DETERMINING THE IMPACT OF THE INTEGRATED TRIADIC MODEL ON TPACK DEVELOPMENT IN PRESERVICE TEACHERS

by

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ABSTRACT

This study applied the researcher-constructed Integrated Triadic Model (ITM) to an elementary social studies teaching methods course and measured the extent that preservice teachers' technological pedagogical content knowledge (TPACK) changed throughout the semester. The study also gathered preservice teachers' beliefs about the effectiveness of ITM-based course activities for developing TPACK. Participants' self-assessment and reflective writings indicated an increase in preservice teachers' understanding of the relationships between technologies, instructional strategies, and social studies content. Although performance-based data did not support similar growth, contextual limitations of the study were not conducive for accurately measuring a change in participants' enacted TPACK.

The application of the ITM created and enhanced course activities that contributed to the development of preservice teachers' TPACK. The ITM represents a new model that combines three TPACK development approaches to prepare teachers to effectively and appropriately teach with technology. The incorporation of learning activities types into the ITM augments existing models that feature learning by design and reflection. Teacher education programs can use the ITM to evaluate and re-design learning experiences in instructional technology courses, methods courses, and field placements to better prepare preservice teachers to integrate technology into teaching and learning activities. Future research should apply the ITM in both preservice and in-service preparatory experiences to engage teachers in a deeper, simultaneous consideration of technology, pedagogy, and content. Research should track teachers' development of TPACK over time using longitudal studies.

DEDICATION

I would like to dedicate this study to my family. To my wife, Ellen – thank you for joining me on this journey as I pursued this dream. You unselfishly supported our family during this adventure. Your positivity encouraged me during the arduous days of coursework and I always appreciated your laughter every time I quit my dissertation. To my daughter, Mary Peyton – the beginning of my dissertation coincided with the good news that you were joining our family. The excitement of your arrival provided a peaceful perspective as I wrote my proposal. The exceeding joy of your birth and first six months of life calmed the anxieties of implementing, writing, and defending my study. To my parents: thank you for emphasizing the value of education, teaching me the importance of helping others, and providing countless opportunities to pursue my passions, explore my interests, and learn. To my extended family and dearest friends who I consider family, thank for your support, words of encouragement, and affirmation of my call to complete this study and earn my doctorate.

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INTRODUCTION

Introduction

Adopting technology from other industries for educational purposes has traditionally brought grandiose promise and unsustainable impact. When technologies emerge, proponents of educational technology typically forecast the potential for transformational change in classrooms. Thomas Edison famously predicted in 1913 that the motion picture would eliminate a need for textbooks, alter the roles of teachers, and transform schools within ten years (Reiser, 2001). However, almost a century later, teachers continue to play an integral role in the classroom. During the 2010-2011 school year, U.S. public schools employed an estimated 1.89 million elementary and 1.34 million secondary teachers (National Education Association, 2011). The famous scientist’s hypothesis was wrong. Consequently, the motion picture, like other educational technologies, failed to produce an Edison-like change in educational practices. A historical review of technology in education reveals a recurring pattern of heightened interest and enthusiasm followed by a waning impact and minimal effect (Cuban, 1986; Saettler, 2004; Reiser, 2001). The emergence of the microcomputer in the early 1980s and the Internet in the 1990s ushered in another wave of optimism about technology’s potential impact on teaching and learning. However, several trends indicate these popular digital tools and techniques in using the devices are assuming a more permanent and profound effect on learning in schools (Collins & Halverson, 2009).

Digital Natives

First, today’s students learn differently with technology in comparison to their parents (Tapscott, 1998). When workers abandoned their farms and rushed into factories during the 19th century Industrial Revolution, a mass-schooling approach to learning replaced the agrarian and trade-based apprenticeship model (Collins & Halverson, 2009). Uniform and teacher-centric technologies such as lecture, textbooks, and drill-and-practice enabled the efficient transmission of information to learners (Collins & Halverson, 2009). In contrast, students in today’s K-12 classrooms make up a generation of learners who have grown up in technology-rich environments, immersed in digital worlds with tools such as video gaming systems, digital music players, computers, mobile communication devices, and the Internet (Prensky, 2001). These interactive and customizable technologies are often attributed to the Knowledge or Information Revolution (Collins & Halverson, 2009). The Net Generation, or whom Prensky (2001) identifies as digital natives, possesses more advanced technological skills and knowledge than previous generations of learners due to the context and environment of their formative years (Tapscott, 1998).

Oblinger and Oblinger (2005) have asserted that the current generation of learners desire immediate access to information, yearn for social connectivity with others, and tend to exhibit an experiential nature. Digital natives are active users of technologies rather than passive recipients (Tapscott, 1998), desiring the ability to control, customize, and interact with and through technology (Collins & Halverson, 2009). As a result, these learners tend to favor active learning experiences, show strong abilities in multitasking, and demonstrate reliance upon digital devices for communicating and collaborating with others (Oblinger & Oblinger, 2005).

Knowing these learning preferences, teachers can use technology to motivate students, implement unique teaching approaches, and increase productivity (Roblyer, Edwards, & Havriluk, 1997). Schacter (1999) analyzed five-large scale research studies and concluded that student access to digital technologies such as computer aided instruction and collaborative networks leads to positive gain in student achievement on benchmark assessments. Seymour Papert (1993) has suggested that the interaction between children and technology provides learning opportunities where children actively manipulate ideas and construct knowledge. Integrating digital technologies familiar to students into instructional activities creates learner-desired experiences that "bridge the gap between how they live and how they learn" (Solomon and Schrum, 2007, p.19).

Societal Demands

Next, today's students will comprise the future workforce and schools should equip students with knowledge and skills needed to succeed in future jobs. The Partnership for 21st Century Skills (2011) constructed a framework to guide educators for preparing students to work and live in the 21st century. In addition to knowledge and skills related to the core subject areas, this framework emphasizes the development of learning skills such as creativity, innovation, problem solving, critical thinking, communication and collaboration. Framework creators also incorporated the development of information, media, and technology literacy because students can use digital technologies to develop the targeted learning skills. Additionally, students will access and manage information via digital technologies in future jobs. The International Society for Technology in Education (ISTE) developed and continually refines technology standards to guide teachers, students and administrators in embedding technology so that students are both successful in their academics and prepared for the workforce (ISTE, 2011a). In 2011, the U.S.

Congress passed the Achievement Through Technology and Innovation (ATTAIN) Act that directs digital technology resources to schools to better prepare students for success in a 21st century workforce (ISTE, 2011b). These groups advocate learning environments and experiences that “match the tools and approaches of the work and civic life that students will encounter after graduation” (National Education Association, 2012, ¶1).

Transformed Learning Environments

Finally, more than ever, technology is transforming the physical environment of classrooms. Corporate partners, government agencies, and school districts are committing both financial and physical resources to equip classrooms with technology. Over a five-year period in the late 1990s, the U.S. federal government contributed more than $8 billion dollars towards equipping classrooms with technological resources (U.S. Department of Education National Center for Education Statistics, 2010). From 1995 to 2008, the number of computers in U.S. public schools used for instructional purposes tripled, with the average number of computers per school increasing from 72 to 189 (U.S. Department of Education National Center for Education Statistics, 2010). The ratio of students to instructional computers fell from 6.6 to 3.1 during that same time span. Only 8% of instructional computers could access the Internet in 1995 whereas 98% of computers were web-accessible in 2008. Schools also provided teachers with instructional technology tools such as projectors, document cameras, and interactive whiteboards, supporting an educational technology revolution and not just an Internet and computer fad. Transformed learning environments welcome learning experiences with digital technology.

Teacher Preparation

Digitally minded students, societal demands, and digitally equipped classrooms support the continual integration of technology to improve teaching and learning. However, the strategic placement of digital devices in a classroom cannot alone transform instructional practices. The implementation of a one-to-one laptop initiative will not guarantee increases in student achievement. Satisfying the digital preferences of technology-craving students does not automatically generate learning. The effective integration of technology into teaching and learning is still dependent on the teachers, who both design and implement curriculum within a classroom (Clandinin & Connelly, 1992; Koehler & Mishra, 2008). Teachers, not principals or policy makers, make daily decisions about what to teach and how to teach with an awareness of the local context only a teacher can understand (Schwab, 1983).

Within these varying and dynamic contexts, the effectiveness of technology integration depends on a teacher's ability to simultaneously consider their targeted content, teaching strategies, and available technology within the learning environment (Koehler & Mishra, 2008). Mishra and Koehler (2006) have argued that teachers with a well-developed technological pedagogical content knowledge (TPACK) make instructional decisions that reflect consideration of content, pedagogy and technology. The foundation for this type of decision-making originates with learning experiences in a teacher education program. Niess (2011) stated that the "instructional methods, lesson planning, classroom management, and even student practicum experiences needs to be re-envisioned with a recognition of the impact and influence of technologies as well as other resources" (p. 309). If teachers are to effectively integrate technology for the improvement of student learning, teacher education programs must provide opportunities for preservice teachers to develop the abilities, strategies, and awareness related to teaching with present and future technologies (Niess, 2008).

Statement of the Problem

Although some scholars trace the origins of educational technology back to school museums in the early 1900s (Reiser, 2001), it was not until the 1980s that researchers began to consider the relationship between teacher education and educational technology (Willis, Thompson, & Sadera, 1999). Up to this point, educational technologies either lost significance in classrooms (Reiser, 2001; Saettler, 2004) or became so transparent and commonplace in education that preservice teachers did not need instruction or training in using them (Bruce & Hogan, 1998; Mishra & Koehler, 2006). As availability and access to computers and the Internet increased in the 1990s, university-based teacher education programs offered little preparation for teaching in a digitally-rich classroom (Willis & Mehlinger, 1996; Schrum, 1999). A "long-standing rift between teacher education and educational technology" (Willis et al., 1999, p. 31) began to diminish after 1999 when federally funded Preparing Tomorrow's Teachers to Use Technology (PT3) grants infused more technology into teacher education and offered professional development to teacher education faculty for learning how to integrate technology into methods courses and field experiences (Mims, Polly, Shepherd, & Inan, 2006).

Consequently, initial efforts on technology integration preparation within preservice education focused on the acquisition of technical skills associated with current and emerging technologies. Teacher education programs offered competency-based courses, encouraged faculty to integrate and model technology in methods classes, or strategically placed preservice teachers in technology-rich field experiences (Schrum, 1999). Preservice teachers completed instructional technology courses that focused on the affordances and constraints of selected technologies without consideration of their pedagogical purpose (Koehler & Mishra, 2008). Course readings and skill-based projects highlighted current and emerging technologies that might or might not exist in future classrooms. This skill-based approach leads to a content neutral emphasis (Mishra & Koehler, 2006) on software and hardware with a wide application to differing subject areas and levels of education and ignores the learning environment in which teaching occurs. Furthermore, Mishra and Koehler (2006) argued that the rapidly evolving capabilities and power of these digital technologies diminish the likelihood that they too will become embedded like former educational technologies.

In methods courses, many preservice faculty do not feel they appropriately model technology in their own instructional practices even though they are possess similar technological skills as their students (Moursund & Bielefeldt, 1999; Strudler & Wetzel, 1999). Even when paired with more proficient practitioners during field experiences, the focus is about learning specific technologies under the assumption that mastered technical competencies will remain with preservice teachers once they begin teaching on their own. These traditional approaches of teaching educators how to integrate technology focus on the development of technological skills, modeling what technology can do and how teachers could use it (Mishra & Koehler, 2006). These efforts of preparing preservice teachers to integrate technology fail to consider strategies for applying technology or the suitability of tools and techniques for certain content. Furthermore, these course experiences disregard the local context in which teaching occurs.

Consequently, preservice teachers entering the teaching field feel ill-equipped to teach with technology because isolated, technology-focused learning experiences provide minimal impact on future teaching with technology (Pellegrino, Goldman, Bertenthal, & Lawless, 2007).

The course experiences and clinical assignments do not provide adequate and appropriate learning experiences that prepare teachers to simultaneously consider subject matter, pedagogy, and technology in decision making (Abbitt, 2011). The No Child Left Behind Act (NCLB) of 2001 states that training programs such as ones offered in higher education should "provide school teachers, principals, and administrators with the capacity to integrate technology effectively into curricula and instruction that are aligned with challenging state academic content and student academic achievement standards" (U.S. Department of Education, 2001, p. 2). The National Council for Accreditation of Teachers (NCATE, 2008) standards specify that teacher facilitation of student learning requires content knowledge, content-specific pedagogy, and the ability to integrate technology. Because of the emphasis of these standards, many teacher education programs now strive to equip preservice teachers with knowledge that weaves subject-matter, instructional methods, and technology, a form of knowledge referred to as technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2006). Abbitt (2011) insists that we must continually develop and evaluate teacher preparation models that best develop TPACK in preservice teachers and identify experiences that lead to the development of TPACK.

Mishra and Koehler (2006) believe that the development of TPACK in preservice teachers needs to be a "critical goal" (p. 1046) of teacher education programs. Various approaches to developing TPACK such as learning technology by design (Koehler & Mishra, 2005) and learning activity types (Harris & Hofer, 2009) exist, but more are needed to better understand how preservice teachers develop TPACK (Niess, 2011). Most often, teacher educators and researchers apply single approaches in stand-alone instructional technology courses. Methods courses establish a foundation for teaching and learning and offer the most conducive environments for developing TPACK in preservice teachers (Niess, 2008). An enhanced methods course that incorporates a combination of effective TPACK approaches can possibly provide opportunities for preservice teachers to learn, design, and implement instructional and classroom management strategies with technology in a local, content-specific environment (Niess, 2008). A model that incorporates multiple approaches and measurement instruments is needed.

Theoretical Framework

Teaching is a complex, decision-making activity in which teachers construct, revise, and implement teaching and learning activities in a dynamic environment (Leinhardt & Greeno, 1986). Decisions about student behavior, subject-matter, lesson development, and instructional techniques depend upon “highly complex bodies of knowledge and skill” (Shulman, 1987, p.4). With the push to integrate technology into teacher instruction and student learning, teachers must consider another body of knowledge: technology knowledge (Koehler & Mishra, 2008). Technology knowledge includes understanding the capabilities and limitations of both analog (e.g. chalkboard, pencil, and hammer) and digital (computer, camera, interactive whiteboard) devices as well as knowing how to use or operate the tools (Koehler & Mishra, 2008). However, teachers should not treat technology knowledge as isolated and separate from their instructional strategies and subject matter. As a result, Koehler & Mishra (2008) argue teachers need an integrated body of knowledge, technological pedagogical content knowledge (TPACK), to effectively teach with technology.

Building upon Shulman’s concept of pedagogical content knowledge (PCK), Mishra and Koehler (2006) argue that a well-developed TPACK enables teachers to plan, design, and implement lessons that effectively incorporate technology. Rittel and Weber (1973) described the planning completed by governing systems as wicked because of the ill-defined problems and varied, unique solutions that exist for the problems. Koehler and Mishra (2008) applied this wicked concept of planning to assert that "teaching with technology is a highly complicated form of problem-seeking and problem-solving that derives from flexible and integrated bases of knowledge" (p. 3): content knowledge (CK), pedagogical knowledge (PK), and technology knowledge (TK). Content knowledge is the facts, concepts, theories, and processes of a given subject matter as well as understanding related to the nature of knowledge within that field (Mishra & Koehler, 2006). Pedagogical knowledge is knowledge about the practices and techniques of many aspects of teaching and learning including but not limited to classroom management, lesson development, and student evaluation (Mishra & Koehler, 2006).

However, quality teaching with technology does not simply rest on the development and application of each of three forms of knowledge in isolation. Instead, teachers must simultaneously draw on the three domains while considering the local context in which teaching occurs (see Figure 1).

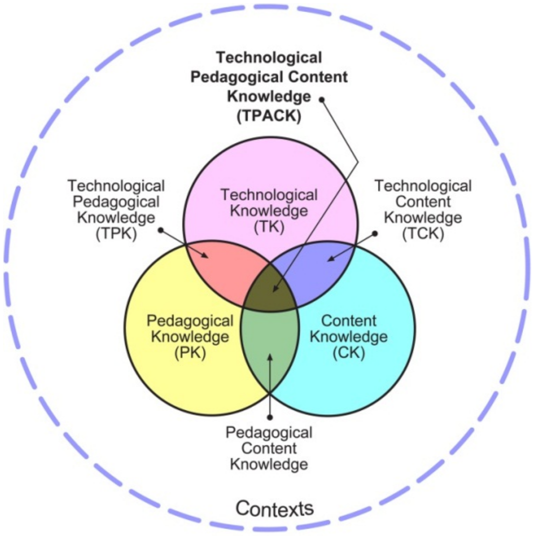

Figure 1. Knowledge domains of the Mishra and Koehler's (2006) TPACK framework. Reprinted with permission from http://tpack.org/.

