5. *SEM of the TPACK-deep latent factors regressed on the traditional beliefs latent variable. Dotted paths indicate non-significance.*

Leadership Support for Technology

Data were collected regarding teachers' perceptions of leadership support for technology using the four items from the Elementary School Principals' Technology Leadership Questionnaire (Chang, et al., 2008) that were included in the web-based survey. The four items were highly correlated. The highest polychoric correlation was between Q41 (My principal demonstrates an understanding of technology needs and concerns of faculty, staff, and students) and Q43 (My principal communicates effectively with faculty, staff, and students about technology) with an estimated value of .923. The smallest estimated polychoric correlation was between Q42 (My principal maintains positive relationships with faculty, staff, and students about technology) and Q44 (My principal encourages school personnel to utilize information sources about technology for professional development) with an estimated value of .698. Table 16 identifies the Polychoric correlation matrix for the leadership items.

Table 16

Polychoric Correlation Matrix for the Leadership Support Items

	Q41	Q42	Q43
Q42	.849		
Q43	.923	.899	
Q44	.846	.698	.892

Fit index measures for the TPACK-deep latent factors regressed on the traditional beliefs and leadership support for technology for technology latent variables are presented in Table 17. Goodness of fit was determined as each model was tested. There was not negative variance. The RMSEA, CFI, TLI and the WRMR indicate the traditional beliefs latent variable and leadership support for technology latent variable model was well suited for this exploratory study.

Table 17

Fit Index Measures for Regression Analysis of the TPACK-deep Latent Factors on the Traditional Beliefs and Leadership Support for Technology Latent Variables

Index	TPACK-deep with Traditional Beliefs and Leadership Support for Technology
Negative variance	No
RMSEA	.043
CFI	.974
TLI	.972
WRMR	.930

Note. Goodness of fit boundaries for indices are found in Table 9.

The standardized model results for the leadership support for technology latent variable are displayed in Table 18. Table 18 displays items (Q), the factor, and statistical significance using the Wald statistic. All items measuring leadership support for technology were statistically significant, $Wald > 1.96$.

Table 18

Leadership Support for Technology Latent Variable Measurement Model

Item	Estimate (*SD*)	*Wald*
Q41	0.946 (.031)	30.793
Q42	0.908 (.034)	26.939
Q43	0.965 (.029)	33.507
Q44	0.907 (.039)	23.110

Note. Estimated standard error is in parentheses; $a = .05$, $Wald > 1.96$.

Pearson product-moment correlations were used to examine correlations among the four TPACK-deep latent factors and the traditional beliefs and leadership support for technology as latent variables. Exertion correlated with Design ($r = .881$), Ethics correlated with Design ($r = .755$), and with Exertion ($r = .839$). Proficiency correlated with Design ($r = .772$), Exertion ($r = .739$), and Ethics ($r = .853$). The results did not indicate a correlation between the TPACK-deep latent factors and traditional beliefs latent variable. There was a negative correlation between the leadership support for technology and traditional beliefs latent variables (*r* = -.074.) but the correlation was not statistically significant (*p* = .100).

An analysis regressing the four TPACK-deep latent factors on the leadership support for technology and traditional beliefs latent variables indicated statistically significant findings (see Table 19). These results indicated that the traditional beliefs latent variable was not predictive of the four TPACK-deep latent factors Design, Exertion, Ethics, and Proficiency. However, the latent variable, leadership support for technology, was positively predictive of the four TPACK-deep latent factors.

Table 19

Regression Analyses of the TPACK-deep Latent Factors on the Traditional Beliefs and Leadership Support for Technology Latent Variables

TPACK-deep	Traditional Beliefs Path Coefficients	Leadership support for technology Path Coefficients
Design	.012	***.537
Exertion	-.062	***.543
Ethics	.087	***.558
Proficiency	.160	***.527

Note. Estimates marked *** are statistically significant at $p < .001$

Figure 6 shows the regression model for the four TPACK-deep latent factors regressed on leadership support for technology and traditional beliefs latent variables. The leadership support for technology latent variable was a statistically significant positive predictor of all TPACK-deep latent factors *(p* < .001). Leadership support for technology was the greatest predictor of Ethics, (path coefficient of .558). The leadership support for technology latent variable predicted the Design latent factor (path coefficient of .537) and Exertion latent factor (path coefficient of .543) as well as Proficiency (path coefficient of .527). The traditional beliefs latent variable approached statistical significance (*p* = .10 and path coefficient = 0.16) in predicting the

Proficiency latent factor. The *p*-values for the three other TPACK-deep latent factors regressed on the traditional belief latent variable were not statistically significant.

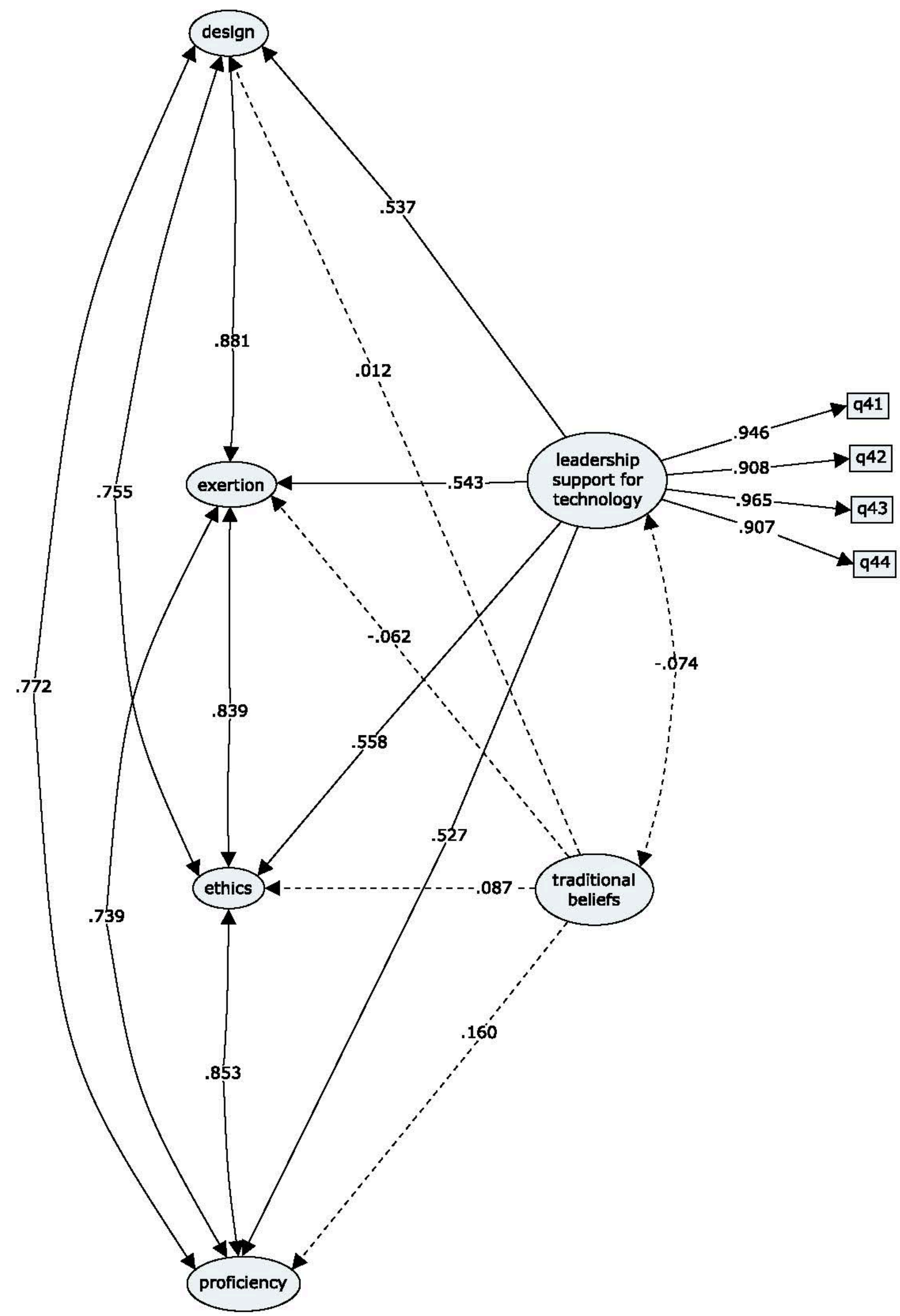

Figure 6. SEM of the TPACK-deep latent factors regressed on the leadership support for technology and traditional beliefs latent variables. Dotted paths indicate non-significance. TPACK-deep and traditional beliefs were not included in the diagram for simplicity. However, they are included in the model.

Teaching Self-Efficacy

Teaching self-efficacy was measured using 11-items from the short form of Teacher Sense of Efficacy Scale (TSES; Tschannen-Moran & Woolfolk Hoy, 2001). The polychoric correlation table for the teaching self-efficacy items is displayed in Table 20. The highest polychoric correlation was between Q47 (How much can you do to motivate students who show low interest in school?) and Q48 (How much can you do to get students to believe they can do will in school work?) with an estimated value of .878. The lowest polychoric correlation was between Q49 (How much can you do to help your students' value learning?) and Q51 (How much can you get students to follow classroom rules?) with an estimated value of .286.

Table 20

Polychoric Correlation Matrix for the Teaching Self-Efficacy Items

	Q47	Q48	Q49	Q50	Q51	Q52	Q53	Q54	Q55	Q56
Q48	.878									
Q49	.647	.812								
Q50	.603	.626	.528							
Q51	.483	.325	.286	.671						
Q52	.685	.586	.414	.599	.715					
Q53	.542	.643	.546	.730	.802	.671				
Q54	.546	.600	.583	.623	.518	.637	.769			
Q55	.678	.616	.560	.744	.679	.740	.739	.829		
Q56	.524	.464	.437	.536	.489	.638	.536	.634	.691	
Q57	.602	.593	.584	.738	.559	.641	.646	.745	.797	.718

The standardized model results for teaching self-efficacy are displayed in Table 21. The Wald statistic, *Wald* > 1.96, indicates statistical significance at $p < .05$ for the teaching self-efficacy items.

Table 21

Teaching Self-Efficacy Latent Variable Measurement Model

Item	Estimate (*SD*)	*Wald*
Q47	0.887 (.033)	27.168
Q48	0.931 (.031)	30.478
Q49	0.776 (.052)	14.963
Q50	0.786 (.049)	15.896
Q51	0.561 (.077)	7.264
Q52	0.807 (.057)	14.194
Q53	0.776 (.051)	15.161
Q54	0.863 (.038)	22.629
Q55	0.861 (.034)	25.151
Q56	0.767 (.054)	14.158
Q57	0.827 (.041)	20.361

Note. Estimated standard error is in parentheses; *a* = .05, *Wald* > 1.96.

TPACK-deep and all Contextual Factors

Fit index measures for the final model analyses are presented in Table 22. Goodness of fit was determined as each model was tested. There was no negative variance. The Root Mean Square Error of Approximation (RMSEA), The Comparative Fit Index (CFI), Tucker-Lewis Fit Index (TLI) and the weighted root mean square residual (WRMR) indicate the final model was well suited for this exploratory study.

Table 22

Fit Index Measures for Regression Analyses of the TPACK-deep Latent Factors on the Traditional Beliefs, Leadership Support for Technology, and Teaching Self-Efficacy Latent Variables

Index	TPACK-deep with Traditional Beliefs, Leadership Support for Technology, and Teaching Self-Efficacy
Negative variance	No
RMSEA	.041
CFI	.968
TLI	.967
WRMR	.971

Note. Goodness of fit boundaries for indices are found in Table 9.

Correlations among the TPACK-deep latent factors and the three contextual latent variables indicate statistically significant findings. Regression analyses of the TPACK-deep latent factors on the teaching self-efficacy, leadership support for technology, and traditional beliefs latent variables indicated (see Table 23) statistically significant findings.

Table 23

Regression Analyses for the TPACK-deep Latent Factors on the Traditional Beliefs, Leadership Support for Technology, and Teaching Self-Efficacy Latent Variables

TPACK-deep Factors	Traditional Beliefs Path Coefficient	Leadership Support for Technology Path Coefficient	Teaching Self-Efficacy Path Coefficient
Design	.014	***.355	***.274
Exertion	-.059	***.307	***.359
Ethics	.089	***.344	***.330
Proficiency	*.161	***.246	***.423

Note. Estimates marked *** are statistically significant at $p < .001$; * $p < .10$.

The final structural model presented in Figure 7 displays the effects of the four TPACK-deep latent factors on the traditional beliefs, leadership support for technology, and teaching self-efficacy latent variables. The results indicate that teaching self-efficacy positively predicted Proficiency (path coefficient of .423, $p < .001$), Ethics (path coefficient of .330, $p < .001$), Exertion (path coefficient of .359, $p < .001$), and Design (path coefficient of .274, $p < .001$). Teaching self-efficacy was positively correlated with leadership (path coefficient of .653, $p < .001$). Non-significant correlations were estimated between traditional beliefs and both teaching self-efficacy and leadership support for technology.