Consequently, Mishra and Koehler (2006) also argued that four additional forms of knowledge emerge as content, pedagogical, and technological knowledge converge: 1) pedagogical content knowledge (PCK); 2) technological content knowledge (TCK); 3) technological pedagogical knowledge (TPK); and 4) technological pedagogical content knowledge (TPCK). Over time, researchers changed the consonant-heavy TPCK acronym to TPACK for ease of use and to emphasize the integration of technology, pedagogy, and content as one, inter-related PACKage (Thompson & Mishra, 2008). Pedagogical content knowledge (PCK) is the selection and application of appropriate teaching practices that fit a designated content to maximize student learning (Mishra & Koehler, 2006). Technological content knowledge (TCK) represents an understanding of how a specific content area can be changed through the application of technology (Mishra & Koehler, 2006). For example, a middle school social studies teacher exhibits this knowledge when considering Google Maps as a tool for teaching geography. Technological pedagogical knowledge (TPK) represents an awareness of the existence and capabilities of technologies for use in teaching or learning activities (Mishra & Koehler, 2006). In other words, TPK is an understanding of how teaching might change because of technology. The middle section in Figure 1 represents technological pedagogical content knowledge (TPACK), which Mishra and Koehler (2006) describe as

> the basis for 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 help redress some of the problems that students face; knowledge of students’ prior knowledge and theories if epistemology (p. 1029).

Solutions to the aforementioned instructional problems “lie in the ability of a teacher to flexibly navigate the space defined by the three elements of content, pedagogy, and technology and the complex interactions among these elements in specific contexts” (Koehler & Mishra, 2008, p. 18). A well-developed TPACK allows teachers to design solutions to their unique instructional problems with “appropriate, context-specific strategies and representations” (Mishra & Koehler, 2006, p. 1029).

The TPACK theoretical framework provides a lens for evaluating the effectiveness of approaches to developing teacher knowledge. Researchers apply the framework to critique approaches within teacher education programs that focus on developing technologically-proficient teachers. Under this framework, researchers and teacher educators develop and implement approaches where preservice teachers “explore technologies in relationship to subject matter in authentic contexts” (Mishra & Koehler, 2006, p. 1045).

Initial efforts aiming to develop TPACK in teachers employed a learning technology by design model, where preservice teachers encounter an authentic problem and design a technological solution of their choice (Koehler & Mishra, 2005). Whether conducted in workshop or course format, “emphasis is placed on learning by doing, and less so on overt lecturing and traditional teaching” (Mishra & Koehler, 2006, p. 1035). Other approaches emerged using learning activity types, instructional modeling, and self-assessment (Niess, 2011), yet few studies have combined TPACK-supported approaches to enhance existing methods courses in a teacher education program.

Purpose of the Research

The purpose of this mixed methods study was to measure the impact of the researcher-constructed Integrated Triadic Model (ITM) on the development of technological pedagogical content knowledge (TPACK) among a group of preservice teachers and to better understand which course experiences they believe contribute to their development of TPACK. Through the application of the ITM to a content-specific methods course, the researcher enhanced both weekly class meetings and a unit plan project using three emerging approaches to developing TPACK: learning activity types, learning by design, and reflection. The study utilized multiple instruments to determine the extent, if any, that preservice teachers' TPACK changed while enrolled in a methods course enhanced by the ITM. The study also explored preservice teachers' beliefs about the effectiveness of course experiences for developing their TPACK.

Significance of the Research

This study proposed and evaluated a model for enhancing technology preparation in a content-specific methods course. Initial approaches to studying TPACK development focused on interventions in stand-alone instructional technology courses. Other studies measured TPACK development in preservice teachers concurrently enrolled in both a technology and methods course. However, few studies have examined TPACK through an enhanced methods course that uses multiple approaches to both develop and measure the perceived knowledge and demonstrated ability (Abbitt, 2011) of preservice teachers. This study evaluated an integrated approach that combines TPACK-supported approaches and applies them in a content-specific methods course.

Furthermore, research using the learning activity types approach is lacking. While numerous publications summarize learning activity types and explain their usefulness for planning curriculum, few studies have evaluated the approach for developing TPACK in preservice teachers. The creators of the taxonomies framed a professional development experience for secondary teachers (Harris & Hofer, 2011), but no similar studies have been conducted at the preservice level. Harris and Hofer (2011) stated the need to vet the activity types through empirical-based studies and have developed rubric instruments (e.g., Technology

Integration Assessment Rubric, Technology Integration Observation Rubric) that identify evidence of TPACK in lesson plans and teacher instruction.

Research Questions

The overarching research question for this study: How did the researcher-constructed Integrated Triadic Model (ITM) impact the development of TPACK in preservice teachers when applied to a content-specific teaching methods course for preservice teachers in elementary education? Subquestions include the following:

1. To what extent did preservice teachers' TPACK change while enrolled in a content-specific teaching methods course enhanced by the application of the Integrated Triadic Model; and
2. Which course experiences did preservice teachers believe contributed to their development of TPACK?

Assumptions of the Study

This study incorporated the following assumptions:

1. Teachers with a well-developed technological pedagogical content knowledge (TPACK) can design and implement instructional activities that effectively and appropriately incorporate technology;
2. Learning experiences in teacher education methods courses are foundational for future teaching;
3. Teacher educators can develop TPACK through learning experiences in a teacher education program;

4. TPACK approaches such as learning by design, learning activity types, and reflection can increase teachers' understanding of technology, pedagogy, content, as well as the relationships between these three forms of knowledge; and
5. Researchers can identify and measure the development of TPACK by collecting and analyzing self-perceptions and performance artifacts.

Definition of Terms

Content – the actual subject matter taught by teachers or learned by students (Mishra & Koehler, 2006, p. 1025).

Digital technology – tools, techniques, and knowledge that utilize computer hardware, software, and/or infrastructure for application (Koehler & Mishra, 2008).

Educational technology – creating, using, and managing appropriate technological processes and resources to generate solutions to teaching and learning problems (Saettler, 2004).

In-service teacher – person currently serving as a classroom teacher in a K-12 school.

Instructional episode – period of time in which a teacher implements a plan of instruction (Hofer, Grandgenett, Harris, & Swann, 2011).

Learning – student's physical and/or cognitive activities leading and reflecting the acquisition of a targeting learning goal.

Lesson plan – a documented description of targeted learning goals and methods by which students will attain the goals for a specified period of time.

Pedagogy – the processes and practice or methods of teaching and learning (Mishra & Koehler, 2006, p. 1025).

Preservice teacher – person enrolled in a university-based, undergraduate teacher education program.

Student – person enrolled in K through 12th grade of a school.

Teaching - any deliberate arrangement of events by the teacher to facilitate a learner's acquisition of a targeted learning goal (Driscoll, 2000, p. 25).

Technology – a tool and/or an applied technique that facilitates solutions to problems (Finn, 1960; Gentry 2011).

Chapter Summary

This dissertation study determined the impact of the Integrated Triadic Model (ITM) on the development of TPACK in preservice teachers. This chapter stated the problem, overviewed the theoretical framework, specified the purpose and significance of the research, stated research questions, and delineated assumptions and terminology for this study. Chapter II reviews literature pertinent to TPACK research to help identify how researchers have approached TPACK development and how researchers have attempted to measure TPACK. Chapter III describes the instruments and research methods for the study. Chapter IV presents the results of data collection and analysis. Chapter V states the conclusions, summarizes limitations of the study, provides implications for practice and research, and offers recommendations for future research.

CHAPTER II:

LITERATURE REVIEW

Introduction

Professional development initiatives and teacher education programs incorporate various strategies into learning experiences to build knowledge and skills needed to integrate technology into teaching and learning. Initial efforts focused on developing technical proficiency in technology courses, modeling technology integration in methods courses, or placing preservice teachers in technology-rich field experiences (Schrum, 1999). As emphasis shifts to building technological pedagogical content knowledge (TPACK) in teachers, teacher educators are challenged to find alternate approaches and models that fit the varied and dynamic contexts of teacher education. Mishra and Koehler (2006) believe the TPACK framework can serve as a critical lens for evaluating how teachers develop the knowledge needed to effectively and appropriately teach with technology. Using the TPACK theoretical framework as a guide, researchers and teacher educators create learning experiences that build teachers' knowledge of technology, pedagogy, content, and relationships between these three forms of knowledge (Mishra & Koehler, 2006). Activities should require teachers to simultaneously consider content, pedagogy, and technology when making instructional decisions (Mishra & Koehler, 2006). This literature review will describe formats in which researchers have applied TPACK approaches. A summary of TPACK approaches will include emphasis on the three approaches used in construction of the Integrated Triadic Model and applied in this study. The review will enumerate the methods and instruments used to measure and track TPACK.

TPACK Formats

The TPACK framework provides a guide for designing learning environments in which teachers learn about technology in authentic contexts where they consider both what they teach and how they teach it (Mishra and Koehler, 2006). These learning environments typically involve either preservice or in-service teachers. Teacher educators have created learning experiences for preservice teachers through courses and field experiences in order to build a solid TPACK foundation (Niess, 2008). Harris (2008) noted the need to continually develop TPACK in experienced, in-service teachers to ensure extensive and effective technology integration.

TPACK Development for In-service Teachers

Graduate-level courses offer opportunities for in-service teachers to extend their current practices by engaging in TPACK-focused learning activities. These opportunities often occur within an instructional technology course or through a series of related technology courses. Shin, Koehler, Mishra, Schmidt, Baran, and Thompson (2009) evaluated TPACK growth of in-service teachers enrolled in a master’s level, summer seminar course that focused on integrating technology into teaching. Koehler, Mishra, Bouck, DeSchryver, Kereluik, Shin, and Wolf (2011) incorporated scaffolded design projects throughout all technology courses in a master’s program. Micro and macro design tasks required students to consider the relationship between content, pedagogy, and technology. Niess and Gillow-Wiles (2010) infused TPACK-building experiences within every course of a master’s program for teaching mathematics and science. Few studies revealed the incorporation into content-specific, graduate-level courses. Elementary teachers enrolled in a graduate mathematics concepts class designed instructional units and shared their plans with classmates (Bos, 2011), but never implemented the designs in an actual classroom.

Outside of university-based teacher education programs, in-service teachers often participate in professional development initiatives. Trainers facilitate these efforts through workshops, collaborative learning groups, or a combination of both approaches. Jimoyiannis (2010) employed a hybrid approached by providing instruction in workshop courses before participants individually worked through learning modules on their own. Participants completed 350 hours of learning activities over a period of four months during an academic semester. The course and learning modules focused on the application of technology to enhance science education. Guzey and Roehrig (2009) implemented a yearlong professional development program where secondary science teachers received instruction during a two-week summer course before designing and implementing technology-enhanced lessons during the school year. The participating teachers interacted with university researchers and other colleagues throughout the year to discuss the effectiveness of implemented lessons.

Similarly, Polly (2011) provided a five-day technology workshop for a group of teachers and then collaboratively constructed a curriculum map with participating teachers over the following months. Using a wiki, the teachers collectively gathered and posted instructional resources related to the targeted standards identified in the curriculum map. Wright, Wilson, Gordon, and Stallworth (2002) organized a professional learning group of preservice teachers, in-service teachers, and university teacher educators. During meetings, members of the group discussed technology-related teaching strategies within focused content areas. In subsequent meetings, members shared their implementation experiences and offered additional recommendations for teaching with technology. Using an apprenticeship model, Shafer (2008) paired a novice teacher with an experienced TPACK teacher that modeled technology lessons and demonstrated TPACK decision-making.

TPACK Development for Preservice Teachers

Researchers and teacher educators develop TPACK in preservice teachers through undergraduate courses within a teacher education program. Longitudinal studies track preservice teachers throughout an entire program, from enrollment to the completion of their student teaching practicum (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009; Schmidt, Seymour, Sahin, & Thompson, 2008). Approaches to developing TPACK typically fall within the context of an instructional technology course, teaching methods courses, or field placements during a practicum.

Some teacher education programs require preservice teachers to take a stand-alone instructional technology course (Chai, Koh, & Tsai, 2010; Ozogul, Olina, & Sullivan, 2008) as means to developing TPACK. Graham, Cox, and Velasquez (2009) offered separate technology integration courses for secondary and elementary preservice teachers using different TPACK approaches in each course. Graham, Borup, and Smith (2012) also developed an introductory educational technology course tailored for TPACK development among early childhood and elementary preservice teachers. Instead of a single course, Lu, Johnson, Tolley, Gilliard-Cook, and Lei (2011) created a series of one-hour technology integration courses that scaffolded learning experiences across three courses. The first course focused on the development of basic technology skills while the second and third targeted technology integration within specific content areas. Some teacher educator program incorporate a mixture of methods and technology courses (Niess, 2005), with some requiring preservice teachers to complete subject-specific methods course while dually enrolled in an instructional technology course (Graham, Cox, & Velasquez, 2009). However, most instructional technology courses focus on highlighting the existence and capabilities of specific technologies without exploring their usefulness for teaching or representing a certain type of content.

Methods courses within a teacher education program provide a foundation for teaching and learning as well as offer opportunities to apply this knowledge in actual classroom during field experiences. As preservice teachers learn methods and strategies considerate of students' background and prior knowledge, Niess (2008) has argued that methods courses provide the best environment for engaging preservice teachers in a TPACK way of thinking because such courses build a foundational knowledge about teaching and learning. While many methods courses incorporate technology into some course activities, few adopt a TPACK-supported approach to frame the course. Ozgun-Koca, Meagher, and Edwards (2009) enhanced a secondary mathematics methods course by requiring preservice teachers to design and implement technology-enriched lessons during student teaching. Participant's thinking about the role of technology shifted from reinforcement to a valuable tool for developing student understanding. Jaipal and Figg (2010) focused on the development of TPACK during the student teaching process. Hechter and Phyfe (2010) incorporated technology-based activities into their lessons in a middle years science methods course that targeted preservice teacher thinking towards a simultaneous consideration of content, pedagogy, and technology. Jang and Chen (2010) applied a transformative TPACK model to redesign a typical science methods course which introduced the TPACK framework, provided opportunities for observation of TPACK teaching, and required teachers to apply designed lessons in actual classrooms. Koh and Divaharan (2011) developed a similar model that focused on the processes through which preservice teachers develop TPACK. These studies mark initial efforts to apply a model to completely enhance an entire methods course. However, neither model incorporated or emphasized learning activity types. This study focused on the development of TPACK within a content-specific methods course through the design and application of an additional model that incorporates three approaches to developing TPACK.

TPACK Approaches

TPACK approaches refer the techniques and strategies employed to increase teachers' understandings of the technology, pedagogy, content, as well as the relationships between these three. Each TPACK approach attempts to create experiences where participants begin to think simultaneously about technology, content, and pedagogy when making instructional decisions. Some research attempts to infuse TPACK learning experiences into existing teacher education practices. Rudimentary strategies use lecture, class discussion, or exploratory activities in which preservice teachers learn about the TPACK framework and receive an orientation to the seven interrelated constructs (Koh & Divaharan 2011; Jang & Chen, 2010). Other approaches focus on more experiential experiences. For example, Wang (2000) asserted that preservice teachers will incorporate technology into their teaching practices after observing models of effective teaching with technology. The incorporation of technology-rich learning activities (Brush & Saye, 2009) and pedagogical modeling (Koh & Divaharan, 2011) in methods course provide examples to preservice teachers of effective teaching with technology. Cavin (2008) implemented a microteaching lesson study experiment in an introductory instructional technology course to grow preservice teachers' TPACK. Teacher educators can also enhance practicum experiences by strategically pairing preservice teachers with experienced TPACK teachers for observing (Jang & Cheng, 2010) and teaching (Brush & Saye, 2009).

Other approaches reach beyond the normal scope of a traditional teacher education program. Professional group and learning community approaches encourage colleagues to share instructional decisions that reflect their simultaneous consideration of technology, pedagogy, and content. A group of K-8 educators in a masters level advanced teaching strategies course discussed, debated, and challenged technological strategies that were incorporated into teaching and learning activities in their math and science classrooms (Niess & Gillow-Wiles, 2010). Similarly, a community of in-service teachers conducted face-to-face meetings and online discussions to discuss barriers faced when integrating technological strategies learned during a summer workshop (Guzey & Roehrig, 2009). The study focused on reforming science instruction through the integration of science-related tools. Instead of online discussions, Polly (2011) facilitated the collaborative construction of a curriculum map by in-service teachers following a summer technology camp. The in-service teachers collectively developed a wiki of related instructional resources after completing the curriculum map. The collaborative portion of this project lasted throughout the school year. Wright, Wilson, Gordon, and Stallworth (2002) combined the aforementioned partnering approach with modeling when creating a professional learning group consisting of preservice teachers, in-service teachers, and university faculty. Partners met to share content-specific, effective teaching practices that incorporated technology and members were encouraged implement strategies as fitting for their classroom and share their experiences during subsequent meetings. Apprenticeship approaches rely on a mentor teacher to model TPACK decision making for observing novice teachers (Shafer, 2008). While multiple strategies exist for both preservice and in-service teachers, TPACK researchers have advocated three approaches for designing TPACK-rich learning experiences: learning by design, learning activity types, and reflection.

Learning by Design

Dissatisfied with isolated technology workshops that focus on skill acquisition, Koehler and Mishra (2005) offered *learning by design* as an approach for developing TPACK. Given an authentic instructional problem within a specific subject matter, participants design a solution to a problem using technology. Instructors provide real-world, ill-structured problems that allow multiple solutions for participants to develop and evaluate (Koehler & Mishra, 2005). The product of this approach is a technological artifact sensitive to both subject matter and instructional goals (Mishra & Koehler, 2006). Through these design experiences, participants gain a deeper understanding of the interwoven complexities of subject matter, instructional strategies, and technology. As Koehler and Mishra (2005) noted, the learning by design approach presents opportunities for participants to “explore the ill-structured domain of educational technology and develop flexible ways of thinking about technology, design, and learning, and thus develop technological pedagogical content knowledge” (p. 99). Instead of teaching digital video production separately from concepts related to educational psychology and educational technology, Koehler and Mishra (2005) challenged students to create idea-based videos about three topics. The instructors did not specify which tools to use or how to structure or create the video. Project facilitators simply provided topics, a type of technology, and stated that the final product needed to communicate an understanding of the related concepts. When the projects were finished, the instructors commented that participants in the design activity “learned a lot about how to focus a message down to just two minutes of video, how to let images and symbolism convey ideas in an effective manner, how to inspire audiences, work together in groups, give and receive feedback, and communicate with audiences” (Koehler & Mishra, 2005,

p. 97). In this design project, participants developed technological knowledge in a specific content and in relation to a specific subject and pedagogy.

The learning by design approach has been implemented to help teachers begin thinking about the connections between technology, pedagogy, and content. Bos (2011) challenged groups of graduate students to design a mathematics unit that incorporated a website with mathematical and pedagogical fidelity to trigger their consideration of the three knowledge domains. After initial frustrations finding appropriate websites, justifications for chosen sites revealed a TPACK way of thinking, or a simultaneous consideration of content, pedagogy, and technology. Lu, Johnson, Tolley, Gilliard-Cook, and Lei (2011) applied the learning by design approach to scaffold design projects over the span of three preservice technology integration courses. In the first course, preservice teachers constructed a step-by-step resource manual for *Microsoft Excel* that a fifth grade student could use. In following courses, preservice teachers engaged in additional design activities such as creating a grade book.

Graham, Cox, and Velasquez (2009) similarly scaffolded a design process in a technology integration course, requiring elementary preservice teachers to design a digital story to teach specific literacy standards. Koehler, Mishra, Bouck, DeSchryver, Kereluik, and Shin (2011) recommended design projects such as the development of instructional websites or the collaborative authoring of book chapters to help teachers engage boundaries that exist between content, pedagogy, and technology.

Most often, the learning by design approach is utilized to structure experiences in which preservice teachers design and implement lesson plans or instructional units (Guzey & Roehrig, 2009; Ozgun-Koca, Meagher, & Edwards, 2009; Jang & Chen, 2010; Ozogul, Olina, & Sullivan, 2008; Niess, 2005). Sometimes, the design experiences are targeted towards specific technologies. Koh and Divaharan (2011) required preservice teachers to design a lesson that incorporated the interactive whiteboard. Within this context, participants explored the relationships between the focused content and instructional strategies in relation to the specific tool. A lack of opportunities for implementation of designed lessons is a limitation often cited by researchers. When incorporated into technology integration courses, preservice teachers often lack a field placement in which to conduct the lesson because these courses are often completed during semesters in which a field experience is not required. Many preservice teachers take instructional technology courses prior to admission into a teacher education program. Graham, Borup, and Smith (2012) provided core curriculum standards in three different subject areas to preservice teachers and asked them whom they might teach with technology. Graham, Cox, and Velasquez (2009) also noted a lack of application as a weakness to the learning by design approach, noting that the participants in their study “do not seem to be able to transfer the technology integration ideas they are learning to contexts that are very different from the very specific ones involved in the challenges” (p. 4084).

Learning Activity Types

The use of learning activity types has emerged as an additional approach for developing TPACK in teachers that “foregrounds pedagogical content knowledge as it shapes and is shaped by the particular affordances and constraints of using different digital and non-digital educational technologies” (Harris, Mishra, & Koehler, 2009, p. 403). Harris and Hofer (2009) believe that professional development should equip teachers with planning tools for designing instruction - learning activity types that guide teachers to build lessons that incorporate their subject-matter, preferred pedagogical acts, and technology. Instead of seeking to transform learning experiences for teachers, this approach seeks to enhance the instructional planning process (Hofer & Harris, 2010). Therefore, the primary design of learning activity types was to "assist teachers in connecting curriculum-based learning goals with content area-specific learning activities and complementary technology tools" (Hofer & Harris, 2010, p. 3858). However, Harris and Hofer (2009) assert that the use of learning activity types as building blocks for lessons is not an innovative concept:

> Activity-based instructional planning strategies are not new. Aligning learning activities with compatible educational technologies, and developing comprehensive, curriculum-keyed taxonomies of activity types that incorporate content, pedagogy, and technology knowledge, along with all their intersections, is the unique contributions of this TPACK development method. (p. 108)

Researchers generated taxonomies of learning activity types for mathematics, K-6 literacy, social studies, secondary English language arts, and world languages (Harris, Hofer, Schmidt, Blanchard, Young, Grandgenett, & Olphen, 2010) and current research is focused on developing similar taxonomies for physical education and visual arts. "Sequence Information" is an example of a learning activity type from the Social Studies taxonomy (see Appendix E). Hofer and Harris (2010) have suggested that teachers can use individual or combinations of learning activity types to construct lesson and unit plans of instruction. When selecting items for the taxonomy that match their target content, teachers evaluate technological options as depicted in the taxonomy. Therefore, learning activity types require teachers to think about content, pedagogy, and technology as they make decisions while planning a learning event (Harris & Hofer, 2009).

Since in-service teachers typically possess more advanced content and pedagogical knowledge than preservice teachers, the application of the learning activity types approach into learning experiences differs for preservice and in-service teachers (Hofer & Harris, 2010). First, with a robust knowledge of content and pedagogy, in-service teachers practice combining specific concepts and general teaching activities with forms of technology to evaluate if and how they fit together (Hofer & Harris, 2010). Next, teachers select and examine the various taxonomies for the content areas in which they teach. Finally, teachers utilize the learning activity types to review existing lesson plans or design new units of instruction.

Hofer and Harris (2010) have asserted that preservice teachers require more scaffolding with a learning activity types approach because they often lack an understanding of how to construct lesson plans. Therefore, preservice teachers must first understand that lessons consist of varying and often combined learning activities. Once teachers understand how learning activity types comprise a lesson plan, Hofer and Harris (2010) have recommended that teachers review existing lesson plans to identify learning activities and evaluate their appropriateness for the targeted content. With a sound understanding that activity types comprise lessons, teachers are introduced to the learning activity type taxonomies and design lesson plans by selecting activities from the list.

Literature reveals very few studies in which teacher educators have applied the learning activities approach when designing TPACK development experiences for teachers. Hofer and Harris (2010) introduced the taxonomies to preservice teachers dually enrolled in an educational technology course and content-specific methods course. However, introduction and application of the activity types was facilitated in the educational technology course rather than the methods course. Graham, Cox, and Velasquez (2009) assigned students to develop their own taxonomies of learning activity types and expand the lists with technology suggestions for each activity. Although the activity was valuable, researchers recommended giving preservice teachers the already completed taxonomies and challenge them to generate additional items and technologies. Harris and Hofer (2011) measured how TPACK changed in seven secondary teachers who completed a professional development initiative based on the use of learning activity type taxonomies for instructional planning. Data revealed that the in-service teachers believed that instruction could be enhanced and student learning improved by the planning of instruction with learning activity types and their accompanying technological options. However, no known studies have measured preservice teachers' change in TPACK while using learning activity types to build lessons in their teacher education programs.

Reflection

Schon (1983) argued that professional knowledge based on the technical rationality model proves inadequate in divergent situations marked by uncertainty and instability. The mere application of scientific explanations and empirically-supported techniques incompletely solves problems existing in dynamic and varying contexts (Schon, 1983). Instead, Schon asserted that practitioners typically think while performing, a "reflection in action which is central to the art by which practitioners sometimes deal with situations of uncertainty, instability, uniqueness, and value conflict" (p. 50). Reflection-in-action brings forth deeper understandings of situations and initiates changes upon existing conditions of knowledge (Schon, 1983), a practice essential as teachers construct knowledge about teaching in similar, unstable situations. Leinhardt and Greeno (1986) have asserted that teaching is a cognitively complex skill applied in ill-structured environments where unknown changes and problems beyond the teachers' control arise. Clark and Lampert (1986) contend that teachers are confronted by "interrelated and competing situations both while planning and during teaching" (p. 28) where technical solutions are unsuitable and insufficient. Development of knowledge for handling these issues originates not from teacher educators but from the actual teachers. Teachers develop knowledge-of-practice (Cochran-Smith & Lytle, 1999) through reflection about their own pedagogical practices.

Reflection produces a situated knowledge that allows teachers "to begin to think about their teaching in fully integrated ways with regards to TPACK" (Koehler, Mishra, Bouck, DeSchryver, Kereluik, & Shin, 2011, p. 157). When describing the TPACK development in K-6 literacy teachers, Schmidt and Gurbo (2008) insist that "preparation and professional development experiences for teachers must include opportunities for them to observe, participate, and reflect upon what they will teach, how they will teach it, and how technology might be used to enhance and expand K-6 literacy in their classrooms" (p. 80). Teachers develop TPACK through reflective activities. Niess (2008) argued that reflection is a necessary component for developing TPACK:

> Throughout all the experiences identified for methods courses, an essential experience in guiding preservice teachers' development of TPCK through planning and problem solving around designing instruction is to have them monitor their progress in their development of the knowledge, skills, and dispositions of TPCK. A reflective expectation with each experience is essential for the development of TPCK. (p. 249)

When preservice teachers reflect upon their consideration of technology, pedagogy, and content while designing lessons, they reflect in action (Schon, 1983) to develop knowledge-of-practice (Cochran-Smith & Lytle, 1999). Reflection is necessary for developing an integrated and context-sensitive form of knowledge like TPACK because reflection allows teachers to monitor their development and build their knowledge of teaching with technology (Niess, 2008).

Literature reveals a ubiquitous inclusion of reflection as an approach to developing TPACK. Teacher educators gather reflections throughout course activities, during lesson design (Jang & Chen, 2010; Niess, 2005) or through an end-of-course reflective activity (Koh & Divaharan, 2011). In a study conducted with in-service teachers, Madeira (2010) found that "teachers who participated more deeply in the scaffolded reflections were able to understand how their lesson plans and enactment patterns fostered student understanding of relevant science concepts" (p. ii). Graham, Borup, and Smith (2012) studied teachers' decision-making while designing lessons, asking teachers to reflect on their rationales for including technology in their lesson plans. Results indicated an increase in TPACK-related rationales for including technology. Cavin (2008) gathered reflections from preservice teachers during a microteaching lesson study where results indicated a shift in TPACK towards a deeper understanding of how technological tools are combined with specific teaching strategies. Jang and Chen (2010) required preservice teachers to videotape an implemented lesson and reflect on their instructional practices with technology while viewing the video.

Teacher reflections organized in professional portfolios about implemented instructional strategies revealed teachers' interwoven consideration of content, pedagogy, and technology (Niess & Gillow-Wiles, 2010). Guzey and Roehrig (2009) recommend action research and reflective blogs as tools for teachers to analyze their teaching experiences and modify practices to effectively teach with technology. When reflection is combined with design experiences, reflection allows preservice teachers to visualize all possible solutions not involved in the design experiment (Koehler et al., 2011). In another study, a science methods instructor modeled TPACK teaching while preservice teachers reflected on what they learned about teaching (Hechter & Phyfe, 2010). Analysis revealed an awareness of the three components of the TPACK framework, an initial building block to understanding the interplay among the components.

Measuring TPACK

As researchers develop and implement approaches to developing TPACK, they are simultaneously faced with the challenge of measuring the presence and growth of TPACK in teachers. Researchers encounter issues of reliability, validity, and efficiency when designing instruments to identify TPACK (Abbitt, 2011). Initial efforts focused on the development and use of self-report surveys in which teacher assessed their own understanding of the connections between technology, pedagogy, and content. Researchers quickly realized the need for additional instruments to measure performance artifacts such as lesson plans, implemented lessons, and reflective writings.

Self-Perception Surveys

Prior to the development of TPACK-focused surveys, most instruments measured a teacher's proficiency with technology, perceived levels of integration, or opinions of technology professional development (Schmidt, Bara, Thompson, Mishra, Koehler, & Shin, 2009). As a result, researchers began developing instruments in which teachers report their perceived understanding of the seven components of the TPACK framework. Koehler and Mishra (2005) designed an initial instrument that measured growth in the components as well as student perceptions about learning processes. However, this instrument was tailored to a specific course and not generalizable to other TPACK approaches (Schmidt et al., 2009). As a result, other self-perception surveys measuring TPACK components emerged. Archambault and Crippen's (2009) survey measured TPACK among a large group of K-12 online teachers. Schmidt et al. (2009) developed the *Survey of Preservice Teachers' Knowledge of Teaching and Technology* to measure TPACK in K-6 educators. Many researchers utilize this instrument today to measure and track TPACK in teachers enrolled in a single course or while completing coursework and field experiences in a teacher education program (Lu, Johnson, Tolley, Gillard-Cook, & Lei, 2011; Koehler, Mishra, Bouck, DeSchryver, Kereluik, & Shin, 2011).

As studies proved the *Survey of Preservice Teachers' Knowledge of Teaching and Technology* (Schmidt et al., 2009) possessed strong validity and reliability, researchers began administering adapted versions to suit the context of their studies. Chai, Koh, and Tsai (2010) replaced the four content areas (math, literacy, science, social studies) of the original survey with the teaching fields of the Singapore preservice teachers in their study. Graham, Cox, and Velasquez (2009) attempted to create their own self-report questionnaire that similarly measured the seven TPACK constructs. However, analysis indicated that survey items did not load on the TPACK constructs. In other words, survey items did not validly assess teachers' understanding of the seven constructs of the TPACK framework.

Other researchers have developed original alternatives that focus on constructs other than those directly specified in the TPACK framework. Guzey and Roehrig (2009) used open-ended items on multiple surveys to collect information about levels of technology skill, perceptions about course experiences, and how technology was used during instruction. Ozgun-Koca, Meagher, and Edwards (2009) combined similar open-ended questions with a mathematics technology attitudes survey. Niess and Gillow-Wiles (2010) administered a TPACK self-efficacy survey that measured a teacher's belief about their ability to integrate technology with their teaching. In light of these adaptations and alternatives, Abbitt (2011) contends that the *Survey of Preservice Teachers' Knowledge of Teaching and Technology* (Schmidt et al., 2009) presents the most reliable and valid self-report survey, but recommends further refinement and triangulation with other reporting instruments and performance-based measures.

Performance Measures

Researchers can measure a teacher's knowledge in the TPACK domains by analyzing products generated by teachers (Abbitt, 2011). Performance artifacts (lesson plans) and observed behavior (instructional episodes) "provide ways for assessors to discern the dimensions and extent of teachers' TPACK in systematic, reliable, and valid ways" (Harris, Grandgenett, &

Hofer, 2010, p. 2). The Technology Integration Assessment Rubric (Harris et al., 2010) evaluates the presence of TPACK thinking as reflected in the instructional that teachers make when designing a lesson plan. No studies were located where the instrument was used other than in the development and testing in which validity and reliability were established. Other studies have analyzed TPACK thinking in lesson plans without specific instruments. For example, Ozgun-Koca, Meagher, and Edwards (2009) analyzed activity write-ups using analytic coding to identify how technology was implemented. Ozogul, Olina, and Sullivan (2008) used a self-developed rubric to evaluate lesson plans. Only one section of the rubric evaluated the inclusion of technology and TPACK was not a focus of this section.

According to Hofer, Grandgenett, Harris, and Swan (2011), teachers demonstrated evidence of TPACK while teaching. Multiple methods have been utilized to capture and identify this evidence. In-service teachers enrolled in a graduate program videotaped themselves teaching and then collectively analyzed the videos within a community of other teachers (Niess & Gillow-Wiles, 2010). The creation of a portfolio and interaction with a community of learners provided a "valid and reliable avenue for teachers to illustrate their understanding of the interplay among technology, pedagogy, and content" (Niess & Gillow-Wiles, 2010, p. 3911). Student teachers in a math and science course videotaped specific lessons and reflected on the experiences (Niess, 2005). Jaipal and Figg (2010) recorded audio of preservice teachers' discussions with mentor teachers and wrote field notes while observing lessons. Guzey and Roehrig (2009) also collected field notes about the techniques teachers were using, the tools they applied, and the effect on student engagement. These studies used analytic coding to determine the presence of TPACK constructs in the collected evidence. Hofer et al. (2011) developed the Technology Integration Observation Rubric to measure observable TPACK during instructional episodes. Other than the studies described above that were used in establishing the validity and reliability, literature reveals no use of this instrument for identifying and measuring TPACK.

TPACK in Reflection

Not only does reflection build knowledge-of-practice (Cochran-Smith & Lytle, 1999), but researchers often evaluate teacher reflections to track the growth of TPACK. Personal journals containing preservice teachers' scaffolded reflections are often analyzed for evidence of TPACK thinking (Lu, Johnson, Tolley, Gilliard-Cook, & Lei, 2011; Jang & Chen 2010; Hechter & Phyfe, 2010; Jang & Chen, 2010). Guzey and Roehrig (2009) conducted similar measurement and analysis on reflections written by in-service teachers after implementing lessons designed for a professional development initiative. Using a codebook comprised of the TPACK constructs, Graham, Borup, and Smith (2012) analyzed preservice teachers' rationales for using technology when designing lessons. Reflections posted by teachers in online discussions during coursework revealed a growth in TPACK thinking (Niess & Gillow-Wiles, 2010).

Instead of guided reflection or open-ended questions, researchers have also conducted interviews to obtain teacher reflections. Jimoyiannis (2010) gathered perceptions and beliefs from in-service teachers about technology in science instruction (Jimoyiannis, 2010). Guzey and Roehrig (2009) interviewed teachers after designing and implementing lessons to obtain reflections. Researchers identify evidence of TPACK in reflective journals or interview transcripts through open-coding (Polly, 2011) or with content analysis (Jaipal & Figg, 2010), using the seven TPACK constructs as a codebook.