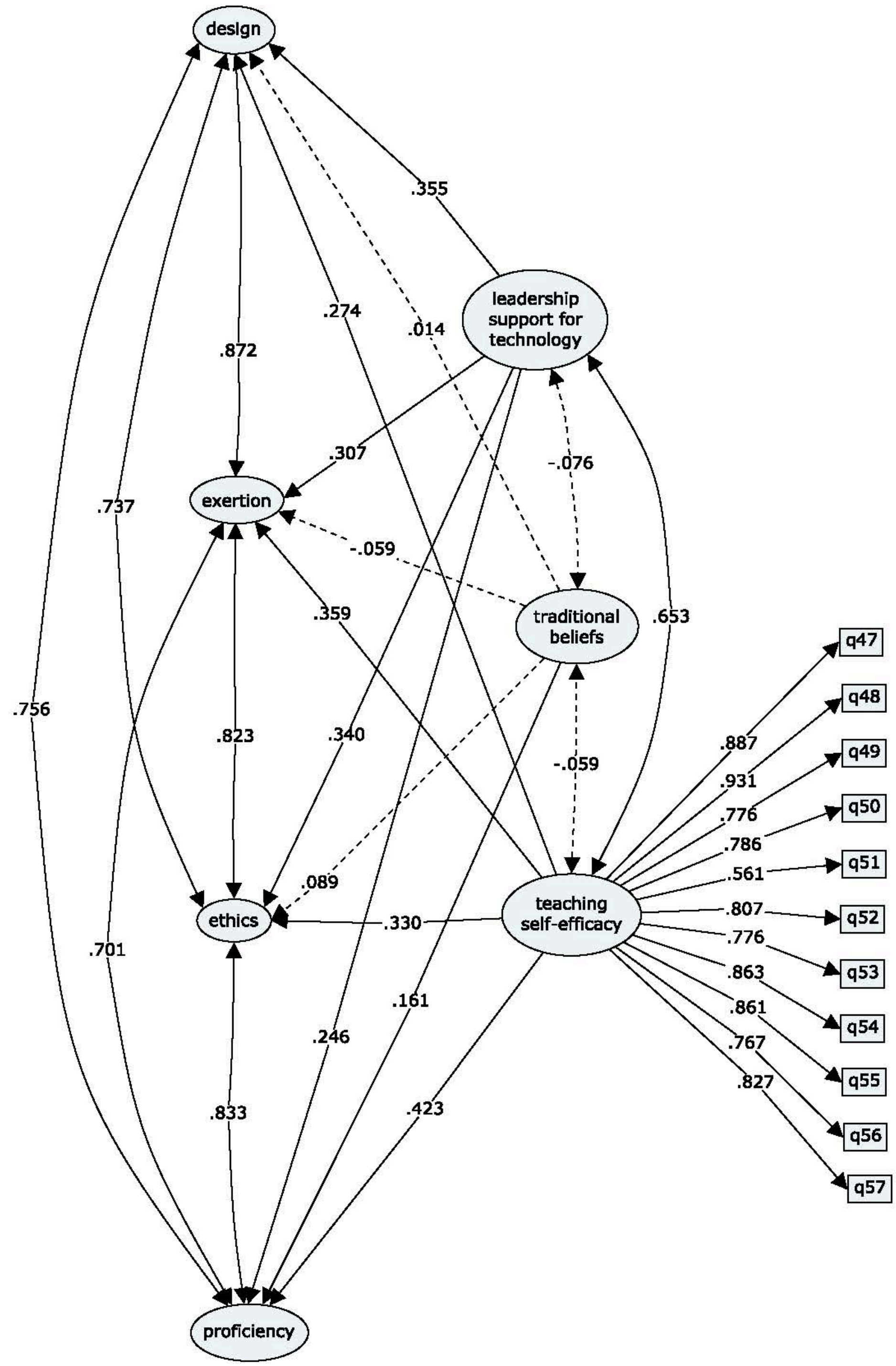

Figure 7. Final SEM for the regression of the TPACK-deep latent factors on the traditional beliefs, leadership support for technology, and teaching self-efficacy latent variables. Dotted paths indicate non-significance.

Tables 24 through 28 fully explain the factor loadings, path coefficients and correlations for the final measurement model. Appendix F includes the polychoric correlation matrix tables for all measurement items used in these analyses.

Table 24

TPACK-deep Latent Variable Measurement Model

Factor	Estimate	*Wald*
Design by		
Q7	0.780	15.707
Q8	0.870	20.999
Q9	0.788	14.116
Q10	0.926	29.359
Q11	0.685	13.015
Q12	0.829	17.385
Q13	0.843	23.634
Q14	0.749	13.967
Q15	0.927	30.022
Q16	0.859	27.052
Exertion by		
Q17	0.654	11.709
Q18	0.865	20.387
Q19	0.809	16.372
Q20	0.668	11.492
Q21	0.581	7.408
Q22	0.898	23.497
Q23	0.665	10.099
Q24	0.749	14.218
Q25	0.678	11.306
Q26	0.735	11.567
Q27	0.789	15.781
Q29	0.424	4.146
Ethics by		
Q30	0.697	10.702
Q31	0.816	20.646
Q32	0.742	13.234
Q33	0.853	21.090
Q35	0.799	15.378
Proficiency by		
Q36	0.740	14.289
Q37	0.866	16.100
Q38	0.861	23.154
Q39	0.883	22.805

Note. $a = .05$ only if *Wald* > 1.96.

Table 25

Leadership Support for Technology, Teaching Self-Efficacy, and Traditional Beliefs Latent Variable Measurement Model

	Estimate	*Wald*
Leadership by		
Q41	0.936	27.146
Q42	0.896	26.936
Q43	0.970	34.047
Q44	0.944	21.813
Efficacy by		
Q47	0.887	27.168
Q48	0.931	30.478
Q49	0.776	14.963
Q50	0.786	15.896
Q51	0.561	7.264
Q52	0.807	14.194
Q53	0.776	15.161
Q54	0.863	22.629
Q55	0.861	25.151
Q56	0.767	14.180
Q57	0.827	20.361
Traditional by		
Q59	0.620	8.915
Q60	0.671	9.432
Q61	0.848	21.347
Q62	0.684	11.118
Q63	0.326	3.711
Q64	0.653	7.741
Q66	0.608	8.068
Q67	0.433	4.572
Q68	0.865	23.401
Q69	0.764	14.069
Q71	0.353	3.175

Note. a = .05 only if *Wald* > 1.96.

Table 26

Regression Path Coefficient Estimates for the TPACK-deep Latent Factors Regressed on Traditional Beliefs, Leadership Support for Technology, and Teaching Self-Efficacy Latent Variables

	Estimate	*Wald*
Design on		
Traditional Beliefs	0.014	0.152
Leadership Support for Technology	***0.355	4.154
Teaching Self-Efficacy	***0.274	3.214
Exertion on		
Traditional Beliefs	-0.059	-0.685
Leadership Support for Technology	***0.307	3.638
Teaching Self-Efficacy	***0.359	4.280
Ethics on		
Traditional Beliefs	0.089	0.922
Leadership Support for Technology	***0.340	2.977
Teaching Self-Efficacy	***0.330	2.577
Proficiency on		
Traditional Beliefs	*0.161	1.871
Leadership Support for Technology	***0.246	2.191
Teaching Self-Efficacy	***0.423	3.996

Note. Estimates marked *** are statistically significant at $p < .001$; *$p < .10$.

Table 27

Latent Variable Correlations for the TPACK-deep Latent Factors on the Traditional Beliefs, Leadership Support for Technology, and Teaching Self-Efficacy Latent Variables

	Estimate	*Wald*
Exertion with		
Design	***0.872	20.548
Ethics with		
Design	***0.737	14.289
Exertion	***0.823	14.629
Proficiency with		
Design	***0.756	13.335
Exertion	***0.701	9.721
Ethics	***0.833	13.216
Leadership Support for Technology with		
Traditional Beliefs	-0.076	-0.731
Teaching Self-Efficacy		
Traditional Beliefs	-0.059	-0.704
Leadership Support for Technology	*0.653	11.002

Note. Estimates marked *** are statistically significant at $p < .001$; *$p < .10$.

Table 28

Item Correlations for the TPACK-deep Latent Factors

	Estimate	*Wald*
Q14 with Q11	0.571	6.455
Q25 with Q21	0.588	7.361
Q27 with Q26	0.844	10.885
Q30 with Q32	0.571	6.562
Q35 with Q36	0.749	9.388
Q51 with Q53	0.703	8.471

Note. a = .05 only if *Wald* > 1.96.

Results of the structural model analyses are presented below to answer the research questions and research hypotheses for the present study.

Research Question #1: In what ways do structural equation model (SEM) results from a measurement model using the TPACK-deep scale items with in-service elementary school teachers in Florida confirm an existing theoretical structure with data provided by pre-service teachers?

SEM results from the this exploratory study confirm a four-factor structure for the TPACK-deep scale using data collected from in-service elementary school teachers in Florida (N = 75) as a measure of teachers' beliefs about their TPACK competencies. The four-factor model allowed for the examination of teacher beliefs related specifically to their abilities to create lessons using appropriate technology (Design), implement and evaluate instruction using the appropriate technology tools (Exertion), behave ethically using technology in professional teacher practice (Ethics), and use technology with Proficiency in the teaching and learning process (Proficiency).

Research Question #2: In what ways are in-service elementary school teachers' beliefs about their leadership support for technology, teaching self-efficacy, and traditional beliefs about children associated with their beliefs about their ability to use technology in their teaching practice?

The associations among the teaching self- efficacy, traditional beliefs about children, and leadership support for technology latent variables and the TPACK-deep latent factors (Design, Exertion, Ethics, and Proficiency) are discussed in research hypotheses 1 - 5.

Research Hypothesis #1: Are the four TPACK-deep scale latent factors—Design, Exertion, Proficiency, and Ethics—correlated? The null hypothesis (H_0) posited that the four TPACK-deep factors are not correlated with each other. The alternative hypothesis (H_1) posited that the four TPACK-deep factors are correlated with each other. The structural model demonstrated statistically significant positive correlations of the TPACK-deep latent factors with each other. Therefore, the findings support the rejection of the null hypothesis and affirm that the four TPACK-deep latent factors (Design, Exertion, Proficiency, and Ethics) are correlated.

Research Hypothesis #2: Is leadership support for technology correlated with teaching self-efficacy? The null hypothesis (H_0) posited that the leadership support for technology and teacher's beliefs about their teaching self-efficacy latent variables are not correlated. The alternative hypothesis (H_2), posited that leadership support for technology and teachers' beliefs about their teaching self-efficacy latent variables are correlated. The structural model demonstrated statistically significant positive correlation between the leadership support for technology and teaching self-efficacy latent variables. Therefore, the findings from this exploratory study support rejecting the null hypothesis and affirm that leadership support for technology and teachers' beliefs about their teaching self-efficacy latent variables are correlated.

Research Hypothesis #3: Does leadership support for technology predict the four TPACK-deep scale latent factors (Design, Exertion, Proficiency, and Ethics)? The null hypothesis (H_0) posited that the leadership support for technology latent variable does not predict the TPACK-deep latent factors (Design, Exertion, Proficiency, and Ethics). The alternative hypothesis (H_3) posited that leadership support for technology latent variable support predicts TPACK-deep latent factors (Design, Exertion, Proficiency, and Ethics). The structural model demonstrated that the leadership support for technology latent variable positively predicts all four TPACK-deep latent factors (Design, Exertion, Ethics, and Proficiency) at a statistically significant level (a = .01). Therefore, results from these data support rejecting the null hypothesis and affirm that the leadership support for technology latent variable does predict the four TPACK-deep latent factors (Design, Exertion, Ethics, and Proficiency).

Research Hypothesis #4: Does teaching self-efficacy predict the four TPACK-deep scale latent factors (Design, Exertion, Proficiency, and Ethics)? The null hypothesis (H_0) posited that the teaching self-efficacy latent variable does not predict the four TPACK-deep latent factors (Design, Exertion, Proficiency, and Ethics). The alternative hypothesis (H_4) posited that the teaching self-efficacy latent variable does predict the four TPACK-deep latent factors (Design, Exertion, Proficiency, and Ethics). The structural model demonstrated that the teachers' self-efficacy latent variable positively predicts all four TPACK-deep latent factors (Design, Exertion, Ethics, and Proficiency) at a statistically significant level (a = .01). Therefore, results from these data support rejecting the null hypothesis and affirm that the teaching self-efficacy latent variable does predict the three of the TPACK-deep latent factors.

Research Hypothesis #5: Do traditional beliefs about children predict the four TPACK-deep scale latent factors (Design, Exertion, Proficiency, and Ethics)? The null hypothesis (H_0) posited that the traditional beliefs about children latent variable does not predict the four TPACK-deep latent factors (Design, Exertion, Proficiency, and Ethics). The alternative hypothesis (H_5) posited that the traditional beliefs about children latent variable predicts the four

TPACK-deep latent factors (Design, Exertion, Proficiency, and Ethics). The structural model did not demonstrate statistically significant prediction of traditional beliefs on the TPACK-deep latent factors (Design, Exertion, or Ethics) on teaching self-efficacy. However, the path coefficient between teachers' traditional beliefs about children and the Proficiency latent factor was .016 ($p = .06$). Therefore findings from this study suggest accepting the null hypothesis, teachers' traditional beliefs about children do not predict the TPACK deep latent factors (Design, Exertion, or Ethics). Conversely, findings from this study also support rejecting the null hypothesis and affirm that teachers' traditional beliefs about children predict the TPACK-deep latent factor of Proficiency.

Summary

The descriptive analyses indicated that the majority (96%) of the data collected for this exploratory study ($N = 75$) was provided by female teachers employed in public elementary schools with more than 500 students. In addition, 52% of respondents were 44 to 66 years old. The internal consistency reliability analyses determined acceptable Cronbach's alpha values for the study data using the selected scales (TPACK-deep, teaching self-efficacy, leadership support for technology, and traditional beliefs about children). The final measurement model provided a good fit for the study's data, yielding statistically significant results.

Chapter 5 provides a summary of the present study, limitations, discussion of findings, opportunities for future research, and implications for practice.

CHAPTER 5 – SUMMARY, DISCUSSION OF FINDINGS, IMPLICATIONS

As an aid to the reader, this final chapter of the dissertation restates the research problem and reviews the methods used in this study. The chapter commences by providing a brief summary of the research problem the study aimed to address, as well as the study objectives and methodology, before proceeding with the discussion of the results. In interpreting the main findings, the limitations of this exploratory study are also acknowledged, thus providing opportunities for making suggestions for future research in this field. The dissertation closes by elucidating the implications of the results obtained for practice before providing concluding remarks.

Research Problem

Owing to the rapidly increasing globalization of the modern world, workforce no longer competes at the local or national level, but rather internationally, which requires a substantial shift in the knowledge and skills required. In response to these trends, educational institutions are investing substantive resources—including money, people, and time—to meet the needs of the globalized workforce by integrating technology into the learning environment. However, implementing this type of transformational change in schools is challenging for both teachers and principals (Grint, 2008). The growing demands placed upon educational institutions are further compounded by the need to incorporate technology into the educational environment. As most teachers and principals lack the prerequisite skills to do so, this issue requires input from researchers and other stakeholders.