Summary

In six years, the conceptualization and application of the TPACK framework has altered approaches to preparing preservice and in-service teachers to integrate technology into their teaching. Within the differing approaches (e.g., learning by design, learning activity types, reflection) and formats (e.g., preservice courses, in-service workshops), researchers and teachers educators utilize a variety of methods to determine the presence or measure the growth of TPACK. Some methods gather self-reported perceptions about TPACK while others evaluate performance artifacts such as lesson plans or instructional episodes. However, Abbitt (2011) identified the tendency of instruments to ignore the context in which preservice teachers learn about the relationship between technology, pedagogy, and content. Therefore, researchers need to use a combination of quantitative and qualitative measures "to maintain context sensitivity necessary to examine specific learning experiences in which gains in TPACK are evident" (Abbitt, 2011, p. 296). Furthermore, Niess argued that methods courses within a teacher education program provide a "natural environment for building on the knowledge, skills, and dispositions identified in TPACK" (2008, p. 248). Content-specific methods courses offer a rich environment for context sensitive TPACK learning experiences and help is needed to develop these experiences (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009). Therefore, a model that combines development approaches and triangulates TPACK growth with multiple instruments is needed for application to enhance existing methods courses.

CHAPTER III:

METHODOLOGY

Introduction

This study investigated the impact of the researcher-constructed Integrated Triadic Model (ITM) on the development of TPACK in preservice teachers when applied to a content-specific teaching methods course for preservice teachers in elementary education. The model integrates three approaches to TPACK development – learning by design, learning activity types, and reflection – to create or enhance learning experiences in which teachers develop and deepen their understanding of the relationships between technology, pedagogy, and content.

Research Questions

The overarching research question for this study was, “How did the researcher-constructed Integrated Triadic Model (ITM) impact the development of TPACK in preservice teachers when applied to a content-specific teaching methods course for preservice teachers in elementary education?” Additional focused research questions for this study are were follows:

1. To what extent did preservice teachers’ TPACK change while enrolled in a content-specific teaching methods course enhanced by the application of the Integrated Triadic Model; and
2. Which course experiences did preservice teachers believe contributed to their development of TPACK?

Research Design

This study utilized a mixed method research design using the concurrent triangulation approach (Creswell, 2003) in which the researcher collected quantitative and qualitative data from multiple sources and then compared results from data analysis to interpret the level of agreement or convergence. Abbitt (2011) recommended using multiple instruments to more accurately track TPACK development. After measuring changes in TPACK in a group of preservice teachers through a survey using a pretest-posttest design, Shin, Koehler, Mishra, Schmidt, Baran, and Thompson (2009) also suggested the need to triangulate data using qualitative methods such as observation and interviews. The incorporation of both quantitative and qualitative data into analysis aimed to provide a more valid measure of TPACK change in preservice teachers.

Using a researcher-adapted pre-survey (see Appendix A) and post-survey (see Appendix B), the study adopted a one-group pretest-posttest design (Creswell, 2003) to gather participants' beliefs about their own TPACK by responding to items that address the seven knowledge domains of the TPACK theoretical framework (TK, CK, PK, PCK, TCK, TPK, TPACK). Participants responded to self-assessment items using a five-point agreement scale. Data were represented as mean scores for each of the seven constructs for the pre-survey as well as the post-survey. For each TPACK construct, a dependent *t*-test determined if a significant difference existed in mean scores between the pre- and post-survey at a significance level of .05 and Cohen's *d* was calculated to determine the effect size.

In addition, the researcher selected a random sample of participants and three raters analyzed the first and final lesson plans using an evaluation rubric (see Appendix C) containing four criteria. Three of the criteria specifically identified a teacher's enacted TCK, TPK, and

TPACK in a lesson plan. For every lesson plan, raters provided a rating for each of the four criteria and the researcher calculated a mean score for each criteria. For every participant in the sample, the researcher compared means scores for each criterion between their first and final lesson plan to determine if and to what extent mean scores changed.

For participants in the sample who designed high-scoring lesson plans, the researcher analyzed ratings from an observation rubric (see Appendix D) completed by the methods instructor while observing the implementation of the lesson plans. The methods instructor provided a rating for six criteria on the rubric, five of which specifically evaluated a teacher's enacted TK, TCK, TPK (twice), and TPACK in an instructional episode. For every implemented lesson selected for analysis, scores for each criterion were compared between the first and final lesson to determine if and to what extent scores changes.

Finally, the researcher and two raters analyzed written reflections for a different, random sample of participants using content analysis. After coding reflections using a pre-established TPACK codebook (see Table 2), the researcher determined the frequency of TPACK-related excerpts during each of the three months in which the study was conducted. Data were represented by the frequencies and relative percentages of each TPACK construct for each of the three months in which the study was conducted. The researcher compared frequencies of identified TPACK constructs over the three months and identified which constructs' frequencies increased or declined during the study. The researcher examined the extent that frequencies for the integrated constructs (TCK, PCK, TPK, and TPACK) changed.

While analyzing the presence and changes in TPACK constructs for each of the four data sources, the researcher noted the convergence or non-convergence of findings "as a way to strengthen the knowledge claims of the study or explain any lack of convergence that may result" (Creswell, 2003, p. 217). First, the researcher ascertained the extent that each data source (survey, lesson plan rubric, observation rubric, coded reflections) revealed the seven constructs of the TPACK framework. Within each data source, the researcher identified whether the data indicated a change in identified constructs. To note convergence, the researcher compared what the four sources of data indicated regarding changes in TPACK. The researcher reported these results by construct, identifying if the construct was depicted in the data and identifying how it changed for each data source.

The post-survey contained seven rating items and an open-ended question. The items asked participants to rate the effectiveness of course activities and identify which course activity they believe contributed most significantly to their TPACK development. The frequencies obtained from this analysis indicated which learning experiences developed or enhanced by the application of the ITM preservice teachers believe are useful for developing an integrated understanding of technology, pedagogy, and content.

Integrated Triadic Model

The researcher-constructed Integrated Triadic Model (see Figure 2) combines three emerging TPACK development approaches – learning by design, learning activity types, and reflection – to create or enhance learning experiences in which teachers develop and deepen their understanding of the relationships between technology, pedagogy, and content. The model focuses on enriching learning experiences by engaging teachers in design tasks related to Hofer and Harris' (2009) learning activity types while reflecting on the usefulness of these activities as instructional strategies for their lesson plans. The model helps identify opportunities where the three approaches can be incorporated to engage teachers in a TPACK way of thinking – a simultaneous consideration of technology, pedagogy, and content.

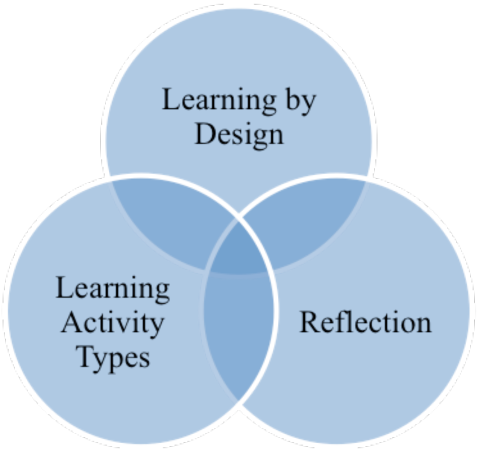

Figure 2. Integrated Triadic Model

Research Context

For this study, the Integrated Triadic Model (ITM) was applied to a content-specific teaching methods course. *CEE 366: Teaching Social Sciences* focuses on concepts, methods, and strategies for teaching social studies at the elementary level. At the institution where this course is offered, elementary education encompasses kindergarten through sixth grade. As indicated by the methods instructor, the course lacked a concerted focus on preparing teachers to integrate technology with elementary social studies instructional strategies. The program of study for juniors and seniors in the teacher education program does not list any courses with a specific focus on integrating technology. Preservice teachers are required to take two instructional technology courses as a prerequisite for admission into the teacher education program. In this study, the ITM was applied to weekly class meetings and the unit plan project in which the preservice teachers develop a unit plan consisting of three individual, yet related lessons. The following sections describe how the ITM was applied to class meetings and the unit plan project.

Class Meetings

During weekly, three-hour class meetings, the methods instructor facilitated learning experiences that introduced methods and strategies for teaching elementary social studies during the first two hours of class. She modeled elementary social studies lessons in which the preservice teachers acted as elementary-age learners. During the last hour of each class meeting, the researcher asked participants to review Harris and Hofer's (2009) taxonomy of social studies learning activity types (see Appendix E) distributed during the first class meeting. The researcher asked participants to identify and orally share learning activity types from the taxonomy they believe the methods instructor incorporated into the model lesson. The researcher noted the suggested technologies in the taxonomy and led participants in a discussion of other digital possibilities for replicating the strategies with technology. This matching activity was repeated every class meeting at the conclusion of the model lesson.

After completing the matching activity, the class moved from the classroom into a computer lab. The researcher presented participants with a design challenge related to one of the learning activity types identified in the model lesson. Working individually or as partners, participants completed these mini-design experiments in which they solved an instructional problem using any technology of their choosing. Each challenge focused on a particular subject matter relating to elementary social studies. Participants shared their varying solutions with the class. Following each mini-design experiment, participants completed a guided reflection activity regarding the methods and strategies emphasized during the class meeting. For example, in one design experiment, participants received a short story about the First Thanksgiving and were challenged to create a digital cartoon of the story. At the conclusion of this activity, participants discussed the various tools and techniques used to create their cartoons. Participants practiced identifying learning activity types in modeled lessons, engaged in design experiments that emphasized a specific subject matter and learning activity type, and reflected on the usefulness of highlighted strategies for helping students learn.

The ITM led to the development of the weekly matching exercises (learning activity types). In addition, the mini-design challenges (learning by design) in the computer lab and concluding writing exercise (reflections) supplemented the modeling of elementary social studies teaching strategies.

Unit Plans

Throughout the semester, participants designed and implemented a unit plan consisting of three lesson plans related to the same general topic. The goal of each lesson plan differed. Preservice teachers first designed a concept lesson plan for the purposes of introducing a social studies concept (i.e., national holidays) to elementary students. Next, participants designed an inquiry skill lesson plan to teach a specific skill (i.e., classifying). Finally, participants designed a generalization lesson plan to teach students how to form a generalization between two or more concepts. Participants were required to include technology in each of their lesson plans and had access to their taxonomy of social studies learning activity types while constructing the lesson plans. After designing the lesson plans throughout the semester, participants implemented the three lessons over a three-day time span in their assigned field placements in local elementary schools. After the implementation of the lessons, the last component of the unit plan required participants to reflect about instructional decisions, explaining how and why technology was incorporated.

The ITM enhanced the existing unit plan project (learning by design) by requiring the inclusion of technology. Preservice teachers also had access to their taxonomies of instructional strategies (learning activity types) when constructing lesson plans. Furthermore, the concluding activity of the unit plan (reflection) provided an opportunity for participants to think about their instructional decisions.

Participants

The participants consisted of forty-two undergraduate, preservice teachers enrolled in an elementary social studies methods course at a large southeastern university during the fall semester of 2012. The teacher education program offered four sections of *CEE 366: Teaching Social Sciences* during the semester, but participants were selected from two sections taught by the same instructor. The participants were chosen using convenience sampling because the methods instructor volunteered her two sections of the course to the researcher for this study. All participants were preservice teachers enrolled in a required course within an accredited teacher education program. Prior to enrollment in the program, participants took twelve hours of coursework in each of the elementary disciplines (math, science, social studies, and English/language arts). The participants also completed two instructional technology courses as a requirement for application to the teacher education program. The participants were completing their final semester of coursework before their full-time student teaching practicum.

During the first class meeting of the semester, the researcher presented the research opportunity to the preservice teachers. The researcher described the administration of the pre- and post-survey, as well as the analysis of reflections, designed lesson plans, and implemented lessons. The researcher provided all preservice teachers with an Informed Consent request. The preservice teachers who agreed to participate in the study signed and returned the request to the researcher.

Some preservice teachers enrolled in the class were enrolled in the alternative certification masters program for elementary education. Having already earned a degree in a field other than education, these preservice teachers were working to earn an education degree and obtain teacher certification. Because most regular masters education courses at the institution are tailored towards graduate students who have already earned an education degree, these alternative certification preservice teachers attend undergraduate methods courses. The alternative certification masters students were excluded from this study because of differences in program requirements.

Instruments

Survey

The Survey of Preservice Teachers' Knowledge of Teaching and Learning (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009) was developed to measure preservice teachers' self-reported perceptions about their own TPACK and the other six knowledge domains (TK, CK, PK, PCK, TPK, and TCK) of the TPACK framework. Instrument designers evaluated similar instruments related to technology integration (Archamault & Crippen, 2009) and reported a focus on self-reported proficiency with specific technologies or attitudes and beliefs about the capabilities of technology for teaching and learning (Schmidt et al., 2009). Schmidt et al. (2009) desired an instrument that specifically measured self-assessment of TPACK.

Originally designed for future elementary or childhood education teachers enrolled in a teacher education program, items on the Survey of Preservice Teachers' Knowledge of Teaching and Learning (Schmidt et al., 2009) were written so that each knowledge domain of the TPACK framework was represented in the survey. Designers constructed an initial pool of forty-four items that was distributed to three nationally recognized TPACK experts for content validity analysis (Schmidt et al., 2009). Each reviewer rated the extent that an item addressed one of the seven TPACK constructs while offering comments and suggestions. Designers reviewed comments, revised existing items, and added items to create a 75-item survey to be tested for construct validity and reliability.

Due to a smaller sample size, construct validity was established with a factor analysis of items organized by each domain of knowledge instead of on the instrument as a whole. Designers also calculated internal consistency for each construct. Using these data, designers removed twenty-eight items that negatively affected the construct validity and reliability of each TPACK construct. A second factor analysis and test of internal consistency produced a final survey consisting of forty-seven items. Designers concluded that the instrument is a valid and reliable instrument for measuring preservice teacher's self-assessment of the seven TPACK constructs. However, the designers suggested that a more content-specific survey and the additional items within each construct could strengthen the validity and reliability of the instrument.

The *Survey of Preservice Teachers' Knowledge of Teaching and Learning* (Schmidt et al., 2009) is available for free use by researchers as long as they provide a description of intended use to the designer for purposes of tracking the instrument's use in research. For this study, the researcher emailed the instrument's designer and received permission to create and use an adapted version of the original survey. The nine demographic items were removed since they were not relevant to this particular study. Additionally, as recommended by Schmidt et al. (2009), similar items were not grouped by their TPACK construct and headers were removed as to not influence participant responses. Next, the original survey targeted elementary preservice or childhood education teachers and items written for the CK, PCK, TCK, and TPACK constructs contained core elementary content areas: mathematics, literacy, science, social studies. Since the context of this study was an elementary social studies methods course, the four core content areas were replaced with the six discipline areas of elementary social studies: civics, government, economics, history, geography, and cultural/global awareness. While other disciplines exist within the social studies area, the aforementioned six disciplines were emphasized in the methods course and were recommended by the elementary social studies methods instructor. As a result, six CK, two PCK, two TCK, and two TPACK questions were added to the original survey, culminating in a total of fifty-eight questions on the researcher-adapted survey. During an initial review, the wording of a question repeated for each content area states, “I can use a [content area] way of thinking.” A committee of reviewers suggested revising the question to enhance the clarity of the item. Schmidt et al. (2009) did not indicate any issues establishing validity for these items during survey construction. However, for clarity purposes, every relevant item was revised with the following wording, “I can view a(n) issue/topic (e.g. voting rights) from a [social studies discipline] perspective.” Finally, seven rating items and one open-ended question were added to the post-survey to gather participants’ beliefs about which course experiences they report contributed to the development of their TPACK.

Lesson Plan Rubric

Harris, Grandgenett, and Hofer (2010) designed the *Technology Integration Assessment Rubric* to “analyze teaching artifacts that both demonstrate the results of teachers’ decision-making, while also providing a pragmatic window into their pedagogical reasoning” (p. 2). Researchers use the instrument to evaluate instructional decisions as reflected in lesson planning documents to identify a teachers’ level of TPACK. The instrument designers adapted Britten and Cassady’s (2005) *Technology Integration Assessment Instrument* because it was the only valid and reliable instrument found in literature that evaluated the quality of technology integration in instructional plans (Harris et al., 2010). However, the Britten and Cassady instrument lacked a TPACK focus. The rubric developed by Harris et al. (2010) measures three constructs of the TPACK framework: technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK). The other four TPACK constructs were omitted as the designers wanted to focus on technology integration (Harris et al., 2010). The rubric also measures the degree that selected technologies, teaching strategies, and content fit together for the purpose of the lesson.

Harris et al. (2010) established construct validity through two separate expert reviews. Technology-using teachers and administrators convenient to the designers reviewed the rubric before six expert TPACK researchers evaluated a revised version. Five of the six TPACK researchers strongly agreed that the TPK, TCK, and TPACK constructs were adequately represented in the rubric. The sixth reviewer suggested the need for additional questions to ascertain the appropriateness of technology for specific sections of an instructional plan. The instrument designers established face validity through feedback offered from scorers during reliability testing. Written comments indicated that the rubric is an appropriate tool for evaluating the quality of TPACK integration based on the information included by teachers in an instructional plan (Harris et al., 2010).