The TPACK knowledge model (Koehler & Mishra, 2009; Mishra & Koehler, 2006) is the dominant conceptual framework for effective technology integration in educational technology research. The model provides researchers and practitioners with a conceptual framework that identifies the three types of knowledge educators simultaneously use when teaching with technology. However, there is little consensus among researchers regarding the most optimal way to measure the complex teaching behaviors that intersect when teachers use their technological, pedagogical, and content knowledge to successfully integrate technology into their classroom practice. Moreover, extant research in the field suggests that contextual factors are also indicative of teacher effectiveness in the application of technology in classroom practice. Examining methods that have the potential to capture these teaching complexities is a prerequisite for gaining a more comprehensive understanding of technological, pedagogical, and content knowledge that is necessary for fully digitally driven education. Yet, despite the evident importance of ensuring that teachers are comfortable with using technology and can effectively integrate it into their curricula, defining and measuring technology integration in formal schooling remains a challenge.

Review of Methods

As explained more thoroughly in Chapter 3, the study reported in this work was an exploratory, quantitative, non-experimental, multivariate correlation and regression research study of in-service elementary school teachers' beliefs about their technology integration abilities in classroom practice. As a quantitative study, this research primarily used structural equation modeling (SEM), attempting to discern the associations among the four TPACK-deep factors (Design, Exertion, Ethics, and Proficiency) and three contextual factors (leadership support for technology, teaching self-efficacy, and traditional beliefs about children).

This exploratory study relied on survey data collected from 75 in-service elementary school teachers in Florida. The data provided by the study participants was used in testing a hypothesized measurement model using simultaneous correlation and regression equations to determine a final structural model. Data were collected from August through October 2015 and the study sample represents participants from 14 public school districts in Florida.

Summary of the Present Study

The conceptual framework undergirding this exploratory study is the TPACK knowledge model (Koehler & Mishra, 2009; Mishra & Koehler, 2006). This framework is used to define the complex intersection of three key types of teacher knowledge—Content (CK), Pedagogy (PK), and Technology (TK). The TPACK method does not view these knowledge bases separately, but rather highlights the knowledge that lies at each intersection, namely Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). The TPACK-deep scale (Kabakci-Yurdakul et al., 2012) is an extension of this framework and was selected for use as the measurement instrument in the present study.

A quantitative research design was utilized to specifically address two overreaching research questions. The first question aimed to confirm or refute the existing theoretical structure of the TPACK-deep measurement scale when used with a different population. The second question aimed to examine how three contextual factors were associated with teachers' beliefs about their technological, pedagogical, and content knowledge competencies. The present study was designed to contribute evidence towards establishing the validity and reliability of the TPACK-deep scale as a tool for assessing in-service elementary school teachers' beliefs about their technological, pedagogical, and content knowledge. In doing so, the goal was to extend the

TPACK measurement research by examining three contextual factors hypothesized to impact in-service teachers' beliefs about their abilities to use technology in their classroom practice. To answer the research questions, five hypotheses were tested as a part of the study.

1. The four TPACK-deep scale latent factors—Design, Exertion, Proficiency, and Ethics—are correlated.
2. Leadership support for technology is correlated with teaching self-efficacy.
3. Leadership support for technology predicts the four TPACK-deep scale latent factors (Design, Exertion, Proficiency, and Ethics).
4. Teaching self-efficacy predicts the four TPACK-deep scale latent factors (Design, Exertion, Proficiency, and Ethics).
5. Traditional beliefs about children predict the four TPACK-deep scale latent factors (Design, Exertion, Proficiency, and Ethics).

Structural equation modeling (SEM) was used to examine the validity of the TPACK-deep measurement instrument and determine whether three contextual factors (leadership support for technology, teaching self-efficacy, and traditional beliefs about children) were associated with teachers' beliefs about their competencies integrating technology in classroom practice. Findings yielded by this exploratory study confirmed that the TPACK-deep scale had a four-factor structure when applied to data pertaining to in-service elementary teachers in Florida. Analyses also identified statistically significant associations among the three contextual variables hypothesized to impact teachers' technological, pedagogical, and content knowledge. Results obtained in the present exploratory study contribute evidence toward establishing the validity of the TPACK-deep scale as a measure of in-service teachers' beliefs about their technology use in the classroom.

Analyses conducted as a part of this investigation further suggest that the TPACK-deep factors are highly correlated. In particular, the two contextual factors that serve as the strongest predictors of teachers' beliefs about their technology integration competencies in their classroom practice are (a) the extent to which principals are supportive of technology use, and (b) teachers' beliefs about their teaching self-efficacy. On the other hand, no predictive relationship could be established among teachers' traditional beliefs about children and the three TPACK-deep factors—Design, Exertion, or Ethics. However, data analyses did suggest that teachers' traditional beliefs about children can serve as a predictor of their beliefs regarding the TPACK-deep factor of Proficiency in classroom practice.

Discussion of Findings

One goal of this research was to determine if the TPACK-deep scale, when used with a different population, would confirm the four-factor structure proposed by Kabakci-Yurdakul et al. (2012). Findings from the present exploratory study did confirm a four-factor structure. Although an exploratory study cannot establish validity or reliability, this study's results would suggest that the TPACK-deep scale has the potential to serve as a measurement instrument when assessing in-service teachers' beliefs about their technological, pedagogical, and content knowledge competencies.

A second goal of this exploratory study was to extend the scope of the TPACK measurement research to include three contextual factors hypothesized to have impact on teachers' beliefs concerning the use of technology in their practice. These three contextual factors were identified as a result of a detailed review of pertinent literature and comprised of (a) leadership support for technology, (b) teaching self-efficacy, and (c) traditional beliefs about children. The inclusion of these three factors in the present study facilitated identifying and measuring three specific contextual variables which are valuable dimensions to examine in order to better understand technology integration in teachers' classroom practice. Findings obtained in this exploratory study suggest that these contextual factors are associated with and predictive of the four TPACK-deep latent factors of Design, Exertion, Ethics, and Proficiency. Contextual factors, such as those that were investigated in the present study, have been insufficiently addressed in extant studies on TPACK measurement (Abbitt, 2011; Crippen & Archibald, 2009; Kabakci-Yurdakul et al., 2012; Rosenberg & Koehler, 2015).

TPACK-deep scale

Results yielded by the present exploratory study suggest that the TPACK-deep scale can be used as a one-factor measure (TPACK as one construct) or, as selected in this study, as a four-factor measure to examine in-service teachers' beliefs about their technology integration competencies in (a) designing their lessons using technology (Design), (b) the implementation of their instruction using technology (Exertion), (c) their ethical behaviors regarding technology use and professional practice (Ethics), and (d) their overall proficiency using technology in the teaching and learning process (Proficiency). Furthermore, all items were found to be statistically significant as measures of the TPACK-deep construct, suggesting reliability when used with this study's population. On the basis of this exploratory study alone, it is difficult to determine the strength of significance among the TPACK-deep latent factors. However, as noted above, all items were found to be statistically significant. Thus, the TPACK-deep scale shows promise as a scale to measure beliefs about technology integration with burgeoning evidence of validity and reliability. The preliminary evidence from the present study also addresses one of the weaknesses highlighted in TPACK measurement studies (see, for example, Abbitt, 2011; Cavannah & Koehler, 2003) in that validity and reliability indicators were reported for all measures.

Leadership Support for Technology

A key finding from this exploratory study is the association between leadership support for technology and teachers' beliefs about their abilities to integrate technology into their classroom practice. The results yielded by the extensive analyses suggest that leadership support for technology is a positive predictor of teachers' beliefs about their competencies in (a) creating curriculum plans using appropriate technological tools to maximize student learning (Design); (b) implementing curriculum plans and facilitating a variety assessments and evaluations utilizing the appropriate technology (Exertion); (c) demonstrating legal and ethical behaviors when utilizing technology in classroom practice (Ethics); and (d) integrating and effectively adapting technology into the teaching and learning process (Proficiency).

Previous studies of principals' technology leadership have concluded, similar to findings of the present study, that the principal is fundamental in providing support to and communicating with teachers regarding technology integration (see, for example, Pierson, 2001; Chang, 2010; Chang, et al., 2008). As such, the school principal is the person most often able to provide valuable feedback in supporting teachers, as changes in practice are required and in determining the most efficacious ways of improving teacher practice.

Teaching Self-Efficacy

Another key finding this exploratory study yielded is the association between teachers' beliefs about their teaching self-efficacy and their beliefs about their competence in teaching with technology. The results reported in the preceding chapter suggest that teachers' beliefs about their teaching self-efficacy positively predict their beliefs about their technological, pedagogical, and content knowledge competencies in classroom practice. More specifically, (a) teachers with a higher sense of teaching self-efficacy tend to have more confidence in their ability to design lessons using the appropriate technology to achieve learning outcomes (Design); (b) a stronger sense of teaching self-efficacy also suggests greater confidence in using technology to implement curriculum plans and evaluate student learning (Exertion); (c) teachers with a higher sense of self-efficacy report a better understanding of ethical behaviors in relation to the use of technology in their classroom practice (Ethics); and (d) the more positive view teachers have of their own teaching efficacy, the more favorable their perceptions of their proficiency in applying technology appropriately and effectively in the teaching and learning process will be (Proficiency).

Previous studies exploring teaching self-efficacy reported findings congruent with those yielded by the present study, suggesting that teachers' beliefs influence how technology is integrated in classroom practice (see, for example, Ertmer, 2005; Ertmer & Ottenbreit-Leftwich, 2010). This assertion is also aligned with Bandura's social cognitive theory (1986, 1997), which postulates teachers' beliefs about leadership support for technology would be similar to their beliefs regarding their own self-efficacy. Ertmer and Ottenbriet-Leftwich (2010) posited that changes in teachers' beliefs were essential in the context of changing classroom practice to integrate technology. As teachers navigate the complexities of teaching, it seems reasonable to assume that teaching self-efficacy can impede or support actual change in practice. As teachers are challenged with reexamining their existing practices, the school principal is given an opportunity to provide them with much-needed direction when their teaching beliefs are challenged.

Traditional Beliefs about Children

A third finding of this exploratory study is related to the association between teachers' traditional beliefs about children and those pertaining to their ability to integrate technological, pedagogical, and content knowledge in their teaching practice. The results yielded by the analyses conducted as a part of this investigation failed to provide a link between teachers' traditional beliefs about children and their beliefs about Design, Exertion, and Ethics—three of the factors comprising the TPACK-deep scale. However, findings from this exploratory study did affirm that teachers' traditional beliefs about children positively predict one TPACK-deep factor, Proficiency. More specifically, teachers that reported having more traditional beliefs about children also perceived their technology use in classroom practice as more proficient. Teachers' beliefs about children were found to be a characteristic that influenced the quality of interactions between teachers and students in several national longitudinal studies of classroom quality (Justice et al., 2008). Findings from the Justice et al. study suggest that teachers who hold more traditional beliefs about children are more proficient in their use of explicit teaching strategies. The present exploratory study focused solely on teachers' traditional beliefs about children, and its findings indicated that these beliefs did not predict their perceptions of their technology abilities in Design, Exertion, or Ethics but did predict their perceptions regarding their proficiency in technology use as a part of their classroom practice. Additional research is thus warranted to determine how beliefs about children may influence teachers' use of technology, as the findings yielded may assist in maximizing learning opportunities designed to prepare both teachers and students for success in a digital classroom.

Limitations

As any study of this nature, this research was also affected by some limitations, presented below. The challenges related to data availability, data collection methodology, and purposive sampling are discussed.

Data Availability

A limitation of the present study relates to the number of participants included in the data analyses. SEM techniques were used to determine the relationships among four latent factors and three latent variables, but the small number of teacher response data may not fully reflect the relationships under investigation. While model fit was found to be acceptable for the final measurement model, many researchers support the use of structural equation modeling for sample sizes greater than 200. However, Muthén and Muthén (2002) report "The sample size needed for a study depends on many factors, including the size of the model, distribution of the variables, amount of missing data, reliability of the variables, and strength of the relations among the variables" (p. 599). Using several fit indices, the final structural model was found to be acceptable for an exploratory study with $N < 100$. It must be noted that the sample obtained in the present study limits the generalizability of results to a broader population. While results from the SEM analyses indicated sufficient statistical power in this exploratory study, limited data may have prevented the ability to obtain more representative findings.

Data Collection Methodology

Data were collected from participants using a web-based survey, as this is a cost-effective data collection method. However, web-based surveys have some limitations as well. One of the drawbacks is the time and focus required to complete a questionnaire, which may deter some individuals from taking part (Duckworth & Yeager, 2015). In addition to low cost, other advantages of web-based surveys stem from enhanced protection against data loss (Mertler, 2003). The web-based survey was electronically delivered anonymously with an anonymous link for confidentiality of responses. However, one district reported that an Internet firewall had prevented the electronic survey from being received by potential participants. Thus, while web-based surveys provide researchers with easy and cost-effective access to a potentially large study sample, researchers should acknowledge the aforementioned limitations when using this data collection method, as these can potentially reduce the size of the study sample.

Purposive Sampling

The participants for this exploratory study were selected via purposive sampling. In the present study, a non-random sample of prekindergarten through grade five elementary school teachers was identified by public records as teachers working in public elementary schools in Florida with a reported student to technology device of ratio at least 2.99. This method ensured that potential participants had access to technology devices at the school level. The goal was to obtain survey data from 300 participants by sampling a large number of technology-using elementary school teachers in Florida. This sampling method did not produce the anticipated results and is considered a limitation of the present study.

Opportunities for Future Research

The findings yielded by the present study, along with its limitations, provide some useful pathways that can be pursued in future research. While this study was exploratory in nature, it nonetheless provides preliminary evidence in establishing the validity of a scale based upon the central construct of the TPACK knowledge model, which is intended to measure teachers' beliefs about their ability to integrate technology into their classrooms. Pertinent literature in which authors examined ways to accurately measure TPACK has demonstrated that researchers are constantly searching for ways to quantify teachers' technological, pedagogical, and content knowledge, which is posited as instrumental in their aptitude to truly embrace digitally driven instruction. While the body of research on these issues, and specifically TPACK, is extensive, there are several opportunities to further the knowledge base on the utility of the TPACK measurement instrument. Suggestions for more robust research studies regarding the TPACK-deep scale are described in the following sections.