Harris et al. (2010) established reliability through two separate trials, each conducted at different universities. Fifteen lesson plans were evaluated using the *Technology Integration Assessment Rubric* by a group of teachers from multiple content areas and grade levels. The teachers were selected because they frequently integrated digital technologies into their instruction. After the first trial, instrument designers modified wording in the rubric and removed an outlier lesson plan that affected reliability statistics. After completing both trials, interrater reliability increased using Intraclass Correlation Coefficient (.646 to .857) and second percent agreement (83.6% to 84.1%). The internal consistency computed was positive and increased from the first to the second trial (.902 to .911). Finally, researchers calculated the test-retest reliability to determine an overall agreement (87%) for both trial groups. Harris et al. (2010) concluded the *Technology Integration Assessment Rubric* to be a valid and reliable instrument and “sufficiently robust to be used to assess other preservice teachers’ written descriptions of their lesson, project, or unit plans” (p. 6).

For the purposes of this study, *curriculum goals,* as used throughout the *Technology Integration Assessment Rubric,* was clarified to ensure interrater agreement or reliability. The researcher added an asterisk and corresponding note on the rubric indicating that curriculum goals refers to the goals and objectives as stated in the lesson plan.

Observation Rubric

The *Technology Integration Observation Instrument* (see Appendix D) was designed to evaluate the quality of technology integration as evident in classroom instruction (Hofer, Grandgenett, Harris, & Swan, 2011). The instrument designers acknowledged the presence of similar technology integration observation instruments, yet noted that none incorporated TPACK constructs into the design. The *Technology Integration Observation Instrument* incorporates a table where observers record the curriculum topic, key instructional strategies, and the various technologies integrated with the strategies. Next, the instrument includes a rubric, similar to the

Technology Integration Assessment Rubric (Harris et al., 2010), which is used by observers to evaluate and score an observed instructional episode.

Hofer et al. (2011) established construct validity by test piloting the rubric in several secondary classrooms and discussed feedback from raters among instrument designers. Next, seven TPACK researchers reviewed the instrument to assess the extent that TCK, TPK, and TPACK were represented in the rubric. The reviewers also offered feedback useful for evaluating the effectiveness of technology integration as witnessed in the implemented lesson. Based on these recommendations, instrument designers clarified wording and added two additional criteria to the rubric that evaluated the effectiveness of technology for instructional purposes and assessed the teacher's proficiency in using technology during the lesson. Therefore, designers identified and included a fourth construct, technology knowledge (TK). Face validity was established using written feedback from the scorers when testing the reliability. Comments supported the use of the instrument as a viable tool to evaluate the "quality of TPACK-based technology integration as demonstrated in observed instruction" (Hofer et al., 2011, p.4355). Clarity on wording was suggested and incorporated. Some confusion on the similarities of two criteria prompted designers to write a scoring guide to accompany the rubric.

Hofer et al. (2011) established reliability through two trials, conducted separately with different sets of scorers. A total of twelve teacher educators at two different universities scored the same six preservice and six in-service videotaped lessons using the *Technology Integration Observation Rubric*. Scorers received training before evaluating the instructional episodes. Written feedback and comments collected during the first trial were used to revise the rubric before the second trial. After both trials, researchers calculated the interrater reliability of eleven scores using Intraclass Correlation Coefficient (.802) and second percent agreement (90.8%).

Internal consistency was calculated using Cronbach's Alpha (.914) and designers calculated the test-retest reliability (93.9%) after each scorer re-assessed three lesson plans a month after the initial scoring of the twelve lesson plans. Only eleven scores were used to calculate reliability because one scorer consistently provided low scores.

Reflections

The study aimed to discover the extent to which course activities, such as reflection, engage preservice teachers in a simultaneous consideration of technology, pedagogy, and content. During the semester, preservice teachers wrote reflections in response to the same reflection prompt at the conclusion of each weekly class meeting. To protect against leading study participants towards a TPACK-biased response, the guided reflection prompt was adapted from a similar item used to understand technology integration decision making (Graham, Borup, & Smith, 2012): *"Describe an instructional activity using strategies and methods from today's class that you might use to help students learn."*

Participants also wrote reflections about the design and implementation of each lesson in their unit plan. The process of lesson planning presents another opportunity to measure how preservice teachers think about technology, pedagogy, and content in relation to one another. In a study assessing teachers' TPACK during instructional planning, Harris and Hofer (2011) asked the following interview question to individual teachers: *"How and why was this particular combination of content, pedagogy, and technology most appropriate for this unit?"* (p. 217). Using this question as a guide, the researcher added two additional questions to the methods instructor's reflection template that preservice teachers completed after implementing each lesson: 1) how did you incorporate technology into the lesson; and 2) why did you incorporate technology into the lesson?

Data Collection

Pre- and Post-Survey

Participants completed the researcher-adapted survey (see Appendix A) during the first class meeting of the semester. After collecting informed consent forms, the researcher distributed a paper copy of the adapted pre-survey to preservice teachers who agreed to participate in the study. The alternative certification masters students who were not participating in the study left the classroom to meet with the methods instructor while participants completed the survey. When completed, participants placed their surveys face-down on a table at the front of the classroom. The researcher collected the completed surveys and stored them in a secure office. During the final class meeting of the semester, the researcher distributed the adapted post-survey (see Appendix B), which included seven rating items as well as an open-response item. Participants completed the surveys during the class meeting and placed them face-down on a table at the front of the classroom when finished. The researched collected the surveys and stored them in a secure office. The researcher inputted survey responses for the pre- and post-survey into SPSS on a secure computer.

Lesson Plans

At the beginning of the semester, the methods instructor previewed the unit plan project that participants completed during the semester. In this project, participants wrote three different types – a concept lesson plan, an inquiry skill lesson plan, and a generalization lesson plan - around the same topic. Participants wrote their completed lesson plans in separate word processing templates provided by the methods instructor and submitted the lesson plans to the instructor using the university’s course management system. Within the template, preservice teachers inserted their name and a unique identification number - the first five digits of participants' campus identification number. The researcher used the numbers for sampling purposes and could not identify participants by their numbers.

After compiling a list of participants by their numbers, the researcher randomly selected 10% (*n* = 5) of the preservice teachers who agreed to participate in the study. Due to the size of the study and time limitations for evaluation, the researcher only selected a sample to identify if and how TPACK changed from the first to the final lesson plan. After participants submitted all three of their lesson plans, the methods instructor removed participants' names from the word processing documents and emailed electronic versions of the first and final lesson plans for the selected sample to the researcher. The second lesson plan was omitted from analysis because the study investigates a growth of TPACK throughout the semester. The researcher stored the electronic versions on a secure computer and printed copies of each lesson plan. Printed copies were placed into binders and stored in a secure office.

Observations

All participants implemented their three designed lesson plans in a local elementary school classroom as a requirement of the methods course. Every semester, the methods instructor conducts observations of these instructional episodes. After evaluating lesson plans for the randomly selected sample, lesson plan raters identified participants who demonstrated strong evidence of TPACK in their lesson plans as indicated by the ratings on the lesson plan evaluation rubric. For these identified students, the methods instructor observed their first and final implemented lesson.

While observing selected participants teaching their lesson, the methods instructor used the *Technology Integration Observation Rubric* (see Appendix D) to gather information related to how participants implemented the lesson and rated each instructional episode using the rubric.

Prior to the observations, the researcher trained the methods instructor to evaluate instructional episodes with the rubric. The researcher explained and discussed the rubrics' six criterion with the methods instructor and then reviewed a scoring guide provided by the rubric's designers. After observing the implemented lesson and scoring a rubric for each episode, the methods instructor provided paper copies of the scored rubrics to the researcher. The researched stored the completed rubrics in a secure office.

Reflections

Weekly reflections. After completing mini-design experiments during weekly class meetings, participants reflected about how they might use teaching strategies or methods emphasized during class to help students learn. Participants used a web browser to navigate to a blog set up for this study using Google's blogging tool (www.blogger.com). The researcher created a new blog post before every week's class. The title contained the date and reflection number (i.e., Reflection #1, Reflection #2, etc.). The following prompt appeared in the body of the post: Describe an instructional activity using strategies and methods from today's class that you might use to help students learn.

Participants provided their reflective responses to the prompt by clicking on the *comments* link below each post. Participants checked the box that identified their response as *anonymous*. In the comments box, the participants typed the first five digits of their unique identification number. Participants typed their response to the prompt beneath their unique identification number. The researcher changed moderation settings for this blog so that all comments required moderation by the researcher. The researcher never approved or published any of the comments. Therefore, participants could not see other participants' responses. The researcher was the only person with access to participants' comments.

Lesson plan reflections. The last requirement of the unit plan project required participants to reflect about the design and implementation of each lesson plan. The methods instructor provided participants with a word processing template that asked them to reflect about decisions in their lesson. Two questions specifically asked participants to indicate how and why technology was incorporated into the lesson. Participants submitted their completed reflections to the methods instructor using the university's course management system.

Reflection compilations. Using a list of participants organized by their unique identification number, the researcher randomly selected a different sample of participants than those chosen for the analysis of lesson plans. Due to the time constraints required for qualitative coding and the time allotted for the study, raters could not evaluate reflections for all participants. Therefore, a 10% (*n* = 5) sample was selected for content analysis. Graham, Borup, and Smith (2012) similarly coded 10% of reflective responses to design tasks to confirm a saturation of responses. The researcher created a separate word processing document for each participant selected in the sample. At the conclusion of the semester, the researcher copied weekly responses from the blog for each participant in the sample and pasted the written responses into each corresponding word document, organized chronologically by the date in which the reflections were posted.

After participants submitted their lesson plan reflections during the final week of the semester, the methods instructor removed names from the sampled participants and emailed the documents to the researcher. The researcher copied participants' responses to the two guiding questions related to the use of technology and pasted them into each participant's word processing document. The researcher stored the documents for all five participants in the sample on a secure computer in a locked office.

Data Analysis

Survey

Reliability was calculated using Cronbach’s alpha for the pre- and post-survey. Reliability, mean scores, and standard deviations were calculated for groups of items based on which of the TPACK constructs the items intended to measure (see Table 1).

Table 1

Survey Items Organized by TPACK Construct

TPACK Construct	Survey Items
Technological Knowledge (TK)	1-6
Content Knowledge (CK)	7-24
Pedagogical Knowledge (PK)	25-31
Pedagogical Content Knowledge (PCK)	32-37
Technological Content Knowledge (TCK)	38-43
Technological Pedagogical Knowledge (TPK)	44-52
Technological Pedagogical Content Knowledge (TPACK	53-58

The pre- and post-survey means for each construct were analyzed in SPSS using a dependent, or paired samples, *t*-test (at the .05 significance level) to determine if a significant difference existed between mean scores on the pre- and post-survey. The researcher calculated Cohen’s *d* calculated by hand to determine the effect size of the change for each construct, if present. Frequency statistics reported participant ratings about the course experiences as well the course activity they believe contributed most significantly to the development of their TPACK.

Lesson Plans

Three raters, one of which was the researcher, analyzed the sample's first and third lesson plans. Rater one graduated from a university-based teacher education program and teaches first grade at a K-5, rural elementary school with approximately 500 students. She has been teaching for four years, frequently incorporates technology into teaching and learning activities, and rates her technology proficiency as intermediate. Rater two teaches fifth grade at a PK-5, urban elementary school with approximately 350 students. He has been teaching for four years, specializes in mathematics instruction, and frequently integrates technology into teaching and learning activities. He considers himself an advanced user of technology. Both raters were chosen because of their experience designing and implementing lesson plans that integrate technology within elementary-level classrooms. The researcher rated lesson plans because of his expertise with designing and implementing curriculum that incorporates technology.

Before evaluating lesson plans for the sampled participants, the researcher trained the other raters on how to use the *Technology Integration Assessment Rubric* (Harris, Grandgenett, & Hofer, 2010). During an initial meeting with the two raters, the researcher explained the purpose of the study and summarized the TPACK theoretical framework. The researcher stated the intent of the social studies teaching methods course and explained why pre-service teachers wrote three different lesson plans.

The researcher provided each rater with a copy of the *Technology Integrated Assessment Rubric* (see Appendix C) and explained the four criteria as well as the four rating levels. Next, the researcher and raters practiced using the rubric. The methods instructor provided the researcher with several lesson plans submitted by preservice teachers during previous semesters of the CEE 366 course. The researcher selected two of these plans for practice. All three raters independently read the first practice lesson and then scored the lesson plan using the rubric. The raters discussed their ratings, explaining why they gave the score they did for each of the four criteria. The researcher reminded raters they were not evaluating the quality of the lesson plan as a whole, but rather the integration of technology. All three raters read through a second practice lesson plan, completed the rubric, and discussed the results. At the conclusion of this training, the researcher provided the raters with a notebook of empty rubrics and the lesson plans for the participants in the sample.

For every lesson plan selected in the sample, the researcher and two raters independently read the plans and used the rubric to score the selected lesson plans. The researcher collected the completed rubrics from the other two raters and calculated mean scores of all criteria of each lesson plan for each participant in the sample. Mean scores for criteria on each participant's first and final lesson plan were compared to determine if any differences existed. Interrater reliability was calculated in SPSS for each criterion on both the first and final lesson plan using the Intraclass Correlation Coefficient (ICC). The ICC was calculated based on a two-mixed model with absolute agreement type because the same three judges were rating a random sample of lesson plans (Shrout & Fleiss, 1979). The researcher reviewed differences in means for each construct to identify patterns or trends among the five participants in the sample.

Observations

After the methods instructor provided scored rubrics to the researcher for the first and final implemented lesson for the three participants, the researcher entered scores into a spreadsheet. The three participants were part of the sample using during lesson plan analysis and were selected for observation because their lesson plans received high scores from the lesson plan raters. Scores for each of the six criteria were compared between the first and final implemented lesson to determine if any differences existed. The researcher reviewed the differences to identify patterns or trends for the three participants observed by the methods instructor.

Reflections

The researcher and the two raters conducted a content analysis of the compiled reflections to measure evidence of TPACK thinking. Rater two was a doctoral student pursuing a degree in Instructional Technology. She also taught undergraduate educational technology courses. She previously taught kindergarten in an urban school elementary school. She considers herself an advanced user of technology and frequently integrates technology into her instruction. Rater three was the same fifth grade teacher who participated in the lesson plan analysis.

During an initial meeting with the raters, the researcher summarized how to conduct a content analysis and provided raters with a copy of the TPACK codebook (see Table 2). The researcher summarized the TPACK theoretical framework and reviewed what each of the seven TPACK constructs represented. Next, the researcher provided raters with an example reflection from a participant not included in the sample. The researcher and the raters practiced the steps for conducting a content analysis together. First, they independently read through the example reflection, looking for excerpts that mentioned a specific technology, teaching strategy, or content-related topic. During this step, the researcher and raters discussed what encompassed an excerpt. Everyone agreed that an excerpt could be a single sentence or entire paragraph. After highlighting excerpts in the example reflection, raters individually labeled each excerpt using the TPACK codebook. After all excerpts were labeled, the researcher and raters shared which excerpts they highlighted and discussed rationales behind coding decisions.

Table 2

TPACK Codebook

Construct	Label	Description
Technological Knowledge	TK	Excerpt describes information about technologies and the skills required to use them. The reflection describes features of the technology as well as generic, non-instructional uses.
Content Knowledge	CK	Excerpt describes the actual subject matter or topic of an activity.
Pedagogical Knowledge	PK	Excerpt describes the methods or strategies of teaching and learning.
Pedagogical Content Knowledge	PCK	Excerpt describes methods or strategies for teaching a specific subject matter learning goal.
Technological Pedagogical Knowledge	TPK	Excerpt describes the existence or use of technology useful for implementing teaching methods or strategies in instruction without consideration of a specific subject matter.
Technological Content Knowledge	TCK	Excerpt *describes the connection between technology and a subject matter without mentioning specific teaching methods or strategies.*
Technological Pedagogical Content Knowledge	TPACK	Excerpt describes teaching methods that use technologies to teach or facilitate learning of a specific subject matter goal.

Similar studies have used the TPACK constructs as categories when conducting analysis. Harris and Hofer (2011) analyzed reflection statements from secondary teachers for evidence of PCK, TCK, TPK, and TPACK. Graham, Borup, and Smith (2012) categorized teacher rationales for integrating technology into constructs described in Mishra and Koehler's (2006) TPACK framework. Koh and Divaharan (2011) also used the seven constructs as categories when coding teacher reflections. Similarly, Koehler, Mishra, and Yahya's (2007) quantitative discourse analysis of field notes utilized the TPACK constructs as a coding scheme.

After training was completed, all three raters individually read the compiled reflections, highlighted excerpts, and assigned labels from the TPACK codebook for all five participants' reflective writings. After coding and categorizing, the raters negotiated agreement on the selected excerpts and their corresponding codes. In instances where the researcher and the raters disagreed, the researcher yielded to the coding decisions of the other two raters. The researcher tabulated frequencies for each construct and organized these frequencies by the month (Month 1, Month 2, Month 3) of the semester in which participants wrote the reflection.

Chapter Summary

This study investigated the impact of the researcher-constructed Integrated Triadic Model (ITM) on the development of TPACK in preservice teachers when applied to an elementary social studies teaching methods course for preservice teachers. A mixed method design gathered both quantitative and qualitative data to measure the development of TPACK among preservice teachers. The application of the ITM created or enhanced learning experiences in the methods course. These course experiences yielded four sources of data with which to track the development of TPACK: self-assessment surveys, designed lesson plans, implemented lessons, and reflective writings. Items on a post-survey asked participants to rate the effectiveness of course activities. Participants reported which course activity they believe contributed most significantly to the development of their TPACK.

CHAPTER IV:

RESULTS

Introduction

The purpose of this study was to measure the impact of the researcher-constructed Integrated Triadic Model (ITM) on the development of TPACK among a group of preservice teachers enrolled in an elementary social studies teaching methods course. The ITM combines three emerging TPACK development approaches – learning by design, learning activity types, and reflection – to create or enhance learning experiences in which teachers develop and deepen their understanding of the relationship between technology, pedagogy, and content. The ITM was applied in this study to a teaching methods course to augment weekly class meetings with additional learning experiences. The application of the ITM also enhanced an existing course project in which preservice teachers design and implement a unit consisting of three related lesson plans. The application of the ITM provided several opportunities to collect varying sources of data useful for tracking the development of TPACK: self-assessment surveys, designed lesson plans, implemented lessons, and reflective writings. The study also investigated which course experiences preservice teachers believe contributed to their development of TPACK. The following research questions guided the study:

1. To what extent did preservice teachers' TPACK change while enrolled in a content-specific teaching methods course enhanced by the application of the Integrated Triadic Model; and

2. Which course experiences did preservice teachers believe contributed to their development of TPACK?

To answer the first question, the researcher collected and analyzed data from four data sources: pre- and post-surveys, lesson plan evaluation rubrics, lesson observation rubrics, and reflective writings. The analysis of each data source is individually discussed in this chapter. The presentation of results for each data source is organized by the TPACK construct that the instrument intended to measure or by the TPACK constructs that emerged during analysis. A section immediately following this discussion summarizes the extent that each TPACK construct changed. The second research question was answered through the analysis of responses provided by participants to items on the post-survey and statistical analyses of frequencies for the rating and open-ended response items are reported.

Research Question 1

TPACK Self-Report Survey

A paper copy of the researcher-adapted, 58-item pre-survey (see Appendix A) was distributed to participants at the conclusion of the first day of class. Participants completed the pre-survey and forty-one usable surveys were received. The pre-survey's reliability was based on forty of the usable surveys as one survey contained items with missing values. The reliability coefficient using Cronbach's alpha ($\infty = .871$) was above the .700 recommended by Pyrczak (1999) for ensuring adequate internal consistency.

A paper copy of the post-survey, containing the same 58 items as the pre-survey, was administered during the final class meeting of the semester. Participants completed the post-survey and forty-two usable surveys were received. The post-survey's reliability was based on thirty-seven of the usable surveys as five surveys contained items with missing values. The reliability coefficient using Cronbach's alpha (∞ = .944) was above the .700 recommended by Pyrczak (1999) for ensuring adequate internal consistency. Means and standard deviations were calculated for each item on the pre- and post-survey. Items were then grouped together based on the TPACK construct they intended to measure and the internal consistency reliability of items for each construct was calculated for the pre- and post-survey (see Table 3).

Table 3

Survey Items and Internal Consistency by TPACK Construct

TPACK Construct	Survey Items	Internal Consistency (alpha)	
		Pre-Survey	*Post-Survey*
Technological Knowledge (TK)	*1-6*	*.766*	*.768*
Content Knowledge (CK)	7-24	.831	.918
Pedagogical Knowledge (PK)	25-31	.688	.808
Pedagogical Content Knowledge (PCK)	32-37	.882	.842
Technological Content Knowledge (TCK)	38-43	.933	.911
Technological Pedagogical Knowledge (TPK)	44-52	.885	.893
Technological Pedagogical Content Knowledge (TPACK)	53-58	.962	.955

The internal consistency of TPACK constructs ranged from .688 to .962 for the pre-survey and from .768 to .955 for the post-survey. The internal consistency for PK on the pre-survey (∞ =.688) was the only value below the .700 benchmark. Dependent *t*-tests were conducted for each of the seven TPACK constructs using a .05 significance level for analysis. However, since the researcher was performing a different *t*-test for each construct using the same set of data, the significance level was modified using the Bonferroni correction or Dunn procedure (Lomax, 2007) to control the family-wise error rate for type I errors when making multiple hypotheses. Therefore, the original alpha of .05 was divided by the number of constructs (n = 7) being evaluated through *t*-tests and a .0071 significance level was used for analysis. The results of the *t*-test for each construct are reported in the following sections.

Technological knowledge (TK). Using an alpha level of .0071, a paired-samples *t*-test was conducted to evaluate whether participants' responses revealed an increased understanding of technological knowledge (TK). A *t*-test compared the pre-survey's mean score for TK items (q1-q6) to the mean score for the same items on the post-survey (see Table 4). The mean of TK items on the pre-survey was 3.39. The mean on the post-survey was 3.88. A significant difference for TK from the pre-survey to the post-survey was found ($t(5) = -6.47$, $p < .007$). Cohen's *d* was calculated by hand ($d = 2.64$), and it was determined the effect size was very large as it was above the .80 benchmark needed to conclude a large effect (Cohen, 1977). These results indicate that participants believed their generic, non-instructional knowledge and skills regarding both standard and advanced technologies significantly improved over the course of the semester.

Table 4

Means, Standard Deviations, t-Test, and Cohen's d for TK

	M	SD	*t*	P	*d*
Pre-Survey	*3.39*	*.319*	*-6.471*	*.001*	*2.64*
Post-Survey	3.88	.247			
Difference in Means	.49				

Content knowledge (CK). Using an alpha level of .0071, a paired-samples *t*-test was conducted to evaluate whether participants' responses revealed an increased understanding of content knowledge (CK). For this study, content referred to the six disciplines of elementary social studies (civics, government, economics, history, geography, culture/global awareness) emphasized by the methods instructor in the course. A *t*-test compared the pre-survey's mean score for CK items (q7-q24) to the mean score for the same items on the post-survey (See Table 5). The mean of CK items on the pre-survey was 3.04. The mean on the post-survey was 3.78. A significant difference for CK from the pre-survey to the post-survey was found ($t(17) = -12.962$, $p <.007$). Cohen's *d* was calculated by hand ($d = 3.055$), and it was determined the effect size was very large as it was above the .80 benchmark needed to conclude a large effect (Cohen, 1977). These results indicate that participants believed their CK regarding the six emphasized social studies disciplines significantly improved over the course of the semester.

Table 5

Means, Standard Deviations, t-Test, and Cohen's d for CK

	M	SD	*t*	P	*d*
Pre-Survey	*3.0489*	*.31613*	*-12.962*	*.000*	*3.055*
Post-Survey	3.7850	.17003			
Difference in Means	.7361				

Pedagogical knowledge (PK). Using an alpha level of .0071, a paired-samples *t*-test was conducted to evaluate whether participants' responses revealed an increased understanding of pedagogical knowledge. A *t*-test compared the pre-survey's mean score for PK items (q25-q31) to the mean score for the same items on the post-survey (see Table 6). The mean of PK items on the pre-survey was 3.54. The mean on the post-survey was 4.39. A significant difference for PK from the pre-survey to the post-survey was found ($t(5) = -5.389$, $p <.007$). Cohen's *d* was calculated by hand ($d = 2.04$), and it was determined the effect size was very large as it was above the .80 benchmark needed to conclude a large effect (Cohen, 1977). These results indicate that participants believed their PK about the practices, methods, and strategies of teaching elementary social studies significantly improved over the course of the semester.

Table 6

Means, Standard Deviations, t-Test, and Cohen's d for PK

	M	SD	*t*	P	*d*
Pre-Survey	*3.5443*	*.40049*	*-5.398*	*.002*	*2.04*
Post-Survey	4.3957	.21392			
Difference in Means	.8514				

Pedagogical content knowledge (PCK). Using an alpha level of .0071, a paired-samples *t*-test was conducted to evaluate whether participants' responses revealed an increased understanding of pedagogical content knowledge (PCK). A *t*-test compared the pre-survey's mean score for PCK items (q32-q37) to the mean score for the same items on the post-survey (see Table 7). The mean of PCK items on the pre-survey was 2.94. The mean on the post-survey was 3.92. A significant difference for PCK from the pre-survey to the post-survey was found ($t(5) = -24.939$, $p < .007$). Cohen's *d* was calculated by hand ($d = 10.18$), and it was determined the effect was very large as it was above the .80 benchmark needed to conclude a large effect (Cohen, 1977). These results indicate that participants believed their PCK about which elementary teaching strategies support the implementation of an elementary social studies curriculum significantly improved over the course of the semester.

Table 7

Means, Standard Deviations, t-Test, and Cohen's d for PCK

	M	SD	*t*	P	*d*
Pre-Survey	*2.9467*	*.22879*	*-24.939*	*.000*	*10.18*
Post-Survey	3.9283	.16364			
Difference in Means	.9816				

Technological content knowledge (TCK). Using an alpha level of .0071, a paired-samples *t*-test was conducted to evaluate whether participants' responses revealed an increased understanding of technological content knowledge (TCK). A *t*-test compared the pre-survey's mean score for PCK items (q38-q43) to the mean score for the same items on the post-survey (see Table 8). The mean of TCK items on the pre-survey was 2.27. The mean on the post-survey was 4.06. A significant difference for TCK from the pre-survey to the post-survey was found ($t(5) = -28.043$, $p <.007$). Cohen's *d* was calculated by hand ($d = 11.44$), and it was determined the effect size was very large as it was above the .80 benchmark needed to conclude a large effect (Cohen, 1977). These results indicate that participants believed their TCK about how various technologies can be used to represent elementary social studies content significantly improved over the course of the semester.

Table 8

Means, Standard Deviations, t-Test, and Cohen's d for TCK

	M	SD	*t*	P	*d*
Pre-Survey	*2.2767*	*.21040*	*-28.043*	*.000*	*11.44*
Post-Survey	4.0617	.13891			
Difference in Means	1.785				

Technological pedagogical knowledge (TPK). Using an alpha level of .0071, a paired-samples *t*-test was conducted to evaluate whether participants' responses revealed an increased understanding of technological pedagogical knowledge (TPK). A *t*-test compared the pre-survey's means score for TPK items (q44-q52) to the mean score for the same items on the post-survey (see Table 9). The mean of TPK items on the pre-survey was 3.63. The mean on the post-survey was 4.46. A significant difference for TPK from the pre-survey to the post-survey was found ($t(8) = -22.272$, $p <.007$). Cohen's *d* was calculated by hand ($d = 7.42$), and it was determined the effect size was very large as it was above the .80 benchmark needed to conclude a large effect (Cohen, 1977). These results indicate that participants believed their TPK, or their understanding about how the capabilities of available technologies can change teaching and learning strategies, significantly improved over the course of the semester.

Table 9

Means, Standard Deviations, t-Test, and Cohen's d for TPK

	M	SD	*t*	P	*d*
Pre-Survey	*3.6322*	*.20669*	*-22.272*	*.000*	*7.42*
Post-Survey	4.4656	.19705			
Difference in Means	.8334				

Technological pedagogical content knowledge (TPACK). Using an alpha level of .0071, a paired-samples *t*-test was conducted to evaluate whether participants' responses revealed an increased understanding of technological pedagogical content knowledge (TPACK). A *t*-test compared the pre-survey's mean score for TPACK items (q53-q58) to the mean score for the same items on the post-survey (see Table 10). The mean of TPACK items on the pre-survey was 2.70, and the mean on the post-survey was 4.01. A significant difference for TPACK from the pre-survey to the post-survey was found ($t(5) = -56.346$, $p <.007$). Cohen's *d* was calculated by hand ($d = 23.00$), and it was determined the effect size was very as it was above the .80 benchmark needed to conclude a large effect (Cohen, 1977). These results indicate that participants believed their TPACK significantly improved over the course of the semester.

Table 10

Means, Standard Deviations, t-Test, and Cohen's d for TPACK

	M	SD	*t*	P	*d*
Pre-Survey	*2.7033*	*.09438*	*-56.346*	*.000*	*23.00*
Post-Survey	4.0100	.10526			
Difference in Means	1.3067				

Lesson Plan Evaluation

The researcher selected a random sample of participants (10%, *n* = 5) and analyzed their designed lesson plans to determine if their TPACK changed from the first to the final lesson plan. Three raters independently read and evaluated the sample's lessons plans, providing a rating score for each of the four criteria on the Technology Integration Assessment Rubric (Harris, Grandgenett, & Hofer, 2010). The rubric used a four-point rating scale to score the following criteria: Curriculum Goals and Technologies, Instructional Strategies and

Technologies, Technology Selections, and Fit. Raters evaluated two lessons plans for each of the five participants in the sample. The researcher, who also served as a rater, collected the completed rubrics from the other two raters.

For each participant, the researcher calculated a mean score for the four criteria for each of the two lesson plans. Interrater reliability was calculated in SPSS for each criterion on both the first and final lesson plan using the Intraclass Correlation Coefficient (ICC). The ICC was calculated based on a two-mixed model with absolute agreement type because the same three judges were rating a random sample of lesson plans (Shrout & Fleiss, 1979). Using ICC, the interrater reliability for the first criterion (.808) was above .700, while criterion #2 (.570), #3 (.508), and criterion #4 (.628) were deemed adequate for the first lesson plan. The raters' first use of the evaluation instrument possibly contributed to the lower coefficients. On the final lesson plans, the interrater reliability was high for criterion #1 (.971), #2 (.901), #3 (.943), and #4 (.917). The mean scores and differences between the first and final evaluated lesson plans are reported in the following sections, organized by the four criteria of the rubric.

Criteria #1: Curriculum goals and technologies. The first criterion of the rubric, Curriculum Goals and Technologies, intended to gauge the extent that technological content knowledge (TCK) is represented in a lesson plan (Harris, Grandgenett, & Hofer, 2010). A score for this criterion indicates the perceived level of alignment between technologies selected for incorporation in the lesson and the stated curriculum goals or learning objectives. The mean scores of the raters and differences between the means between the first and third lesson plan are found in Table 11.

Table 11

Means and Differences for Curriculum Goals and Technologies

	Lesson #1	Lesson #3	*M* Difference
Participant #1	*2.17*	*1.00*	*-1.17*
Participant #2	*3.00*	*3.17*	0.17
Participant #3	*2.33*	*1.50*	-0.83
Participant #4	*2.50*	*2.00*	-0.50
Participant #5	*3.00*	*3.17*	0.17

Scores for three of the five participants (#1, #3, #4) in the sample decreased from the first to third lesson plan, while scores for the other two participants (#2 and #5) only slightly increased by the same value (*M* = 0.17). Using a four-point rating scale, no lesson plans improved by more than a third of a full rubric score, while mean scores for three participants (#1, #3, #4) all declined by more than a half of a full rubric score (*M* =1.17, 0.83, 0.50). Participants with the two highest scoring first lesson plans, participant #2 (*M* = 3.00) and participant #5 (*M* = 3.00), showed slight improvement on their third lesson plan. However, the difference (*M* = .17) was so minimal that raters did believe that "technologies selected for use in the instructional plan were *strongly* aligned with one or more curriculum goals" plan (Harris, Grandgenett, & Hofer, p.3840) for both the first and third lesson plan. Consequently, raters' scores revealed that participants' TCK did not increase from the first to the third lesson plan.

Criteria #2: Instructional strategies and technologies. The second criterion of the rubric, Instructional Strategies and Technologies, intended to assess the extent that technological pedagogical knowledge (TPK) is represented in a lesson plan (Harris, Grandgenett, & Hofer, 2010). A score for this criterion indicates how well technologies selected for use in a lesson plan support the instructional strategies described in a lesson plan. The mean scores of the raters and differences between the means between the first and third lesson plan are found in Table 12.

Table 12

Means and Differences for Instructional Strategies and Technologies

	Lesson #1	Lesson #3	*M* Difference
Participant #1	*2.50*	*1.33*	*-1.17*
Participant #2	*3.00*	*3.33*	0.33
Participant #3	*2.17*	*2.00*	-0.17
Participant #4	*2.50*	*2.67*	0.17
Participant #5	*3.33*	*3.17*	-0.17

Using a four-point scale, results show that mean scores for participant #1 declined by more than a full rubric score (*M* = 1.17) while the other four participants in the sample neither improved nor declined from the first to the third lesson plan by more than a third of a rubric score. Mean differences for participant #2 (*M* = .33) and participant #4 (*M* = .17) indicate a small improvement while scores for participant #3 and #4 declined by the same value (*M* = .17). As a result, raters' scores reveal that participants' TPK did not increase from the first to the third lesson plan.

Criteria #3: Technology selections. The third criterion of the rubric, *Technology Selections*, intended to assess the extent that technological pedagogical content knowledge (TPACK) is represented in a lesson plan (Harris, Grandgenett, & Hofer, 2010). A score indicates the appropriateness of technologies selected for a lesson plan, given the stated lesson objectives and instructional strategies described in the lesson plan. The mean scores of the raters and differences between the means between the first and third lesson plan are found in Table 13.