Sampling with a Larger Population

The present study focused on the TPACK-deep scale and yielded satisfactory results. However, the study sample was small. Hence, additional research using a larger sample is warranted to provide more robust evidence for establishing the validity and reliability of the TPACK-deep scale when applied to in-service teachers. While findings from this exploratory study provide preliminary evidence supporting the utility of TPACK-deep scale as a measure of in-service teachers' beliefs about their abilities to use technology in their classroom practice, recruiting a larger sample from a more diverse population would certainly contribute to the generalizability of findings.

Direct Administration of the TPACK-deep scale

The findings from the present study suggest web-based survey methods may not yield a strong response rate. While web-based surveys offer researchers a cost-effective method to obtain data from a potentially large sample of respondents, findings of the present study would suggest other data collection methods also be explored. Other possibilities include the direct administration of the TPACK-deep scale with potential participants. Although direct survey administration is more costly than a web-based survey method, Mertler (2015) reports that direct administration yields the highest response rate in survey research. Direct, personal contact with potential participants may increase the study sample. This method could provide an opportunity to discuss how participation may personally impact individuals and allow the researcher to communicate greater detail regarding the responsibilities and time associated with survey completion. Direct administrations of surveys may have the potential to increase participation and thus lead to more generalizable results.

A Mixed Method Research Design to Examine TPACK-deep

The present study was designed using multivariate, quantitative, research methods. Findings from the present study, although exploratory, confirmed statistically significant relationships among teachers' beliefs about their abilities to integrate technology in their classroom practice, their beliefs about leadership support for technology, and their beliefs about their teaching efficacy. These findings suggest that effectively integrating technology in classroom practice is a complex undertaking that is influenced by contextual factors. An opportunity for future TPACK-deep research that includes a mixed method research design may have the potential to capture more fully the complexity of teaching with technology. Triangulating the results of TPACK-deep self-report survey data, teacher interviews, and direct observations of teachers provides an opportunity for researchers to further investigate teachers' technology integration abilities in classroom practice using a mixed quantitative and qualitative methodological design.

Public School Districts in Florida: Student to Device Ratio and TPACK-deep

In the present study, data were collected from 14 of the 68 public school districts in Florida. Further, this study's sample was limited to only public school districts that reported, via a state mandated district Digital Classrooms Plan, a student to technology device ratio of 2:99 to one to the Florida Department of Education. A suggestion for future research would be to examine more fully the extent to which teachers' beliefs about their technology integration abilities are associated with the student to technology device ratio reported in all district Digital Classroom plans to the Florida Department of Education. A study to examine the districts in

Florida who report higher ratios of student to technology devices and those districts who report lower ratios has the potential to provide a better understanding of teachers' beliefs about their technology integration competencies among all of the 68 public school districts in Florida. Results from such a study may be beneficial to state-level and school-level school leaders who allocate resources for professional development and technology for the 68 public school districts.

Implications for Educational Practice

Though the results of an exploratory study are not intended for broad generalization, results and limitations of the present study provide implications for practice. Findings from this study provide preliminary evidence that in-service teachers' beliefs about leadership support for technology positively predict their beliefs about technology integration competencies. Results from the present study also suggest that teachers' beliefs about leadership support are positively correlated with their beliefs about their teaching efficacy.

Taken together, these findings would suggest that the school principal, as leader of technology integration, is significant in shaping teachers' beliefs about their classroom teaching practices. The International Society for Technology in Education (ISTE) identified five Standards of Practice for Educational Administrators (2009), which are directly related to leadership support for technology, a contextual factor that was examined the present study. The ISTE (2009) standards provide a framework that could be used by school principals to create essential conditions and implement communication and collaboration strategies that have the potential to change the educational landscape of their schools in ways that support teachers' use of technology. The five ISTE (2009) standards for administrators include:

Standard 1: Principals should provide visionary leadership and must serve as the driving force in creating a shared vision for educational technology (ISTE, 2009). A shared vision for technology integration provides teachers, students, staff, and community members with an understanding of what the technology plan is designed to achieve (see, for example, Chang et al., 2008; Hew & Brush, 2007). A principal who develops a shared vision for technology integration has the opportunity to minimize barriers related to teachers' technology use in that the vision can be used to communicate how technology will be utilized at the school level and how technology integration may impact the individuals and their roles in the school community.

Standard 2: Principals should create a digital age learning culture. To build a digital age learning culture, the principal must align the goals of curriculum with expected uses of technology. Previous studies also suggest that a curriculum framework is beneficial to teachers in that the framework provides a tool that identifies the alignment of content standards, technology resources, and the teaching and learning practices in the school setting (Chang et al., 2008; Hew & Brush, 2007; ISTE, 2009; Voogt & Pelgrum, 2005).

Standard 3: Principals should expect excellence in professional practice by promoting a digitally engaged professional learning environment (ISTE, 2009). A digitally engaged professional learning environment not only provides teachers with the knowledge and skills necessary for utilizing technology in their classroom practice, but also promotes a school-wide community of collaboration. Prior research on effective professional development also suggests that sharing challenges, lessons learned, and solutions for overcoming barriers and successes in classroom instruction are critical to changing teachers' practice (see, for example, DuFour & Marzano, 2015; Ertmer, & Ottenbreit-Leftwich, 2010). The principal is essential to the professional learning process at the school level. Demonstrating a commitment to a digitally engaged professional learning environment can be achieved when the school principal provides purposeful professional development and uses effective feedback to communicate expectations for technology integration with teachers.

Standard 4: Principals should support systemic improvement by engaging in a continuous improvement process to integrate technology in classroom practice (ISTE, 2009). Continuous improvement is an ongoing process of examination and reexamination to assess effectiveness, determine challenges and adaptations, and identify growth. The purpose of these processes is to determine how the teacher and the student are integrating technology at the classroom level. Additionally, the improvement process provides opportunities to examine how the school as an entire entity is utilizing technology. Systemic improvement is an important part of technology integration; as the evaluation process provides critical feedback that principals may find beneficial as they track progress towards meeting technology outcome goals.

Standard 5: Principals should promote digital citizenship defined as the social, ethical, and legal behaviors associated with technology use (ISTE, 2009). Promoting digital citizenship requires the responsible protection of students and teachers from digital harm by promoting the ethical and responsible use of technology within the school building. School principals may want to consider how digital citizenship is promoted in school policy, teacher professional learning, and in the curriculum framework.

Results from the present study suggest that in-service teachers who report a high sense of leadership support for technology use are more likely to have a stronger sense of their teaching efficacy and more positive beliefs about their technology integration abilities. For teachers to use technology effectively in their classroom practice and have an efficacious teaching disposition, school principals should assume a direct and strategic role as leader of technology.

In the present study, leadership support for technology was assessed using four indicators related to elementary principals' communication and interpersonal skills as a technology leader. Results from this study suggest that the school principal communication abilities are critical to teachers' success in integrating technology in their classroom practice. Communication and collaboration strategies for principals are highlighted in the ISTE (2009) Standards of Practice for School Administrators. Although an exploratory study cannot provide broad generalizability of findings, this study (and other studies with similar findings) would suggest that teachers expect the principal to be technology leader who can communicate a vision and expectations for technology use in classroom. The ISTE (2009) standards provide a framework to guide the principal's actions as they navigate and transform their educational setting into digital learning community that embraces 21st century learning, teaching, and leading.

Conclusion

The persistent dilemmas of teaching are exasperated by the necessity of a digitally driven educational environment that challenges the traditional roles of teachers. Effectively integrating technology into classroom instruction presents teachers and principals with considerable challenges that must be urgently addressed if students are to be fully prepared for the increasingly globalized and competitive workforce. However, this shift in the approach to education requires better understanding of how students learn, as well as a reconceptualization of teaching and leading (Windschitl, 2002). To maximize the results yielded by efforts aimed at helping teachers embed technology into classroom practice, measurement instruments are necessary, as these tools can assist in identifying the complex factors associated with technology integration. The TPACK knowledge model provides researchers and practitioners with a conceptual framework to identify the three types of knowledge teachers simultaneously use when teaching with technology. Researchers have struggled with how to measure the complex teaching behaviors that intersect when teachers use their technological, pedagogical, and content knowledge to successfully integrate technology into their classroom practice. Of the TPACK measurement tools that are currently in use, the TPACK-deep scale (Kabakci-Yurdakul et al., 2012) was identified as the most appropriate tool for use in the present study. The findings reported in this exploratory study offer evidence towards establishing the validity and reliability of the scale, and thus found to be appropriate for measuring the complex intersection of teachers' technological, pedagogical, and content knowledge.

A review of literature indicated that context also affects teachers' use of technology. Thus, three contextual factors and their corresponding measures were examined in this exploratory research study—leadership support for technology, teaching self-efficacy, and traditional beliefs about children. Structural equation modeling (SEM) was selected as an analytical method appropriate for this research design. The associations among four latent factors and three latent variables of interest for the present study were therefore examined using measurement models to determine a final structural model.

Results from this exploratory study, while based on a relatively small sample of elementary in-service teachers in Florida (*N* = 75), provide valuable evidence toward establishing the reliability of the TPACK-deep scale as a measure of teachers' beliefs about their technological, pedagogical, and content knowledge (TPACK) competencies. Furthermore, findings yielded by this exploratory study suggest presence of positive predictive relationships between leadership support for technology and technology abilities, as well as between self-efficacy and technology abilities.

Preliminary evidence from this exploratory study suggests that the role of the principal is essential in supporting teachers' use of technology in their classroom. Moreover, an association between leadership support of technology and teachers' sense of teaching efficacy was also established. A 21st century principal is responsible for much more than simply placing technology into the hands of students and teachers. Today's school principal must understand and fully embrace the power of technology to radically transform teachers' classroom practice. School principals are essential for teachers' success in this digital era and they must demonstrate their leadership and support for technology integration by defining a vision for digital age teaching and learning that provides direction for the use of technology. Most importantly, the school principal—who is a technological leader—has the opportunity and responsibility to communicate that technology vision to others, as only the collective effort of the school community would result in any meaningful change.

References

Abbitt, J. T. (2011). Measuring technological, pedagogical content knowledge in preservice teacher education: A review of current methods and instruments. *Journal of Research on Technology in Education*, *43*(4), 281-300. doi:10.1080/15391523.2011.10782573

Afshari, M., Bakar, K. A., Luan, W. S., Samah, B. A., & Fooi, F. S. (2009). Factors affecting teachers' use of information and communication technology. *International Journal of Instruction*, *2*(1), 77-104. Retrieved from http://files.eric.ed.gov/fulltext/ED524156.pdf

Andersen, N. (2002). New media and new media literacy. *Thinking Critically About Media: Schools and Families in Partnership.* Cable in the Classroom, 30-35. Retrieved from http://www.medialiteracy.com/sites/default/files/552_CIC_ML_Report.pdf

Anderson, R. E., & Dexter, S. (2005). School technology leadership: An empirical investigation of prevalence and effect. *Educational Administration Quarterly*, *41*, 49-82. doi:10.1177/0013161X04269517

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological Bulletin*, *103*, 411. doi:10.1037/0033-2909.103.3.411

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological, pedagogical content knowledge (TPCK). *Computers & Education*, *52*, 154-168. doi:10.1016/j.compedu.2008.07.006

Archambault, L. M., & Barnett, J. H. (2010). Revisiting technological pedagogical content knowledge: Exploring the TPACK framework. *Computers & Education*, *55*(4), 1656-1662.

Archambault, L., & Crippen, K. (2009). Examining TPACK among K-12 online distance educators in the United States. *Contemporary Issues in Technology and Teacher Education*, *9*(1). Retrieved from http://www.citejournal.org/vol9/iss1/general/article2.cfm

Bandura, A. (1999). Perceived self-efficacy in the exercise of personal agency. *Adolescence: development, diversity, and context*, 65-78.

Barnes, K., Marateo, R., & Ferris, S. P. (2007). Teaching and learning with the net generation. *Innovate: Journal of Online Education, 3*(4), 1-7. Retrieved from http://nsuworks.nova.edu/innovate/vol3/iss4/1

Baylor, A. L., & Ritchie, D. (2002). What factors facilitate teacher skill, teacher morale, and perceived student learning in technology-using classrooms? *Computers & Education*, *39*, 395-414. doi:10.1016/S0360-1315(02)00075-1

Becker H. J. (1991). How computers are used in United States schools: Basic data from the 1989 I.E.A. Computers in Education survey. *Journal of Educational Computing Research*, *7*, 385-406. doi:10.2190/P2UT-R3U3-FK1L-B89L

Bennett, S., & Maton, K. (2010). Beyond the ‘digital natives’ debate: Towards a more nuanced understanding of students' technology experiences. *Journal of Computer Assisted Learning*, *26*, 321-331. doi:10.1111/j.1365-2729.2010.00360.x

Bernanke, B. S. (2007). Education and economic competitiveness. *US Chamber Education and Workforce Summit, September*, *24*. Retrieved from http://www.federalreserve.gov/newsevents/speech/bernanke20070924a.htm

Bollen, K. A. (1989). *Structural equations with latent variables*. John Wiley & Sons.

Bonk, C. J., & Cunningham, D. J. (1998). Searching for learner-centered, constructivist, and sociocultural components of collaborative educational learning tools. In C. J. Bonk & K. King (Eds.), *Electronic collaborators: Learner-centered technologies for literacy, apprenticeship, and discourse* (pp. 25-50). New York and London: Routledge.

Brantley-Dias, L., & Ertmer, P. A. (2013). Goldilocks and TPACK: Is the construct 'just right?' *Journal of Research on Technology in Education*, *46*(2), 103-128. doi:10.1080/15391523.2013.10782615

Brinkerhoff, J. (2006). Effects of a long-duration, professional development academy on technology skills, computer self-efficacy, and technology integration beliefs and practices. *Journal of Research on Technology in Education*, *39*(1), 22-43.

Brown, R. B. (2006). *Doing your dissertation in business and management: The reality of researching and writing*. Thousand Oaks, CA: Sage.

Brzycki, D., & Dudt, K. (2005). Overcoming barriers to technology use in teacher preparation programs. *Journal of Technology and Teacher Education*, *13*(4), 619-641.

Burke, W. W. (2011). *Organization change: Theory and practice* (3rd ed.). Thousand Oaks, CA: SAGE.

Byrne, B. M. (2013). *Structural equation modeling with AMOS: Basic concepts, applications, and programming*. New York and London: Routledge.