Table 13

Means and Differences for Technology Selections

	Lesson #1	Lesson #3	*M* Difference
Participant #1	*2.50*	*1.00*	*-1.50*
Participant #2	*2.33*	*3.00*	0.67
Participant #3	*2.17*	*1.83*	-0.33
Participant #4	*2.67*	*1.67*	-1.00
Participant #5	*3.33*	*3.17*	-0.17

Using a four-point rating scale, scores between the first and third lesson plan decreased by a full rubric score for participants #1 (*M* = 1.50) and #4 (*M* = 1.00). Rubric scores for participant #2 improved from the first (*M* = 2.33) to the third (*M* = 3.00) lesson plan by more than a half of full rubric score, while the other two participants neither improved nor declined from the first to the third lesson plan by more than a third of a rubric score. The mean difference for participant #2 (*M* = 0.67) indicates a slight improvement while scores on the third lesson were lower than the first for participants #1, #3, #4, and #5. With just a slight improvement for one participant in the sample, the scores reveal that participants' TPACK did not increase from the first to the third lesson plan.

Criteria #4: Fit. The fourth criteria of the rubric, *Fit*, does not specifically measure the presence of a TPACK construct. The criterion measured the perceived "fit of selected content, teaching strategies, and technologies considered together" plan (Harris, Grandgenett, & Hofer, 2010, p. 3834) in a lesson. A rating for *Fit* indicates how strongly curriculum, instructional strategies, and technology fit together in a lesson plan. The mean scores of the raters and differences between the means between the first and third lesson plan are found in Table 14.

Table 14

Means and Differences for Fit

	Lesson #1	Lesson #3	*M* Difference
Participant #1	*2.50*	*1.33*	*-1.17*
Participant #2	*2.67*	*3.67*	1.00
Participant #3	*2.00*	*1.50*	-0.50
Participant #4	*2.83*	*2.00*	-0.083
Participant #5	*3.17*	*3.33*	0.17

Using a four-point rating scale, participant #2 scored a full rubric score higher on the third lesson plan (*M* = 3.67) than on the first (*M* = 2.67). Participant #5 slightly improved (*M* = .17), while scores for the other three participants (#1, #3, #4) declined by at least a half of a rubric score (1.17, 0.50, 0.83). The raters' scores for the fit between curriculum, pedagogy, and technology did not improve from the first to third lesson plan for four of the five participants in the sample.

Observed Instruction

The researcher selected a single rater, the methods instructor, to observe the first and third implemented lesson for three participants of the samples used for lesson plan analysis because the participants' scores from the lesson plan analysis were relatively high. The methods instructor was selected to observe because she routinely observes the implementation of lesson plans. Additional raters were considered, but the time needed for approval from the school system and institution's review board was not adequate for this study.

The methods instructor evaluated the instructional episodes using the *Technology Integration Observation Rubric* (Hofer, Grandgenett, Harris, & Swan, 2011). Prior to the observations, the researcher trained the rater on use of the rubric by explaining the components of the note-taking sheet and its use for capturing essential information in the lesson. As suggested by the instrument designers, the researcher also reviewed the rubrics' six criteria with the rater, explained the terminology of each criterion, and discussed the scoring guidelines (Hofer, Grandgenett, Harris, & Swan, 2011). The rubric used a four-point rating scale to score the following criteria: Curriculum Goals and Technologies, Instructional Strategies and Technologies, Technology Selections, Fit, Instructional Use, and Technology Logistics.

During observations, the rater recorded notes and provided a score for each of the six criteria on *Technology Integration Observation Rubric* (see Appendix D). The researcher collected the rubrics from the rater and calculated the difference in scores for each criterion from the first to the third lesson plan. The scores and differences are reported in the following sections, organized by the six criteria of the evaluation rubric.

Criteria #1: Curriculum goals and technologies. The first criterion of the rubric intended to gauge how well technological content knowledge (TCK) is represented in an implemented lesson (Hofer, Grandgenett, Harris, & Swan, 2011). A score for Curriculum Goals and Technology indicates how well technologies used by a teacher during implementation of a lesson are aligned with the stated goals of that lesson. The rater's scores and differences in scores between the first and third lesson implementation for the three participants are found in Table 15.

Scores for participant #5 were the same for the first (3.00) and third (3.00) implemented lesson. Using a four-point rating scale, results indicate that participant #4 scored one rubric score lower on the third implementation and participant #2 scored two rubric scores lower. These results indicate that no scores for Curriculum Goals and Technologies improved from the first to the third implemented lesson, suggesting that preservice teachers did not demonstrate an increase in TCK.

Table 15

Scores and Differences for Curriculum Goals and Technologies

	Lesson #1	Lesson #3	Difference
Participant #2	*3.00*	*1.00*	-2.00
Participant #4	*3.00*	*2.00*	-1.00
Participant #5	*3.00*	*3.00*	0.00

Criteria #2: Instructional strategies and technologies. The second criterion of the rubric intended to gauge how well technological pedagogical knowledge (TPK) is represented in an implemented lesson (Hofer, Grandgenett, Harris, & Swan, 2011). A score indicates how well technologies used by in a teacher during implementation of a lesson support the teaching and learning strategies used during the lesson. The rater’s scores and differences in scores between the first and third lesson implementation for the three participants are found in Table 16.

Scores for participant #5 were the same for the first and third lesson implementation. Using a four-point score, results indicate that both participant #2 and #4 scored one rubric score lower on the third implemented lesson. These results indicate that no scores for Instructional Strategies and Technolog*y* improved from the first to the third lesson plan, suggesting that preservice teachers did not demonstrate an increase in TPK.

Table 16

Scores and Differences for Instructional Strategies and Technologies

	Lesson #1	Lesson #3	Difference
Participant #2	*3.00*	*2.00*	-1.00
Participant #4	*3.00*	*2.00*	-1.00
Participant #5	*3.00*	*3.00*	0.00

Criteria #3: Technology selections. The third criterion of the rubric intended to gauge how well technological pedagogical content knowledge (TPACK) is represented in an implemented lesson (Hofer, Grandgenett, Harris, & Swan, 2011). A score indicates the appropriateness of technologies used in a lesson, given the stated lesson goals and instructional strategies utilized in the lesson's implementation. The rater's scores and differences in scores between the first and third lesson implementation for the three participants are found in Table 17.

No participants in the sample indicated a growth in TPACK from the first to the third lesson plan. Scores for participant #5 were the same for the first and third lesson implementation. Using a four-point rating scale, results indicate that participant #2 scored two rubric scores lower on the third implemented lesson while participant #4 scored one rubric score lower. These results indicate that no scores for Technology Selections improved from the first to the third lesson plan, suggesting that preservice teachers did not demonstrate an increase in TPACK.

Table 17

Scores and Differences Technology Selections

	Lesson #1	Lesson #3	Difference
Participant #2	*3.00*	*1.00*	-2.00
Participant #4	*3.00*	*2.00*	-1.00
Participant #5	*3.00*	*3.00*	0.00

Criteria #4: Fit. The fourth criterion of the rubric intended to assess the extent that that selected technologies, instructional strategies, and curriculum goals "fit" together in an instructional episode. This particular criterion is not aligned with any of the seven TPACK constructs. The rater's scores and differences in scores between the first and third lesson implementation for the three participants are found in Table 18.

Scores for participant #5 were the same for the first and third lesson implementation. Using a four-point rating scale, results indicate that participant #2 scored one rubric score lower on the third implemented lesson and participant #4 scored two rubric scores lower. These results indicate that no scores for Fit improved from the first to the third lesson plan.

Table 18

Scores and Differences for "Fit"

	Lesson #1	Lesson #3	Difference
Participant #2	*3.00*	*2.00*	-1.00
Participant #4	*3.00*	*1.00*	-2.00
Participant #5	*3.00*	*3.00*	0.00

Criteria #5: Instructional use. The fifth criterion of the rubric represented a teacher's enacted TPK in an implemented lesson (Hofer, Grandgenett, Harris, & Swan, 2011). A score indicates the effectiveness of a teacher's instructional use of selected technologies (Hofer et al., 2011). The rater's scores and differences in scores between the first and third lesson implementation for the three participants are found in Table 19.

Scores for participant #5 were the same for the first and third lesson implementation. Using a four-point rating scale, results indicate that both participant #2 and participant #4 scored two rubric scores lower on the third implemented lesson. These results indicate that no scores for *Instructional Use* improved from the first to the third lesson plan, suggesting that preservice teachers did not demonstrate an increase in enacted TPK.

Table 19

Scores and Differences for Instructional Use

	Lesson #1	Lesson #3	Difference
Participant #2	*3.00*	*1.00*	-2.00
Participant #4	*3.00*	*1.00*	-2.00
Participant #5	*3.00*	*3.00*	0.00

Criteria #6: Technology and logistics. The sixth criterion of the rubric intended to address a teacher's demonstrated technological knowledge (TK) in an implemented lesson (Hofer, Grandgenett, Harris, & Swan, 2011). A score indicates a teacher's effectiveness in operating whichever technologies were used by the teaching during a lesson. The rater's scores and differences in scores between the first and third lesson implementation for the three participants are found in Table 20.

Scores for participant #5 were the same for the first and third lesson implementation. Using a four-point rating scale, participant #2 scored one rubric score lower on the third implemented lesson and participant #5 scored two rubric scores lower. These results indicate that no scores for *Instructional Strategies and Technologies* improved from the first to the third lesson plan, suggesting that preservice teachers did not demonstrate an increase in TK.

Table 20

Scores and Difference for Instructional Strategies and Technologies

	Lesson #1	Lesson #3	Difference
Participant #2	*3.00*	*2.00*	-1.00
Participant #4	*3.00*	*1.00*	-2.00
Participant #5	*3.00*	*3.00*	0.00

Reflections

The ITM incorporated written reflections about instructional decision-making into both weekly class meetings and the unit plan project. From the beginning of the semester until the submission of the final project, participants reflected about teaching with technology. The researcher chronologically compiled all reflections for a sample (10%, *n* = 5) of participants into separate word processing documents. The researcher and two additional raters individually read a participant's written reflections and highlighted excerpts that represented thinking about technology, instructional strategies, or specific social studies content. During a training session, the raters agreed that an excerpt could be a single sentence or entire paragraph that encompassed a participants' thinking about pedagogy, content, or technology. Raters agreed not to tally single words that might allude to one of the TPACK constructs. The raters used a pre-established TPACK codebook (see Table 2) to assign each highlighted excerpt a label. After repeating this process for the remaining participants in the sample, the three raters shared the results of their coding and negotiated agreement on both excerpts and coding labels.

The researcher then conducted a content analysis that yielded a total of 75 excerpts from all five participants related to the seven constructs of the TPACK framework. The excerpts were categorized by the month in which they were written. The researcher counted the number of occurrences for each TPACK construct as indicated with the label agreed upon by the three raters. The frequency and percentage of TPACK responses varied across months 1, 2, and 3 of the study (see Table 21).

Table 21

Frequency and Percentage of TPACK Constructs Identified in Reflections

	Month 1		Month 2		Month 3	
	Excerpts	%	Excerpts	%	Excerpts	%
TK	*1*	*4.76*	*0*	*0.00*	*8*	*24.24*
CK	1	4.76	0	0.00	0	0.00
PK	7	33.33	6	26.09	2	6.06
PCK	3	14.29	0	0.00	0	0.00
TCK	0	0.00	0	0.00	0	0.00
TPK	7	33.33	15	65.22	12	36.36
TPACK	2	9.52	2	8.70	11	33.33
Total	21		23		31	

Month 1. Out of the 21 identified excerpts in Month 1, PK (33.33%) and TPK (33.33%) comprised the majority of identified reflection comments, while PCK (14.29%), TPACK (9.52%), CK (4.76%), and TK (4.76%) accounted for the other selections. During Month 1, no excerpts were identified for TCK. The participants’ reflections revealed a consideration of

pedagogical practices as evidenced by the frequency of PK, TPK, PCK, and TPACK excerpts. Excerpts for these four TPACK constructs accounted for 91.3% (*n* = 21) of the excerpts in Month 1. The following excerpts represent preservice teachers' thinking about the usefulness of certain teaching strategies from Month 1.

> PK: They discussed constructing an activity for sequence of events by labeling cards.
>
> TPK: I found that various technology sources can be used to help students learn. Using the google presentation and photopeach to present information to students can make it fun and interesting for the students and teacher.
>
> PCK: I really enjoyed the drawing of the peacemaker as a way to develop and organize information related to people. I have already decided that I want to teach older grades, and this is a great way to make biographical information more fun.
>
> TPACK: In addition to this, using the matrix on an interactive white board is an effective method to supplement the drawing of the cartoon peacemaker.

Month 2. Out of the 23 identified excerpts in Month 2, TPK (65.22%) comprised the majority of comments while PK (26.09%) was the second most identified TPACK construct. Two excerpts were marked for TPACK (8.7%), while no identified excerpts were found for TK, CK, PCK, or TCK. All of the identified excerpts during Month 2 reveal thinking about pedagogical practices. For example, the following excerpts depict participants' thinking about interacting with students while presenting content:

> PK: I really like the idea of using polling strategies to assess student understanding. When students feel anonymous, there is less cheating.
>
> TPK: I learned how to utilize a survey to collect or assess what the students have learned about a new concept. This can be done through multiple technologies like computers, cell phones, and tablets. This strategy can be extremely useful for those students who get bored with pencil and paper responses.
>
> TPACK: I felt that the PowerPoint presentation about the rain forest from class today was a great instructional activity. It really got us interested in the lesson. It was not just a "read the PowerPoint" but it was interactive and engaging.

Furthermore, the combination of TPACK and TPK (*n* = 17, 73.92%) responses revealed participants' thinking about how the capabilities of certain technologies can support the implementation of specific teaching strategies. The following excerpts represent participants' understanding of the usefulness of various technologies to support the creation of cartoons or comic strips:

> TPK: I would use the comic creator as a fun strategy to explain the topic from class. The students can take the lesson and illustrate it in an interesting way to present the topic.
>
> TPACK: I like the idea of allowing students the ability to create comic strips to express their thoughts and comprehension. As a student, I wouldn't have enjoyed this assignment very much because I am not very creative. I think that allowing this as an option for students to use is excellent because there are many students that love to draw. Using ToonDoo.com would be great to use as long as there is a way to easily log students in as well as having access to a class set of laptops or a computer lab. Students are constantly looking for alternative methods to writing down their thinking- they are forced to do that a lot for comprehension. If students want to draw, they should be able to as long as they are still clearly expressing their comprehension.

Month 3. Out of the 33 identified excerpts in Month 3, 36.36% of excerpts were related to TPK, 33.33% related to TPACK, and 24.24% related to TK. Only two comments were marked for PK (6.06%), while no excerpts were found for CK, PCK, or TCK. Similar to Month 2, the majority of excerpts (69.69%) in Month 3 reveal participants' TPK and TPACK thinking. The excerpts again reflect thinking about how technology can support the implementation of specific teaching strategies:

> TPACK: The "I'm Just a Bill" video helped the students to see the process of passing a law- it turned the words into visual representation. The hover camera was extremely useful in allowing students to see the concept map as they were writing their own. This helped with any confusion the students may have about where to write the information on their paper.

The content analysis also identified eight excerpts (24.24%) labeled as TK in which participants' writing described a specific technology without mentioning a related teaching strategy or specific content. The presence of these excerpts might be due to a guiding reflection question in Month 3 that asked participants to identify how they incorporated technology into their lesson.

TPACK construct trends. Participants' awareness of and the capability of technologies (TK), represented by excerpts of their thinking in written reflections, grew from Month 1 (*n* = 1, 4.76%) to Month 3 (*n* = 8, 24.24%). With only one excerpt identified in Month 1 and none in Month 2 or 3, the content analysis revealed minimal representation of CK, in which participants reflected on social studies subject matter with considering teaching strategies that support that content. The frequency of excerpts identified as PK declined from Month 1 (*n* = 7, 33.33%) to Month 2 (*n* = 6, 26.09%) to Month 3 (*n* = 2, 6.06%). The frequency of PCK excerpts similarly decreased from Month 1 (*n* = 3, 14.29%) to Month 3 (*n* = 0, 0.00%).

While the frequency of excerpts for PK and PCK declined, the results revealed a growth in TPK excerpts from Month 1 (*n* = 7, 33.33%) to Month 2 (*n* = 15, 65.22%), before slightly declining in Month 3 (*n* = 12, 36.36%). While frequencies for PK and TPK both significantly declined from Month 2 to Month 3, TPACK frequencies grew significantly from Month 2 (*n* = 2, 8.7%) to Month 3 (*n* = 11, 33.33%). As the frequency of PK and PCK excerpts declined during the study, the frequency of technology-integrated constructs (TPK, TPACK) grew.

Changes in TPACK

The following sections describe the extent that each TPACK was identified in each of the four sources of data by triangulating the results. Furthermore, the sections depict any increases or decreases in the knowledge as indicated by the results of the data analysis.

Technological knowledge (TK). The analysis of participants' responses between the pre- and post-survey revealed a significant growth in TK with a very large effect size (*d* = 2.64) from the beginning to the end of the semester. No evidence of TK emerged during the analysis of lesson plans because the Technology Integration Assessment Rubric was not designed to identify the presence of TK. Score ratings from the Technology and Logistics section of the *Technology Integration Observation Rubric* used for evaluating implemented lessons revealed strong ratings for TK in the first implemented lesson. However, participants either showed no improvement in the third lesson or scored lower with regards to their actual use of selected technologies. The content analysis revealed few excerpts from reflective writings in which participants wrote about the capabilities of a technology without considering its pedagogical application or usefulness for representing a specific on content.