Casner-Lotto, J., & Barrington, L. (2006). *Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st Century US workforce*. Washington, DC: Partnership for 21st Century Skills. Retrieved from http://files.eric.ed.gov/fulltext/ED519465.pdf

Cavanagh, R. F., & Koehler, M. J. (2013). A turn toward specifying validity criteria in the measurement of technological pedagogical content knowledge (TPACK). *Journal of Research on Technology in Education*, *46*(2), 129-148.

Center for Digital Education. (2013). *2013 yearbook: Technology innovation in education*. Retrieved from http://media.navigatored.com/documents/CDE13+YEARBOOK_V.PDF

Chang, I. H. (2012). The effect of principals' technological leadership on teachers' technological literacy and teaching effectiveness in Taiwanese elementary schools. *Journal of Educational Technology & Society*, *15*(2), 328-340.

Chang, I. H., Chin, J. M., & Hsu, C. M. (2008). Teachers' perceptions of the dimensions and implementation of technology leadership of principals in Taiwanese elementary schools. *Journal of Educational Technology & Society, 11*(4), 229-245.

Chen, F. H., Looi, C. K., & Chen, W. (2009). Integrating technology in the classroom: a visual conceptualization of teachers' knowledge, goals and beliefs. *Journal of Computer Assisted Learning*, *25*(5), 470-488. doi:10.1111/j.1365-2729.2009.00323.x

Cook, T. D., Campbell, D. T., & Day, A. (1979). *Quasi-experimentation: Design & analysis issues for field settings*. Boston, MA: Houghton Mifflin.

Cuban, L. (1986). *Teachers and machines: The classroom use of technology since 1920*. New York, NY: Teachers College Press.

Cuban, L. (1996). Techno-reformers and classroom teachers. *Education Week*, *16*(6), 1-4.

Cuban, L. (1998). How schools change reforms: Redefining reform success and failure. *The Teachers College Record*, *99*(3), 453-477.

Cuban, L. (2001). *Oversold and underused: Reforming schools through technology, 1980-2000*. Cambridge, MA: Harvard University Press.

Cuban, L., Kirkpatrick, H., & Peck, C. (2001). High access and low use of technologies in high school classrooms: Explaining an apparent paradox. *American Educational Research Journal*, *38*, 813-834. doi:10.3102/00028312038004813

Darling-Hammond, L., Ancess, J., & Ort, S. W. (2002). Reinventing high school: Outcomes of the coalition campus schools project. *American Educational Research Journal*, *39*, 639-673. doi:10.3102/00028312039003639

Darling-Hammond, L. (2006). Constructing 21st-century teacher education. *Journal of Teacher Education*, *57*, 300-314. doi:10.1177/0022487105285962

Dawson, C., & Rakes, G. C. (2003). The influence of principals' technology training on the integration of technology into schools. *Journal of Research on Technology in Education*, *36*(1), 29-49. doi:10.1080/15391523.2003.10782401

Doering, A., Veletsianos, G., Scharber, C., & Miller, C. (2009). Using the technological, pedagogical, and content knowledge framework to design online learning environments and professional development. *Journal of Educational Computing Research*, *41*(3), 319-346. doi:10.2190/EC.41.3.d

Drayton, B., Falk, J. K., Stroud, R., Hobbs, K., & Hammerman, J. (2010) After installation: ubiquitous computing and high school science in three experienced, high-technology schools. *The Journal of Technology, Learning and Assessment, 9*(3). Retrieved from http://ejournals.bc.edu/ojs/index.php/jtla/article/viewFile/1608/1461

Duckworth, A. L., & Yeager, D. S. (2015). Measurement matters assessing personal qualities other than cognitive ability for educational purposes. *Educational Researcher*, *44*(4), 237-251.

Duffin, L. C., French, B. F., & Patrick, H. (2012). The Teachers' Sense of Efficacy Scale: Confirming the factor structure with beginning pre-service teachers. *Teaching and Teacher Education*, *28*, 827-834. doi:10.1016/j.tate.2012.03.004

DuFour, R., & Marzano, R. J. (2015). *Leaders of Learning: How District, School, and Classroom Leaders Improve Student Achievement*. Solution Tree Press.

Earle, R. S. (2002). The integration of instructional technology into public education: Promises and challenges. *Educational Technology, 42*(1), 5-13. Retrieved from http://isites.harvard.edu/fs/docs/icb.topic87187.files/Earle02.pdf

Elmore, R. F. (2005). Accountable leadership. *The Educational Forum, 69*(2), 134-142. doi:10.1080/00131720508984677

Ertmer, P. A. (1999). Addressing first-and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development*, *47*(4), 47-61.

Ertmer, P. A. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, *53*(4), 25-39. doi:10.1007/BF02504683

Ertmer, P. A., Gopalakrishnan, S., & Ross, E. (2000). Technology-using teachers: Comparing perceptions of exemplary technology use to best practice. *ERIC Clearinghouse*. Retrieved from http://www.edci.purdue.edu/ertmer/docs/AERA_2000.pdf

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, *42*(3), 255-284. doi:10.1080/15391523.2010.10782551

Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadikb, O., Sendururc, E., & Senduruc, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers in Education, 59*, 423-435. doi:10.1016/j.compedu.2012.02.001

Fabian, K., & MacLean, D. (2014). Keep taking the tablets? Assessing the use of tablet devices in learning and teaching activities in the Further Education sector. *Research in Learning Technology*, *22*. doi: 10.3402/rlt.v22.22648

Flanagan, L., & Jacobsen, M. (2003). Technology leadership for the twenty-first century principal. *Journal of Educational Administration, 41,* 124-142. doi:10.1108/09578230310464648

Franklin, C. A. (2005). Factors that influence elementary teachers' use of computers*. ERIC Clearinghouse*. Retrieved from http://files.eric.ed.gov/fulltext/ED490605.pdf

Fullan, M. (2006). The future of educational change: System thinkers in action. *Journal of Educational Change*, *7*(3), 113-122. doi:10.1007/s10833-006-9003-9

Graham, R. C., Burgoyne, N., Cantrell, P., Smith, L., St Clair, L., & Harris, R. (2009). Measuring the TPACK confidence of inservice science teachers. *TechTrends*, *53*, 70-79.

Grint, K. (2008). Wicked problems and clumsy solutions: The role of leadership. *Clinical Leader*, *1*(2), 54-68.

Harris, J. (2005). Our agenda for technology integration: It’s time to choose. *Contemporary Issues in Technology and Teacher Education*, *5*(2), 116-122.

Hew, K. F., & Brush, T. (2007). Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. *Educational Technology Research and Development*, *55*, 223-252. doi:10.1007/s11423-006-9022-5

Hicks, S. D. (2011). Technology in today's classroom: Are you a tech-savvy teacher? *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *84*(5), 188-191. doi:10.1080/00098655.2011.557406

Hoyle, R. H. (1995). *Structural equation modeling: Concepts, issues, and applications*. Thousand Oaks, CA: Sage Publications.

Hsu, S. (2010). The relationship between teacher's technology integration ability and usage. *Journal of Educational Computing Research*, *43*, 309-325. doi:10.2190/EC.43.3.c

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: a Multidisciplinary Journal*, *6*(1), 1-55.

Hughes, J. (2005). The role of teacher knowledge and learning experiences in forming technology-integrated pedagogy. *Journal of Technology and Teacher Education*, *13*(2), 277-302.

Hughes, J. E., McLeod, S., Dikkers, A. G., Brahier, B., & Whiteside, A. (2005). School technology leadership: Theory to practice. *Academic Exchange Quarterly*, *9*(2), 51-55.

Inan, F. A., & Lowther, D. L. (2010). Factors affecting technology integration in K-12 classrooms: A path model. *Educational Technology Research and Development*, *58*(2), 137-154. doi:10.1007/s11423-009-9132-y

International Reading Association. (2009). *New literacies and 21st Century technologies: A Position statement.* Retrieved from http://www.reading.org/Libraries/position-statements-and-resolutions/ps1067_NewLiteracies21stCentury.pdf

International Society for Technology in Education. (2009). *Standards for administrators*. Retrieved from http://www.iste.org/docs/pdfs/20-14_iste_standards-a_pdf.pdf

Jamieson-Proctor, R., Albion, P., Finger, G., Cavanagh, R., Fitzgerald, R., Bond, T., & Grimbeek, P. (2013). Development of the TTF TPACK survey instrument. *Australian Educational Computing*, *27*(3), 26-35. Retrieved from http://espace.library.curtin.edu.au/R?func=dbin-jump-full&local_base=gen01-era02&object_id=194612

Jones, B., & Flannigan, S. L. (2006). Connecting the digital dots: Literacy of the 21st century. *Educause Quarterly*, *29*(2), 8-10.

Jones, C., & Shao, B. (2011). The net generation and digital natives: implications for higher education. *Higher Education Academy, York*. Retrieved from http://www.heacademy.ac.uk/resources/detail/evidencenet/net-generation-and-digital-natives

Justice, L. M., Mashburn, A. J., Hamre, B. K., & Pianta, R. C. (2008). Quality of language and literacy instruction in preschool classrooms serving at-risk pupils. *Early Childhood Research Quarterly*, *23*(1), 51-68.

Kabakci Yurdakul, I. K., Odabasi, H. F., Kilicer, K., Coklar, A. N., Birinci, G., & Kurt, A. A. (2012). The development, validity and reliability of TPACK-deep: A technological, pedagogical content knowledge scale. *Computers & Education*, *58*, 964-977. doi:10.1016/j.compedu.2011.10.012

Katz, J. H., & Miller, F. A. (2010). Inclusion: The HOW for organizational breakthrough. In W. J. Rothwell, J. M. Stavros, R. L. Sullivan, A. Sullivan, & A. Pfeiffer (Eds.), *Practicing Organizational Development: A Guide for Leading Change* (3rd ed., pp. 436-445). San Francisco, CA: Pfeiffer.

Kelloway, K. E. (1998). *Using LISREL for structural equation modeling: A researcher's guide*. Thousand Oaks, CA: Sage.

Klem, L. (2000). Structural equation modeling. In L. G. Grimm & P. R. Yarnold (Eds.), *Reading and understanding MORE multivariate statistics* (pp. 227-260). Washington, DC: American Psychological Association.

Kline, R. B. (2015). *Principles and practice of structural equation modeling*. Guilford, UK: Guilford Publications.

Koehler, M. J., & Mishra, P. (2005). What happens when teachers design educational technology? The development of technological pedagogical content knowledge. *Journal of Educational Computing Research*, *32*(2), 131-152.

Koehler, M. J., & Mishra, P. (2009). What is technological, pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education, 9*(1), 60-70.

Koehler, M. J., Mishra, P., & Cain, W. (2013). What is technological, pedagogical content knowledge (TPACK)? *Journal of Education*, *193*(3), 13-19. Retrieved from http://www.bu.edu/journalofeducation/files/2014/02/BUJoE.193.3.Koehleretal.pdf

Koehler, M. J., Shin, T. S., & Mishra, P. (2011). How do we measure TPACK? Let me count the ways. *Educational technology, teacher knowledge, and classroom impact: A research handbook on frameworks and approaches*, 16-31.

Koh, J. H. L., Chai, C. S., & Tsai, C. C. (2010). Examining the technological, pedagogical content knowledge of Singapore pre-service teachers with a large-scale survey. *Journal of Computer Assisted Learning, 26*, 563-573. doi:10.1111/j.1365-2729.2010.00372.x

Koltay, T. (2011). The media and the literacies: media literacy, information literacy, digital literacy. *Media, Culture & Society*, *33*, 211-221. doi:10.1177/0163443710393382

Kozloski, K. C. (2006). *Principal leadership for technology integration: A study of principal technology leadership* (Doctoral dissertation). Retrieved from https://idea.library.drexel.edu/islandora/object/idea%3A886/datastream/OBJ/view

Kritsonis, A. (2005). Comparison of change theories. *International Journal of Scholarly Academic Intellectual Diversity*, *8*(1), 1-7. Retrieved from http://commonweb.unifr.ch/artsdean/pub/gestens/f/as/files/4655/31876_103146.pdf

Lankshear, C., & Knobel, M. (2011). *New literacies: Everyday practices and social learning.* Berkshire, England: McGraw-Hill Open University Press.

Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning: Knowns, unknowns, and ways to pursue better questions and answers. *Review of Educational Research, 77*, 575-614. doi:10.3102/0034654307309921

Lei, J. (2010). Quantity versus quality: A new approach to examine the relationship between technology use and student outcomes. *British Journal of Educational Technology*, *41*(3), 455-472.

Lei, J., & Zhao, Y. (2007). Technology uses and student achievement: A longitudinal study. *Computers & Education*, *49*, 284-296. doi:10.1016/j.compedu.2005.06.013

Leithwood, K. (1994). Leadership for school restructuring. *Educational Administration Quarterly*, *30*(4), 498-518.

Levin, D., Arafeh, S., Lenhart, A., & Rainie, L. (2002) The digital disconnect: The widening gap between Internet-savvy students and their schools. *ERIC Clearinghouse*. Retrieved from http://files.eric.ed.gov/fulltext/ED471133.pdf

Levin, T., & Wadmany, R. (2008). Teachers' views on factors affecting effective integration of information technology in the classroom: Developmental scenery. *Journal of Technology and Teacher Education*, *16*(2), 233-263.Lewin, K. (1951). *Field theory in social science.* New York, NY: Harper & Brothers.

Liu, S. S. (2011). Factors related to pedagogical beliefs of teachers and technology integration. *Computers & Education, 56*, 1012-1022.

Lowery, N. V. (2003). Teachers, professional development, and technology. *Society for Information Technology & Teacher Education International Conference Proceedings*, *2003*(1), 2934-2936. Retrieved from EditLib Database: http://www.editlib.org

Lowther, D. L., Ross, S. M., & Morrison, G. M., (2003) When each one has one: The influences on teaching strategies and student achievement of using laptops in the classroom. *Educational Technology Research and Development, 51*(3)*,* 23-44. doi:10.1007/BF02504551

MacCallum, R. C., Widaman, K. F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological methods*, *4*(1), 84.

MacNeil, A. J., & Delafield, D. P. (1998). Principal leadership for successful school technology implementation. *ERIC Clearinghouse*. Retrieved from http://files.eric.ed.gov/fulltext/ED421126.pdf

Martin, W., Strother, S., Beglau, M., Bates, L., Reitzes, T., & McMillan Culp, K. (2010). Connecting instructional technology professional development to teacher and student outcomes. *Journal of Research on Technology in Education*, *43*(1), 53-74. doi:10.1080/15391523.2010.10782561

Mertler, C. A. (2003). Patterns of response and nonresponse from teachers to traditional and web surveys. *Practical Assessment, Research and Evaluation, 8*(22), 1-17. Retrieved from http://www.pareonline.net/getvn.asp?v=8&n=22

Mishra, P., & Koehler, M. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *The Teachers College Record*, *108*(6), 1017-1054.

Moersch, C. (1995). Levels of technology implementation (LoTi): A framework for measuring classroom technology use. *Learning & Leading With Technology, 23*(3), 40-42. Retrieved from http://loticonnection.cachefly.net/global_documents/1995_11NOV_LoTiFramework.pdf

Muthén, L. K., & Muthén, B. O. (2002). How to use a Monte Carlo study to decide on sample size and determine power. *Structural Equation Modeling*, *9*(4), 599-620.

Muthén, L. K., & Muthén, B. O. (2014). *Mplus user's guide* (7th ed.). Los Angeles, CA: Muthén & Muthén.

National Association of the Education of Young Children (NAEYC). (2012). *Technology and interactive media as tools in early childhood programs serving children from birth through age 8: A joint position statement of the National Association for the Education of Young Children and the Fred Rogers Center for Early Learning and Children's Media at Saint Vincent College*. Washington DC: Author. Retrieved from http://www.naeyc.org/files/naeyc/file/positions/PS_technology_WEB2.pdf.

Niederhauser, D. S., & Stoddart, T. (2001). Teachers' instructional perspectives and use of educational software. *Teaching and Teacher Education*, *17*(1), 15-31.

O'Brien, D., & Scharber, C. (2008). Digital literacies go to school: Potholes and possibilities. *Journal of Adolescent & Adult Literacy*, *52*(1), 66-68. doi:10.1598/JAAL.52.1.7

Ottenbreit-Leftwich, A. T., Glazewski, K. D., Newby, T. J., & Ertmer, P. A. (2010). Teacher value beliefs associated with using technology: Addressing professional and student needs. *Computers & Education*, *55*, 1321-1335. doi:10.1016/j.compedu.2010.06.002

Palfrey, J. & Gasser, U. (2008). *Born digital: Understanding the first generation of digital natives*. New York, NY: Basic Books.

Pedersen, S., & Min, L. (2003). Teachers' beliefs about issues in the implementation of a student-centered learning environment. *Educational Technology Research and Development, 51*(2), 57-76. doi:10.1007/BF02504526

Pierson, M. E. (2001). Technology integration practice as a function of pedagogical expertise. *Journal of Research on Computing in Education, 33*(4), 413-430. doi:10.1080/08886504.2001.10782325

Prensky, M. (2001). Digital natives, digital immigrants part 1. *On the horizon*, *9*(5), 1-6. doi:10.1108/10748120110424816

Puentedura, R. (2010). *SAMR and TPCK: Intro to advanced practice*. Retrieved from http://hippasus.com/resources/sweden2010/SAMR_TPCK_IntroToAdvancedPractice.pdf

Rakes, G. C., Fields, V. S., & Cox, K. E. (2006). The influence of teachers' technology use on instructional practices. *Journal of Research on Technology in Education*, *38*, 409-424. doi:10.1080/15391523.2006.10782467

Reiser, R. A. (2001). A history of instructional design and technology: Part II: A history of instructional design. *Educational Technology Research and Development*, *49*(2), 57-67. doi:10.1007/BF02504928

Rosenberg, J. M., & Koehler, M. J. (2015) Context and Technological Pedagogical Content Knowledge (TPACK): A systematic review. *Journal of Research on Technology in Education, 47*, 186-210. doi:10.1080/15391523.2015.1052663

Russell, M., Bebell, D., O'Dwyer, L., & O'Connor, K. (2003). Examining teacher technology use implications for preservice and inservice teacher preparation. *Journal of Teacher Education*, *54*, 297-310. doi:10.1177/0022487103255985

Sandholtz, J. H., Ringsraff, C., & Dwyer, D. C. (1997). *Teaching with technology: Creating student-centered classrooms*. New York, NY: Teachers College Press.

Schaefer, E. S., & Edgerton, M. (1985). Parent and child correlates of parental modernity. In I. E. Sigel (Ed.), Parental belief systems: The psychological consequences for children (pp. 287-318). Hillsdale, NJ: Erlbaum.

Schmidt, D. A., Baran, E., Thompson, A. D., Mishra, P., Koehler, M. J., & Shin, T. S. (2009). Technological, pedagogical content knowledge (TPACK) the development and validation of an assessment instrument for preservice teachers. *Journal of Research on Technology in Education*, *42*(2), 123-149. doi:10.1080/15391523.2009.10782544

Schreiber, J. B., Nora, A., Stage, F. K., Barlow, E. A., & King, J. (2006). Reporting structural equation modeling and confirmatory factor analysis results: A review. *The Journal of Educational Research*, *99*, 323-338. doi:10.3200/JOER.99.6.323-338

Schumacker, R. E., & Lomax, R. G. (2004). *A beginner's guide to structural equation modeling* (2nd ed.). Mahwah, NJ: Lawrence Erlbaum.

Senge, P., Smith, B., Kruschwitz, N., Laur, J., & Schley, S. (2010). *The necessary revolution: Working together to create a sustainable world*. New York, NY: Broadway Books.

Shapley, K. S., Sheehan, D. C., Maloney, C., & Caranikas-Walker, F. (2010). Evaluating the implementation fidelity of technology immersion and its relationship with student achievement. *The Journal of Technology, Learning and Assessment, 9*(4), 5-68. Retrieved from https://ejournals.bc.edu/ojs/index.php/jtla/article/viewFile/1609/1460

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 4-14. doi:10.3102/0013189X015002004

Siemens, G. (2005). Connectivism: A learning theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, *2*(1), 3-10. Retrieved from http://www.itdl.org/Journal/Jan_05/article01.htm

SPSS (IBM Corp). (2013). IBM SPSS Statistics for Windows (Version 22.0) [Computer softwre]. Armonk, NY: IBM Corp.

Spann, M. G. (2000). Remediation: A must for the 21st-century learning society. Policy Paper. *ERIC Clearinghouse*. Retrieved from http://files.eric.ed.gov/fulltext/ED439771.pdf

Tapscott, D. (1998). *Growing up digital: The rise of the net generation*. New York, NY:McGraw-Hill.

Tapscott, D. (2009). *Grown up digital*. New York, NY: McGraw-Hill.

Taylor, S., & Todd, P. A. (1995). Understanding information technology usage: A test of competing models. *Information Systems Research*, *6*(2), 144-176.

Tschannen-Moran, M., & Woolfolk Hoy, A. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education, 17,* 783-805. doi:10.1016/S0742-051X(01)00036-1

Tschannen-Moran, M., Woolfolk Hoy, A., & Hoy, W. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research, 68*(2), 202-248.

Ullman, J. B. (2006). Structural equation modeling: Reviewing the basics and moving forward. *Journal of Personality Assessment*, *87*(1), 35-50. doi:10.1207/s15327752jpa8701_03

US Department of Education. (2014). *Setting the pace Expanding opportunity for America's students under Race to the top*. Retrieved from http://www.whitehouse.gov/sites/default/files/docs/settingthepacerttreport_3-2414_b.pdf.

Voogt, J., & Pelgrum, H. (2005). ICT and curriculum change. *Human Technology, 1*(2) 157-175Retrieved from https://jyx.jyu.fi/dspace/bitstream/handle/123456789/20180/HT_2005_v01_n02_p_157-175.pdf?sequence=1

Watson, G. (2001). Models of information technology teacher professional development that engage with teachers' hearts and minds. *Journal of Information Technology for Teacher Education*, *10*(1-2), 179-190. doi:10.1080/14759390100200110

Weimer, M. (2002). *Learner-centered teaching: Five key changes to practice*. San Francisco, CA: John Wiley & Sons.

Wenglinsky, H. (2005). *Using technology wisely: The keys to success in schools*. New York, NY: Teachers College Press.

Weston, M. E., & Bain, A. (2010). The end of techno-critique: the naked truth about 1:1 laptop initiatives and educational change. *The Journal of Technology, Learning and Assessment, 9*(6). Retrieved from https://ejournals.bc.edu/ojs/index.php/jtla/article/viewFile/1611/1458

Windschitl, M. (2002). Framing constructivism in practice as the negotiation of dilemmas: An analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. *Review of Educational Research*, *72*, 131-175. doi:10.3102/00346543072002131

Wozney, L., Venkatesh, V., & Abrami, P. (2006). Implementing computer technologies: Teachers' perceptions and practices. *Journal of Technology and Teacher Education*, *14*(1), 173-207.

Yalin, H. I., Karadeniz, S., & Sahin, S. (2007). Barriers to information and communication technologies integration into elementary schools in Turkey. *Journal of Applied Sciences*, *7*, 4036-4039.

Yu, C. Y., & Muthen, B. (2002, April). Evaluation of model fit indices for latent variable models with categorical and continuous outcomes. In *Annual meeting of the American Educational Research Association, New Orleans, LA*.

Zelkowski, J., Gleason, J., Cox, D. C., & Bismarck, S. (2013). Developing and validating a reliable TPACK instrument for secondary mathematics pre-service teachers. *Journal of Research on Technology in Education (International Society for Technology in Education)*, *46*, 173-206.

Zhao, Y. (2007). Social studies teachers' perspectives of technology integration. *Journal of Technology and Teacher Education*, *15*(3), 311.

Zhao, Y., & Cziko, G. A. (2001). Teacher adoption of technology: A perceptual control theory perspective. *Journal of Technology and Teacher Education, 9*(1), 5-30.

Appendix A: Institutional Review Board Memorandum

UNF
UNIVERSITY *of* NORTH FLORIDA.

Office of Research and Sponsored Programs
1 UNF Drive
Jacksonville, FL 32224-2665
904-620-2455 FAX 904-620-2457
Equal Opportunity/Equal Access/Affirmative Action Institution

MEMORANDUM

UNF IRB Number: 741917-1
Exemption Date: 7-27-2015
Status Report Due Date: 7-27-2018
Processed on behalf of UNF's IRB KLC

DATE: July 27, 2015

TO: Ms. Heather Monroe-Ossi

VIA: Dr. Sandra Gupton
Leadership, School Counseling & Sports Management

FROM: Dr. Jennifer Wesely, Chairperson
On behalf of the UNF Institutional Review Board

RE: Declaration of Exempt Status for IRB#741917-1:
"Validation Study: Investigating Factors Impacting Technology Integration"

Your project, "Validation Study: Investigating Factors Impacting Technology Integration" was reviewed on behalf of the UNF Institutional Review Board and declared "Exempt" category 2. Based on the recently revised Standard Operating Procedures regarding exempt projects, the UNF IRB no longer reviews and approves exempt research according to the 45 CFR 46 regulations. Projects declared exempt review are only reviewed to the extent necessary to confirm exempt status.

Please note, this exemption only exempts this specific project from further UNF IRB review and is not meant to supersede other federal, state, or local requirements associated with this project. Duval County Public Schools (DCPS) requires you to obtain approval from the Accountability and Assessment department of DCPS before you can utilize staff, facilities, students, or data associated with DCPS. Other school districts may have similar requirements. Please obtain school district approval from all applicable districts before initiating your research. If you need to make changes to your project based on your communications with the school districtss, a formal IRB amendment may be required. Please contact a research integrity administrator if you are unsure if a formal IRB amendment is required.

Please also consider including a note on your consent document informing potential participants that you contacted the school districts and received their approval prior to contacting potential participants. Because your project was declared exempt from further UNF IRB review, you will not be required to submit your district approval or an updated consent form to the UNF IRB. However, you will need to present a copy of the school district approval along with this Declaration of Exempt Status Memo to school principals, teachers, staff and others when you approach them about this research. In good faith the UNF IRB will trust that you will receive school district approval and present the updated informed consent information to all potential participants and obtain their informed consent before asking them to complete your survey. In the event that this project is audited, copies of all project documentation including district approval and the updated consent document may be requested.

Once data collection under the exempt status begins, the researchers agree to abide by these requirements:

- All investigators and co-investigators, or those who obtain informed consent, collect data, or have access to identifiable data are trained in the ethical principles and federal, state, and institutional policies governing human subjects research (please see the FAQs on UNF IRB CITI Training for more information).
- An informed consent process will be used, when necessary, to ensure that participants voluntarily consent to participate in the research and are provided with pertinent information such as identification of the activity as research; a description of the procedures, right to withdraw at any time, risks, and benefits; and contact information for the PI and IRB chair.
- Human subjects will be selected equitably so that the risks and benefits of research are justly distributed.
- The IRB will be informed as soon as practicable but no later than 3 business days from receipt of any complaints from participants regarding risks and benefits of the research.
- The IRB will be informed as soon as practicable but no later than 3 business days from receipt of the complaint of any information and unexpected or adverse events that would increase the risk to the participants and cause the level of review to change. Please use the Event Report Form to submit information about such events.
- The confidentiality and privacy of the participants and the research data will be maintained appropriately.

While the exempt status is effective for the life of the study, if it is modified, all substantive changes must be submitted to the IRB for prospective review. In some circumstances, changes to the protocol may disqualify the project from exempt status. Revisions in procedures or documents that would change the review level from exempt to expedited or full board review include, but are not limited to, the following:

- New knowledge that increases the risk level;
- Use of methods that do not meet the exempt criteria;
- Surveying or interview children or participating in the activities being observed;
- Change in the way identifiers are recorded so that participants can be identified;
- Addition of an instrument, survey questions, or other change in instrumentation that could pose more than minimal risk;
- Addition of prisoners as research participants;
- Addition of other vulnerable populations;
- Under certain circumstances, addition of a funding source

UNF IRB Number: 741917-1
Exemption Date: 7-27-2015
Status Report Due Date: 7-27-2018
Processed on behalf of UNF's IRB KLC

To submit an amendment, please complete an Amendment Request Document and submit it along with any updated documents affected by the changes via a new package in IRBNet. If investigators are unsure of whether an amendment needs to be submitted or if they have questions about the amendment review process, they should contact the IRB staff for clarification.

Your study was declared exempt effective 7/27/2015. Please submit an Exempt Status Report by **7/27/2018** if this project is still active at the end of three years. However, if the project is complete and you would like to close the project, please submit a Closing Report Form. This will remove the project from the group of projects subject to an audit. An investigator must close a project when the research no longer meets the definition of human subject research (e.g., data collection is complete and data are de-identified so the researcher does not have the ability to match data to participants) or data collection *and* analysis are complete. If the IRB has not received correspondence at the three-year anniversary, you will be reminded to submit an Exempt Status Report. If no Exempt Status Report is received from the Principal Investigator within 90 days of the status report due date listed above, then the IRB will close the research file. The closing report or exempt status report will need to be submitted as a new package in IRBNet.

All principal investigators, co-investigators, those who obtain informed consent, collect data, or have access to identifiable data must be CITI certified in the protection of human subjects. As you may know, **CITI Course Completion Reports are valid for 3 years**. Your completion report is valid through 10/10/2016, Dr. Gupton's completion report is valid through 12/18/2016, Dr. Fountain's completion report is valid through 10/24/2016, and Dr. Wehry's completion report is valid through 10/22/2016. The CITI training for renewal will become available 90 days before your CITI training expires. Please renew your CITI training when necessary and ensure that all key personnel maintain current CITI training. Individuals can access CITI by following this link: http://www.citiprogram.org/. Should you have questions regarding your project or any other IRB issues, please contact the research integrity unit of the Office of Research and Sponsored Programs by emailing IRB@unf.edu or calling (904) 620-2455.

This letter has been electronically signed in accordance with all applicable regulations, and a copy is retained within UNF's records. All records shall be accessible for inspection and copying by authorized representatives of the department or agency at reasonable times and in a reasonable manner. A copy of this memo may also be sent to the dean and/or chair of your department.

UNF IRB Number: 741917-1
Exemption Date: 7-27-2015
Status Report Due Date: 7-27-2018
Processed on behalf of UNF's IRB KLC

Appendix B: School District Research Request Letter

July 30, 2015

(District Administrator)
(Title)
(School District)
(Address)

RE: Permission to Conduct Research Study

Dear XX:
I am writing to request permission to conduct a research study in XX County District Schools. I am currently enrolled in the doctoral program at the University of North Florida in Jacksonville, FL, and am in the process of completing my dissertation. The study is entitled Complexities of Technology Integration in the Elementary School Setting: A Structural Equation Model Study.

I hope that the school administration will allow me to recruit XX elementary teachers from the schools to anonymously complete a 71-item survey (copy enclosed). Teachers, who volunteer to participate, will be given a consent form to be signed electronically and returned to the primary researcher at the beginning of the survey process. If approval is granted, teacher participants will receive an email link and complete the survey online. The survey process should take no longer than (25 minutes). The survey results will be pooled for the dissertation research and individual results of this study will remain absolutely confidential and anonymous. Should this study be published, only pooled results will be documented. No costs will be incurred by the XX district schools or the individual participants. I have also enclosed an overview of the proposed research, a copy of the survey, a teacher consent, a principal request, and the approved UNF Institutional Review Board memo.

Your approval to conduct this study will be greatly appreciated. I will follow up with an email and telephone call next week and would be happy to answer any questions or concerns that you may have at that time. You may contact me at my email address h.monroe-ossi@unf.edu.

If you agree, kindly sign below and return the signed form in the enclosed self-addressed envelope. Alternatively, kindly submit a signed letter of permission on your institution's letterhead acknowledging your consent and permission for me to conduct this survey/study at in your school district.

Sincerely,
Heather Monroe-Ossi,
Florida Institute of Education at the University of North Florida

Enclosures: Overview of Research Study, Survey, Teacher Consent, Principal Request, UNF IRB Memorandum

cc: Dr. Sandra Gupton, Research Advisor, UNF/College of Education and Human Services

Approved by:

______________________	______________________	__________
Print your name and title here	Signature	Date

Appendix C: Principal Research Request Letter

(Principal Name)
(Elementary School)
(Address)
(School District)

RE: Permission to Conduct Research Study

Dear Principal XX:
I am writing to request permission to conduct a research study in XX Elementary. I am currently enrolled in the doctoral program at the University of North Florida in Jacksonville, FL, and am in the process of completing my dissertation. The study is entitled Complexities of Technology Integration in the Elementary School Setting: A Structural Equation Model Study. Approval for this research study has been granted by the XX County School District.

I am hoping the school administration will allow me to recruit PreKindergarten through Grade 5 elementary teachers from XX Elementary to anonymously complete a 71-item survey (copy attached). Teachers who volunteer to participate will be given a consent form to be signed electronically and returned to the primary researcher at the beginning of the survey process. If approval is granted, teacher participants will receive an email link and complete the survey online. The survey process should take no longer than 25 minutes. The survey results will be pooled for the dissertation research and individual results of this study will remain absolutely confidential and anonymous. Should this study be published, only pooled results will be documented. No costs will be incurred by XX Elementary or the individual participants. I have also attached an overview of the proposed research, a sample of the teacher informed consent that will be included in the electronic survey, the approved UNF Institutional Review Board memo, and the approval letter from XX County Public Schools.

Your approval to conduct this study will be greatly appreciated. I will follow up with an email next week and am happy to answer any questions or concerns that you may have at any time. You may contact me at my email address

Kindly respond via email as to your interest in having your teachers participate in this study. Your response is greatly appreciated.

Sincerely,
Heather Monroe-Ossi

Appendix D: Sample of Teacher Informed Consent Form

Online Survey Consent Form
Factors Impacting Technology Integration

Hi my name is ***Heather Monroe-Ossi*** and I am a doctoral student and staff member at the University of North Florida. You are being invited to participate in a research study titled ***Validation Study: Factors Impacting Technology Integration***. This study is being done for my dissertation from the University of North Florida. You were selected to participate in this study because your elementary school reports technology use in the classroom by the Florida Department of Education.

The purpose of this research study is to better understand the complexities of integrating technology in the elementary classroom by investigating the validity of an instrument to measure Florida in-service teachers' understanding of technological pedagogical knowledge (TPACK). If you agree to take part in this study, you will be asked to complete an online survey/questionnaire. This survey/questionnaire will ask about how you use technology in the teaching and learning process, your teaching beliefs, learner perspectives, as well as your perceptions of leadership support related to technology integration. The online survey will take you approximately 25 minutes to complete.

You may not directly benefit from this research; however, we hope that your participation in the study may inform how learning, teaching, and leading in the digital age can be strengthened in the interest of preparing our students to be successful in the globalized society.

We believe there are no known risks associated with this research study; however, as with any online related activity the risk of a breach of confidentiality is always possible. To the best of our ability your answers in this study will remain anonymous. Your school district and school principal have approved this research study. We will minimize any risks by sending this electronic survey using the *Anonymous Link* and *Anonymize Response* features to keep your identify and responses anonymous. Data will be kept anonymous and destroyed after five years. Raw data will be stored in an EXCEL workbook on a university secure server. Data will be maintained in a safe locked in a cabinet in a university office. This study is designed to protect the confidentiality of participants and the names of their schools. No identifiable information will be shared in compliance with Human Subjects Research. One potential cost of participation is the 25 minutes of your time to complete the online survey.

Your participation in this research study is completely voluntary. There are no penalties for deciding not to participate, skipping questions, or withdrawing your participation. You may choose not to participate in this research without negatively impacting your relationship with the University of North Florida or your school district.
If you have questions about this project or if you have a research-related problem, you may contact the researcher, ***Heather Monroe-Ossi at*** . If you have any questions concerning your rights as a research subject, you may contact the ***UNF Institutional Review Board*** at (904) 620-2498 or emailing ***IRB@unf.edu***.

By clicking "I agree" below you are indicating that you are at least 18 years old, have read and understood this consent form and agree to participate in this research study. Please print a copy of this page for your records.

I Agree

I Do Not Agree

Appendix E: Teacher Survey

Default Question Block Turn on/off large block mode. Block Options

Q1

Hi my name is Heather Monroe-Ossi and I am a doctoral student and staff member at the University of North Florida. You are being invited to participate in a research study titled Validation Study: Factors Impacting Technology Integration. This study is being done for my dissertation from the University of North Florida. You were selected to participate in this study because your elementary school reports technology use in the classroom by the Florida Department of Education.
()

Q2

The purpose of this research study is to better understand the complexities of integrating technology in the elementary classroom by investigating the validity of an instrument to measure Florida in-service teachers' understanding of technological pedagogical knowledge (TPACK). If you agree to take part in this study, you will be asked to complete an on-line survey/questionnaire. This survey/questionnaire will ask about how you use technology in the teaching and learning process, your teaching beliefs, learner perspectives, as well as your perceptions of leadership support related to technology integration. The on-line survey will take you approximately 25 minutes to complete.
()

Q3

You may not directly benefit from this research; however, we hope that your participation in the study may inform how learning, teaching, and leading in the digital age can be strengthened in the interest of preparing our students to be successful in the globalized society.

We believe there are no known risks associated with this research study; however, as with any on-line related activity the risk of a breach of confidentiality is always possible. To the best of our ability your answers in this study will remain anonymous. Your school district and school principal have approved this research study. We will minimize any risks by sending this electronic survey using the Anonymous Link and Anonymize Response features to keep your identify and responses anonymous. Data will be kept anonymous and destroyed after five years. Raw data will be stored in an EXCEL workbook on a university secure server. Data will be maintained in a safe locked in a cabinet in a university office. This study is designed to protect the confidentiality of participants and the names

of their schools. No identifiable information will be shared in compliance with Human Subjects Research. One potential cost of participation is the 25 minutes of your time to complete the on-line survey.
()

Q4 Your participation in this research study is completely voluntary. There are no penalties for deciding not to participate, skipping questions, or withdrawing your participation. You may choose not to participate in this research without negatively impacting your relationship with the University of North Florida or your school district.

If you have questions about this project or if you have a research-related problem, you may contact the researcher, Heather Monroe-Ossi at . If you have any questions concerning your rights as a research subject, you may contact the UNF Institutional Review Board at (904) 620-2498 or emailing IRB@unf.edu.
()

Q5 By selecting "I agree" below you are indicating that you are at least 18 years old, have read and understood this consent form and agree to participate in this research study. Please print a copy of this page for your records.
(I agree to participate in this study., I do not wish to participate in this study)

Page Break

Q6

SECTION 1

For each item, choose only one option (Strongly Disagree, Disagree, Neither Agree or Disagree, Agree, Strongly Agree) that best describes you. Please answer all of the questions, and if you are uncertain of or neutral about your response you may always select Neither Agree or Disagree.
The purpose of this section is gather information about combining technology, pedagogy, and content knowledge in the teaching and learning process.
()

Q7 I can update instructional material (paper based, electronic or multimedia materials, etc.) based on the needs (students, environment, duration, etc.) by using technology.
(Strongly Disagree, Disagree, Neither Agree or Disagree, Agree, Strongly Agree)

Q8 I can use technology to determine students' needs relative to a content area in the pre-teaching process.
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q9 I can use technology to develop activities based on student needs to enrich the teaching and learning process.
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q10 I can plan the teaching and learning process according to available technological resources.
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q11 I can conduct a needs analysis for using technologies in the teaching and learning process.
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q12 I can optimize the duration of my lessons by using technologies (educational software, tablets, smart boards).
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q13 I can develop appropriate assessment tools using technology.
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q14 **I can evalute the attributes of various methods, techniques, and technologies to present content effectively.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q15 **I can use technology to appropriately design materials for an effective teaching and learning process.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q16 **I can organize the educational environment appropriately to use technology.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Page Break

Q82 **SECTION 1**
For each item, choose only one option (Strongly Disagree, Disagree, Neither Agree or Disagree, Agree, Strongly Agree) that best describes you. Please answer all of the questions, and if you are uncertain of or neutral about your response you may always select Neither Agree or Disagree.
The purpose of this section is gather information about combining technology, pedagogy, and content knowledge in the teaching and learning process.
()

Q17 **I can implement effective classroom management in the teaching and learning process when using technology.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q18 **I can assess whether students have the appropriate content knowledge by technology.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q19 **I can apply instructional approaches and methods to differentiate instruction using technology.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q20 **I can use technology for implementing educational activities (homework, projects, etc.).**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q21 **I can use the technology-based communication tools (blog, forum, chat, e-mail, etc.) in the teaching process.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q22 **I can use technology to assess students' achievement in related content areas.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q23 **I can be a model for others by following codes of ethics when using technology in my teaching.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q24 **I can guide students in the process of designing technology-based products (presentations, games, films, etc.).**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q25 **I can use innovative technologies (Facebook, blogs, Twitter, podcasting, etc.) to**

support the teaching and learning process.
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q26 **I can use technology to update my knowledge and skills in teaching.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q27 **I can update my technological knowledge for the teaching process.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q28 **I can use technology to keep my content knowledge updated.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q29 **I can provide each student with equal access to technology.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Page Break

Q83 **SECTION 1**
For each item, choose only one option (Strongly Disagree, Disagree, Neither Agree or Disagree, Agree, Strongly Agree) that best describes you. Please answer all of the questions, and if you are uncertain of or neutral about your response you may always select Neither Agree or Disagree.
The purpose of this section is gather information about combining technology, pedagogy, and content knowledge in the teaching and learning process.
()

Q30 **I can behave ethically in acquiring and using special/private information-which will be used in teaching a subject area – via technology (audio records, video records, documents, etc.).**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q31 **I can use technology in every phase of the teaching and learning process by considering the copyright issues (e.g. license).**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q32 **I can follow the teaching profession's code of ethics in on-line educational environments (BlackBoard, Moodle, etc.).**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q33 **I can provide guidance to students by leading them to valid and reliable digital sources.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q34 **I can behave ethically regarding the appropriate use of technology in educational environments.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q35 **I can troubleshoot problems that could be encountered with on-line educational environments (Blackboard, Moodle, Edmodo, etc.).**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q36 **I can troubleshoot any kind of problem that may occur while using technology in any phase of the teaching and learning process.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q37 **I can use technology to find solutions to problems (structuring, updating and relating the content to real life, etc.).**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q38 **I can become a leader in spreading the use of technological innovations in my teaching community.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q39 **I can cooperate with other teachers regarding the use of technology to solve problems encountered in the process of presenting content.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Page Break

Q40 **SECTION 2**
For each item, choose the one option (Strongly Disagree, Disagree, Neither Agree or Disagree, Agree, Strongly Agree) that best describes your opinion regarding the principal's role in facilitating technology use in your school.
()

Q41 **My principal demonstrates an understanding of technology needs and concerns of faculty, staff, and students.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q42 **My principal maintains positive relationships with faculty, staff, and students about technology.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q43 **My principal communicates effectively with faculty, staff, and students about technology.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Q44 **My principal encourages school personnel to utilize information sources about technology for professional development.**
(Strongly Disagree, Disagree, Neither Agree nor Disagree, Agree, Strongly Agree)

Page Break

Q45 **SECTION 3**
For each item, circle one option rating from Nothing (1) to A Great Deal (9), that best describes your opinion about how much you can do about the kinds of things that create difficulties for teachers in classroom activities.
()

Q47 **How much can you do to motivate students who show low interest in school work?**
(<div style="text-align: center;">Nothing
 1</div> , 2, <div style="text-ali...)

Q48 **How much can you do to get students to believe they can do well in school work?**
(<div style="text-align: center;">Nothing
 1</div> , 2, <div style="text-ali...)

Q49 **How much can you do to help your students value learning?**
(<div style="text-align: center;">Nothing
 1</div> , 2, <div style="text-ali...)

Page Break

Q84 **SECTION 3**
For each item, circle one option rating from Nothing (1) to A Great Deal (9), that best describes your opinion about how much you can do about the kinds of things that create difficulties for teachers in classroom activities.
()

Q50 **To what extent can you craft good questions for your students?**
(<div style="text-align: center;">Nothing
 1</div> , 2, <div style="text-ali...)

Q51 **How much can you get students to follow classroom rules?**
(<div style="text-align: center;">Nothing
 1</div> , 2, <div style="text-ali...)

Q52 **How much can you do to calm a student who is disruptive or noisy?**
(<div style="text-align: center;">Nothing
 1</div> , 2, <div style="text-ali...)

Q53 **How well can you establish a classroom management system with each group of students?**
(<div style="text-align: center;">Nothing
 1</div> , 2, <div style="text-ali...)

Q54 **How much can you use a variety of assessment strategies?**
(<div style="text-align: center;">Nothing
 1</div> , 2, <div style="text-ali...)

Q55 **To what extent can you provide an alternate explanation or example when students are confused?**
(<div style="text-align: center;">Nothing
 1</div> , 2, <div style="text-ali...)

Q56 **How much can you assist families in helping their children do well in school?**
(<div style="text-align: center;">Nothing
 1</div> , 2, <div style="text-ali...)

Q57 **How well can you implement alternative strategies in your classroom?**
(<div style="text-align: center;">Nothing
 1</div> , 2, <div style="text-ali...)

Page Break

Q58 **SECTION 4**
For each item, choose the one option (Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree) that best describes your opinion about rearing and educating children. For each one, please mark the box that best indicates how you feel in general, not just about your own child.
()

Q59 **Since parents lack special training in education, they should not question the teacher's teaching methods.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Q60 **Children should be treated the same regardless of the differences among them.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Q61 **Teachers should discipline all children the same.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Q62 **Children should always obey the teacher.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Q63 **Preparing for the future is more important for a child than enjoying today.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Q64 **Children will not do the right thing unless they must.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Q65 **Children should be allowed to disagree with their parents if they feel their own ideas are better.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Q66 **Children should be kept busy with work and study at home and at school.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Q67 **The major goal of education is to put basic information into the minds of children.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Q68 **In order to be fair, a teacher must treat all children alike.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Page Break

Q85 **SECTION 4**
For each item, choose the one option (Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree) that best describes your opinion about rearing and educating children. For each one, please mark the box that best indicates how you feel in general, not just about your own child.
()

Q69 **The most important thing to teach children is absolute obedience to whoever is in authority.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Q70 **Children learn best by doing things themselves rather than listening to others.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Q71 **Children must be carefully trained early in life or their natural impulses will make them unmanageable.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Q72 **Children have a right to their own point of view and should be allowed to express it.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Children like to teach other children.

Q74 **Children generally do not do what they should unless someone sees to it.**
(Strongly Disagree, Mildly Disagree, Not Sure, Mildly Agree, Strongly Agree)

Page Break

Q75 **SECTION 5**
Demographic Information
()

Q76 **What is your gender?**
(Male, Female)

Q77 **What is your age?**

Q78 **What is your highest level of education?**

Q79 **What size is your school?**
(SMALL - under 100 students, MEDIUM - 100 to 500 students, LARGE - over 500 students)

Q80 **In what school district are you employed?**

Appendix F: Polychoric Correlation Matrix Tables

Table 29

Polychoric Correlation Matrix for Items 17 to 29

	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q29
Q17												
Q18	.597											
Q19	.431	.692										
Q20	.393	.686	.462									
Q21	.306	.573	.426	.637								
Q22	.464	.752	.725	.548	.549							
Q23	.339	.663	.373	.368	.316	.604						
Q24	.400	.621	.418	.363	.397	.620	.627					
Q25	.291	.620	.639	.618	.746	.523	.380	.522				
Q26	.294	.486	.569	.441	.515	.729	.541	.475	.496			
Q27	.338	.713	.612	.558	.685	.755	.536	.458	.622	.932		
Q29	.335	.491	.428	.324	.210	.337	.183	.193	.325	.174	.220	
Q30	.452	.468	.285	.412	.394	.555	.653	.383	.344	.530	.441	.215
Q31	.483	.637	.442	.349	.472	.463	.518	.617	.494	.503	.513	.418
Q32	.547	.545	.318	.371	.320	.455	.600	.438	.320	.443	.431	.314
Q33	.514	.590	.545	.512	.454	.684	.616	.636	.607	.639	.574	.309
Q35	.447	.547	.548	.362	.365	.572	.395	.670	.471	.487	.531	.238
Q36	.459	.501	.377	.268	.358	.447	.420	.532	.465	.392	.404	.249
Q37	.564	.538	.560	.442	.416	.629	.232	.504	.528	.504	.529	.271
Q38	.329	.567	.444	.524	.309	.584	.501	.666	.539	.399	.442	.195
Q39	.242	.625	.582	.563	.452	.701	.556	.630	.497	.451	.525	.293

Table 30

Polychoric Correlation Matrix for Items 7 to 16

	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
Q7										
Q8	.719									
Q9	.676	.758								
Q10	.658	.815	.707							
Q11	.572	.678	.443	.647	.					
Q12	.710	.648	.864	.725	576	.				
Q13	.703	.709	.613	.793	.571	.675				
Q14	.599	.692	.510	.608	.789	.696	.566			
Q15	.749	.711	.644	.793	.592	.807	.771	.778		
Q16	.698	.657	.661	.787	.512	.708	.636	.681	.819	
Q17	.475	.526	.532	.493	.243	.493	.546	.467	.571	.637
Q18	.583	.643	.670	.773	.411	.633	.635	.440	.681	.731
Q19	.532	.808	.532	.801	.437	.700	.576	.497	.717	.672
Q20	.555	.479	.471	.456	.267	.491	.570	.332	.592	.517
Q21	.472	.341	.303	.474	.279	.271	.512	.167	.464	.534
Q22	.518	.710	.705	.702	.565	.647	.608	.624	.769	.633
Q23	.471	.543	.533	.585	.369	.404	.561	.458	.501	.318
Q24	.438	.576	.579	.661	.614	.575	.629	.500	.680	.528
Q25	.473	.499	.462	.539	.503	.536	.461	.417	.501	.547
Q26	.594	.675	.568	.759	.527	.597	.544	.550	.527	.477
Q27	.693	.657	.590	.799	.492	.597	.710	.504	.574	.568
Q29	.179	.134	.353	.493	.172	.429	.379	.209	.271	.372
Q30	.515	.529	.555	.510	.392	.373	.463	.397	.366	.433
Q31	.598	.478	.598	.694	.537	.627	.597	.477	.569	.680
Q32	.415	.536	.477	.581	.334	.342	.594	.474	.516	.498
Q33	.573	.579	.542	.621	.439	.500	.604	.505	.628	.598
Q35	.391	.570	.418	.590	.505	.451	.619	.588	.611	.604
Q36	.298	.604	.443	.461	.421	.385	.617	.432	.499	.461
Q37	.497	.578	.439	.548	.499	.451	.601	.594	.579	.575
Q38	.458	.618	.463	.603	.505	.523	.737	.552	.699	.573
Q39	.458	.613	.469	.725	.441	.614	.701	.529	.860	.613

Table 31

Polychoric Correlation Matrix Items 30 to 39

	Q30	Q31	Q32	Q33	Q35	Q36	Q37	Q38
Q30								
Q31	.657							
Q32	.792	.668						
Q33	.607	.683	.653					
Q35	.435	.539	.584	.714				
Q36	.389	.406	.541	.668	.830			
Q37	.476	.568	.485	.753	.764	.663		
Q38	.425	.510	.602	.696	.700	.759	.630	
Q39	.472	.554	.633	.598	.588	.559	.502	.799

Table 32

Polychoric Correlation Matrix for Items 41 to 44

	Q41	Q42	Q43
Q41			
Q42	.849		
Q43	.923	.899	
Q44	.846	.698	.892

Table 33

Polychoric Correlation Matrix for Items 47 to 57

	Q47	Q48	Q49	Q50	Q51	Q52	Q53	Q54	Q55	Q56
Q47										
Q48	.878									
Q49	.647	.812								
Q50	.603	.626	.528							
Q51	.483	.325	.286	.671						
Q52	.685	.586	.414	.599	.715					
Q53	.542	.643	.546	.730	.802	.671				
Q54	.546	.600	.583	.623	.518	.637	.769			
Q55	.678	.616	.560	.744	.679	.740	.739	.829		
Q56	.524	.464	.437	.536	.489	.638	.536	.634	.691	
Q57	.602	.593	.584	.738	.559	.641	.646	.745	.797	.718

Table 34

Polychoric Correlation Matrix for Items 59 to 71

	Q59	Q60	Q61	Q62	Q63	Q64	Q66	Q67	Q68	Q69
Q59										
Q60	.398									
Q61	.519	.620								
Q62	.468	.593	.550							
Q63	.180	.088	.382	.112						
Q64	.360	.323	.522	.489	.459					
Q66	.356	.420	.508	.509	.187	.310				
Q67	.308	.288	.311	.368	.317	.253	.337			
Q68	.479	.554	.772	.573	.099	.521	.470	.317		
Q69	.504	.590	.558	.493	.141	.442	.545	.280	.675	
Q71	.264	.047	.198	.202	.079	.405	.196	.168	.192	.345

Appendix G: Vita

HEATHER M. MONROE-OSSI

EDUCATION

2016	Ed.D Educational Leadership, University of North Florida
2006	M.Ed. Educational Leadership, University of North Florida
2000	B.A. Elementary Education, University of North Florida

PROFESSIONAL EXPERIENCE

2015-Present	Interim Associate Director for Program Development and Administration Florida Institute of Education at the University of North Florida
2010-2015	Curriculum & Technology Research Associate Florida Institute of Education at the University of North Florida
2008-2010	Director, UNF/FIE PreCollegiate Connections: College Reach-Out Program Florida Institute of Education at the University of North Florida
2006-2008	Applied Research Coordinator Florida Institute of Education at the University of North Florida
2000-2006	District Resource Teacher for Elementary Programs, Duval County Public Schools School-based Reading Coach, West Jacksonville Elementary Elementary Teacher, West Jacksonville Elementary

SELECTED HONORS

2013	NCGE Journal of Geography Award for *Concept Mapping Strategies: Content, Tools, and Assessment* for Best Secondary Teaching Article
2008	Recognized as Outstanding Young Alumni by the UNF Alumni Association
2003	Duval County Public Schools - West Jacksonville Elementary “Teacher of the Year”

SELECTED PUBLICATIONS AND PRESENTATIONS

Ohlson, T., Monroe-Ossi, H. & Parris, S. (2015). The secondary classroom: Improving comprehension of fictional texts. In S. Parris & K. Headley (Eds.), *Comprehension instruction: Research-based best practices* (3rd ed.). New York: Guilford.

Monroe-Ossi, H., McLemore, B., Ohlson, T., & Maki, K. (2014). iPads with a Purpose: Selecting Apps to Meet the Differing Instructional Needs of Young Children. In *World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education* (Vol. 2014, No. 1, pp. 1397-1400).

Merten, J. W., Barr, E. M. Monroe-Ossi, H., King, J. L., Griner, S. & Vosoughi, M. (2014). Asset mapping and resource guide development in partnership with Title I schools. *International Journal of Social Science, 3*(5), 66- 71.

Kerr, S., Jo, I., Collins, L., Monroe-Ossi, H., Ray, W., Whitcraft, A., Solem, M., & Stoltman, J. (2013). Teacher education and geography: Research perspectives. *Research in Geographic Education, 15*(2), 44-58

Wehry, S., Monroe-Ossi, H., Cobb, S. & Fountain, C. (2012). Concept mapping strategies: Content, tools and assessment for human geography. *Journal of Geography, 111,* 83-92.

Monroe-Ossi, H., Wehry, S., & Fountain, C. (2010). Utilizing concept mapping as an instructional tool in an afterschool setting: A study of at-risk students' conceptual development in a complementary learning environment. In J. Sánchez, A. J. Cañas, & J. D. Novak (Eds.) *Concept Maps: Making Learning Meaningful. Proceedings of the Fourth International Conference on Concept Mapping.* Viña del Mar, Chile: Universidad de Chile.

Monroe-Ossi, H., Wehry, S., Algina, J., & Hunter, J. (2008). Healthy Habits through Literacy: A concept mapping and health curriculum for preschool and prekindergarten children. In A. J. Cañas, P. Reiske, M. Åhlberg. D. Novak (Eds.) *Concept Maps: Connecting Educators. Proceedings of the Third International Conference on Concept Mapping.* Tallinn, Estonia & Helsinki, Finland: University of Finland.