Content knowledge (CK). The analysis of participants' responses between the pre- and post-survey revealed a significant growth in CK with a very large effect size (d = 3.055) from the beginning to the end of the semester. No evidence of CK emerged during the analysis of lesson plans or implemented instruction because the evaluation instruments were designed to focus on technology integration and not the identification of content knowledge. Content analysis of written reflections yielded a single excerpt representing a participant's thinking about content. However, no other excerpts were identified and labeled CK throughout the remaining two months of the semester.

Pedagogical knowledge (PK). The analysis of participants' responses between the pre- and post-survey revealed a significant growth in PK with a very large effect size (d = 2.04) from the beginning to the end of the semester. No evidence of PK emerged during the analysis of lesson plans or implemented instruction because the evaluation instruments were designed to focus on technology integration and not the identification of pedagogical knowledge. The content analysis of written reflections revealed a decline in the number of excerpts from Month 1 (n =7, 33.33%) to Month 2 (n =6, 26.09%) to Month 3 (n =2, 6.06%).

Pedagogical content knowledge (PCK). The analysis of participants' responses between the pre- and post-survey revealed a significant growth in PCK with a very large effect size (*d* = 10.18) from the beginning to the end of the semester. No evidence of PCK emerged during analysis of lesson plans or implemented instruction because the evaluation instruments were designed to focus on technology integration and not the identification of pedagogical content knowledge. The content analysis of written reflections identified three excerpts from the first month of the semester that represented a simultaneous consideration of content and pedagogy. However, no similar excerpts were identified in Month 2 or 3.

Technological content knowledge (TCK). The analysis of participants' responses between the pre- and post-survey revealed a significant growth in TCK with a very large effect size (*d* = 11.44) from the beginning to the end of the semester. Scores from the criterion measuring TCK in written lesson plans did not portray a growth in TCK for the sample. Participants either scored very similar on lesson plans or somewhat lower on their final designed lesson plan. Score ratings from the criterion measuring TCK in observed instruction were strong for the first implemented lesson. However, scores either remained the same or decreased in the final implemented lesson, indicating a lack of growth in TCK. The content analysis of written reflections did not identify a single excerpt in any of the months that represented participants' thinking of technology and content. Therefore, there was no identified growth of TCK as evidenced in the reflections.

Technological pedagogical knowledge (TPK). The analysis of participants' responses between the pre- and post-survey revealed a significant growth in TPK with a very large effect size (*d* = 7.42) from the beginning to the end of the semester. Scores from the criterion measuring TPK in written lesson plans indicated a lack of growth in TPK. Four out of the five participants either scored slightly higher or slightly lower on their final designed lesson than they did on their first. Score ratings from the criterion measuring TPK in observed instruction were strong for the first implemented lesson. Scores either remained the same or declined in the final implemented lesson, indicating a lack of growth in TPK. The content analysis of written reflections revealed strong evidence of TPK in all three months of the semester. The number of excerpts jumped from 7 (33.33%) to 15 (65.22%) from Month 1 to Month 2, before declining slightly in Month 3 (12, 36.36%). This trend indicates a growth in TPK.

Technological pedagogical content knowledge (TPACK). The analysis of participants' responses between the pre- and post-survey revealed a significant growth in TPACK with a very large effect size (*d* = 23.00) from the beginning to the end of the semester. This growth in TPACK was the largest in comparison to the other six constructs. Scores from the criterion measuring TPACK in written lesson plans indicated a lack of growth in TPACK. Four out of the five participants in the samples scored lower on the final lesson plan than they did on the first lesson plan they designed. Score ratings from the observation rubric for TPACK were steady or declined by one rubric score from the first to the third implemented lesson. These trends reflected a lack of growth in TPACK as evidenced in the observed instruction. The content analysis of written reflections revealed a distinct growth in TPACK from Month 2 to Month 3. Two excerpts were identified for each of the first two months of the semester before the number of excerpts increased to 11 (33.33%) in the final month of the semester. This increase over the last month is indicative of a growth in TPACK.

Research Question 2

Seven rating items were added to the post-survey to gather preservice teachers' perceptions about the effectiveness of course activities for developing TPACK. These items utilized a four-point rating scale (Not Effective, Minimally Effective, Effective, Very Effective) to rate the following class activities: observing instructor's teaching strategies, matching methods with learning activity types, design experiments during class meetings, reflecting about class activities, designing lesson plans, reflecting on decisions in lesson plans, and implementing lessons in elementary classrooms. An open-ended response item allowed participants to report which course experience they believe contributed most significantly to the development of their TPACK. The results for each set of items are reported in the following sections.

Effectiveness of Class Activities

All 42 participants responded to the seven ranking items that addressed the effectiveness of course activities for developing TPACK. The seven items had reliability using Cronbach's alpha of .722, above the .700 recommended by Pyrczak (1999) for ensuring adequate internal consistency. The item-to-total correlations ranged from .468 to .701, all above .300, an arbitrary guideline for defining discriminating items (Nunnally & Bernstein, 1994). This suggests that most of the items gave a significant contribution to the total instrument. High item-to-total correlations not only support the reliability of the items, but also document validity in that the items are measuring the same construct.

Observing instructor's teaching strategies. During each class meeting, the methods instructor modeled an elementary social studies lesson in which preservice teachers participated in the lesson as if they were elementary students. Modeled lessons incorporated strategies (i.e., reading a trade book) useful for teaching social studies at the elementary level. Participants rated the effectiveness of these model lessons for developing TPACK (see Table 22). All of the participants reported that the lessons were either effective (*n* = 21, 50%) or very effective (*n* =

21, 50%) for developing TPACK. No participants rated the activity as not effective or minimally effective.

Table 22

Frequencies and Percentages for Observing Instructors' Teaching Strategies

	Frequency	Percentage (%)
Not Effective	0	0
Minimally Effective	0	0
Effective	21	50
Very Effective	21	50

Matching methods with learning activity types. After the methods instructor modeled an elementary social studies lesson during a class meeting, participants reviewed Hofer and Harris' (2011) Taxonomy of Social Studies Learning Activity Types to identify activity types that matched strategies modeled by the methods instructor during the model lesson. The researcher facilitated this matching activity. For each identified learning activity type, the researcher asked participants to review the list of possible technologies that accompanied each learning activity type. Participants and the researcher shared additional technologies that support each learning activity type that matched a modeled strategy.

Participants rated the effectiveness of this matching activity for developing TPACK (see Table 23). A large majority of participants reported that this activity was effective (*n* = 22, 52.4%) or very effective (*n* = 16, 38.1%). One participant (2.4%) believed the activity was not effective for developing TPACK while 3 (7.1%) participants indicated that matching methods with learning activity types was minimally effective.

Table 23

Frequencies and Percentages for Matching Methods with Learning Activity Types

	Frequency	Percentage
Not Effective	1	2.4
Minimally Effective	3	7.1
Effective	22	52.4
Very Effective	16	38.1

Design experiments during class meetings. During the last thirty to forty-five minutes of each class meeting, participants completed a design experiment created and facilitated by the researcher. The experiment framed each experiment around a social studies topic (e.g., the Jamestown Settlement) and a learning activity type modeled by the methods instructor during the first part of the class meeting. The experiments required participants to use technology.

Participants rated the effectiveness of these design experiments for developing TPACK (see Table 24). All but one participant reported that this activity was either effective (*n* = 21, 50%) or very effective (*n* = 20, 47.6%) for developing TPACK. No participants reported the activity was not effective.

Table 24

Frequencies and Percentages for Class Design Experiments

	Frequency	Percentage (%)
Not Effective	0	0.0
Minimally Effective	1	2.4
Effective	21	50.0
Very Effective	20	47.6

Reflecting about class activities. After the completion of the design experiment during class meetings, participants reflected about how they might use strategies and methods from that day's class to help students learn. They completed this reflection before the methods instructor dismissed class. Participants rated the effectiveness of this reflection exercise for developing TPACK (see Table 25). A large majority of the participants reported that this activity was either effective (*n* = 24, 57.1%) or very effective (*n* = 15, 35.7%) for developing TPACK. One participant (2.4%) rated the activity as not effective for developing TPACK while 2 (4.8%) participants indicated that the weekly reflections were minimally effective.

Table 25

Frequencies and Percentages for Class Activity Reflections

	Frequency	Percentage (%)
Not Effective	1	2.4
Minimally Effective	2	4.8
Effective	24	57.1
Very Effective	15	35.7

Designing lesson plans. Throughout the semester, participants designed three separate, but interrelated lesson plans. The plans revolved around the same topic, but each lesson plan was a different type (concept, skill, generalization). Participants rated the effectiveness of designing lessons for developing TPACK (see Table 26). Participants reported that designing the lesson plans was effective (*n* = 24, 57.1%) or very effective (*n* = 18, 42.9%) for developing TPACK. No participants reported that this course activity was minimally effective or not effective at all.

Table 26

Frequencies and Percentages for Designing Lesson Plans

	Frequency	Percentage (%)
Not Effective	0	0
Minimally Effective	0	0
Effective	24	57.1
Very Effective	18	42.9

Reflecting on decisions in lesson plans. After submitting their final lesson plans, participants completed a template in which they reflected upon decisions they made while designing their three lesson plans. Two of the guiding questions on the template related to the use of technology, asking participants how and why they incorporated technology. Participants rated the effectiveness of this reflection exercise (see Table 27). Half of the participants rated the activity as effective (*n* = 21, 50%) for developing TPACK, while another significant portion reported that the post-design reflections were very effective (*n* = 19, 45.2%). Two (4.8%) participants reported that reflections were minimally effective. No participants reported that this course activity was not effective.

Table 27

Frequencies and Percentages for Lesson Plan Decision Reflections

	Frequency	Percentage (%)
Not Effective	0	0
Minimally Effective	2	4.8
Effective	21	50
Very Effective	19	45.2

Implementing lesson plans in elementary classrooms. After designing three lesson plans, participants implemented the plans in local elementary school classrooms. The participants were assigned these classrooms earlier in the semester for observation and teaching as a requirement for the university's teacher education program. Participants rated the effectiveness of implementing the lessons for developing TPACK (see Table 28). All participants reported that implementing the lesson plans was effective (*n* = 13, 31%) or very effective (*n* = 29, 69%) for developing TPACK. No participants reported that this activity was minimally effective or not effective.

Table 28

Frequencies and Percentages for Lesson Implementation

	Frequency	Percentage (%)
Not Effective	0	0
Minimally Effective	0	0
Effective	13	31
Very Effective	29	69

Most Significant Activity

All 42 participants responded to the final item on the post-survey. Participants indicated which course activity they believe contributed most significantly to their development of TPACK. Frequencies and percentages for this item are found in Table 29.

The largest percentage of students reported that the design experiments during class meetings (*n* = 14, 33%) contributed most significantly to their development of TPACK. In these experiments, students explored technological approaches for implementing a learning activity type. As previously mentioned, these experiments centered on a specific elementary social studies concept. A similarly large group (*n* = 13, 31%) of participants reported that the methods instructor's model lessons during weekly class meetings contributed most significantly to their development of TPACK. Three participants indicated that matching the methods instructor's modeled strategies with learning activity types contributed most significantly while one participant chose the weekly class reflections. These four course activities all took place during weekly class meetings. Therefore, 73.5% of participants indicated that the activity that contributed most significantly to the development of their TPACK took place during weekly class meetings.

Seven participants (16.7%) believe that teaching their lessons in assigned field placements contributed most significantly to their TPACK development. Four participants selected the process of designing lesson plans while no participants selected reflections about instructional decisions in the lesson plans.

Table 29

Frequencies and Percentages for Course Activities

	Frequency	Percentage (%)
Matching Methods with Learning Activity Types	3	7.1
Observing Instructor Teaching Strategies	13	31.0
Design Experiments During Class Meetings	14	33.0
Reflecting About Class Activities	1	2.4
Designing Lesson Plans	4	9.5
Reflecting About Lesson Plan Decisions	0	0.0
Implementing Plans in Elementary Classrooms	7	16.7

Chapter Summary

This chapter presented data collected from multiple sources to answer the two research questions. The first research question focused on the extent that TPACK changes over the course of a semester. Results from a dependent *t*-test revealed that a significant difference existed between means for all seven constructs of the TPACK theoretical framework. Scores from lesson plan and observation rubrics decreased from the first the final lesson plan for TCK, TPK, and TPACK. Finally, a content analysis of written reflections indicated a growth in integrated thinking evidenced by increased instances of TPK and TPACK thinking in reflective writings as the semester progressed. The second research question gathered participants' perceptions about course experiences and their usefulness for developing TPACK. Statistical analysis indicated that participants found all course activities relatively effective or very effective for developing TPACK. Chapter five presents the conclusions, implications, limitations and recommendations for future research.

CHAPTER V:

CONCLUSIONS, LIMITATIONS, IMPLICATIONS, AND RECOMMENDATIONS

Introduction

This chapter summarizes the impact of the researcher-constructed Integrated Triadic Model (ITM) on the development of technological pedagogical content knowledge (TPACK) among a group of pre-service teachers. The ITM combines three TPACK development approaches – learning by design, learning activity types, and reflection – to create or enhance learning experiences in which teachers develop and deepen their understanding of the relationships between technology, pedagogy, and content. This study applied the ITM to a content-specific teaching methods course in a university-based teacher education program. The sections in this chapter provide a summary of the study, present findings and conclusions related to the research questions, discuss specific contributions of the ITM, delineate study limitations, offer implications for research and practice, and list recommendations for future research.

Summary of the Study

The TPACK theoretical framework provides a critical lens for evaluating how education programs prepare teachers to integrate technology into their instruction (Mishra & Koehler, 2006). Since the framework is built on the premise that effective teaching with technology requires an integrated form of knowledge, the framework serves as an analytical tool for development approaches that emphasize technological tools without consideration of their pedagogical application or usefulness for representing a specific content. Under the guidance of this analytic framework, Abbitt (2011) urges the creation and evaluation of teacher education models to discover if and how preservice teachers develop TPACK.

The researcher constructed the ITM by combining three TPACK development approaches – learning by design, learning activity types, and reflection – to engage teachers in technology-focused design tasks related to learning activity types while providing opportunities to reflect on instructional decisions. Mishra and Koehler (2006) contend that the creation of digital artifacts in learning by design experiences lead to products sensitive to both subject matter and instructional strategies. Hofer and Harris (2010) believe exposure to and experience using learning activity types helps teachers connect "curriculum-based learning goals with content area-specific learning activities and complementary technology tools" (p. 3858). Finally, reflection activities bring forth thinking in action (Schon, 1983), something Niess (2008) argued is necessary and essential for developing TPACK. In this study, the ITM was applied to a content-specific methods course because they provide environments conducive for developing TPACK in pre-service teachers (Niess, 2008).

The application of the model enabled the researcher to gather data from multiple sources to determine the extent that preservice teachers' understanding of TPACK changed over the course of a semester. Significant differences between mean scores on a pre- and post-survey, differences in evaluation scores between two designed and implemented lessons, and changes in thoughts evident in reflective writings were examined to determine if pre-service teachers demonstrated a growth in each of the seven constructs of the TPACK theoretical framework. Items on a post-survey asked participants to rate the effectiveness of learning experiences and identify which course activity they believe contributed most significantly to their development of TPACK.

Findings and Conclusions

Research Question 1

The first research question focused on measuring the extent, if any, that preservice teachers' understanding of the relationships between content, pedagogy, and technology changed. The researcher collected a combination of self-report and performance-based data to identify changes in TPACK. Shifts in preservice teachers' TPACK were measured and tracked using four sources of data.

Self-assessment of TPACK. The researcher administered a pre-survey at the beginning of the semester and a post-survey during the final class meeting. As recommended by instrument designers, the researcher adapted the *Survey of Preservice Teachers' Knowledge of Teaching and Learning* to gather teachers' self-assessment of their TPACK that focused on a specific content area (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009). Chai, Koh, and Tsai (2010) similarly altered the original TPACK survey, replacing traditional elementary content areas with teaching subjects of Singapore teachers. Dependent *t*-tests revealed a significant growth in mean scores from the pre- to the post-survey for all seven knowledge domains of the TPACK theoretical framework: technology knowledge (TK), content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK).

Significant increases between mean scores on the pre- and post-survey for all constructs indicated that the application of the ITM had a significant effect on the preservice teachers' self-assessed TPACK. Preservice teachers' reported an increased understanding of the relationships between content, pedagogy, and technology as evidenced in their responses to items on the survey. Shin, Koehler, Mishra, Schmidt, Baran, and Thompson (2009) similarly concluded that preservice teachers' TK, TCK, TPK, and TPACK improved over a semester while enrolled in an instructional technology course, conclusions deduced from significant differences calculated from a dependent *t*-test of items on Schmidt et al.'s (2009) TPACK survey. After enhancing a series of technology courses with learning by design experiments, Lu, Johnson, Tolley, Gilliard-Cook, and Lei (2011) administered the original Survey of Preservice Teachers' Knowledge of Teaching and Technology (Schmidt et al. 2009) and similarly concluded that significant increases in mean scores for the TPACK constructs indicated that their experiments had a significant effect on the development of participants' self-assessed TPACK. Chai et al. (2010) also concluded that significant differences between mean scores of participants' responses on an adapted TPACK survey suggest that design experiences in an instructional technology course supported the development of preservice teachers' self-assessed TPACK.

Thinking about TPACK. A content analysis identified 75 excerpts related to the seven constructs of the TPACK theoretical framework in the reflective writings of five participants over a three-month period. No excerpts were identified for TCK and only one excerpt was coded as CK. The frequency of excerpts coded as TK, TPK, and TPACK increased over the time span while frequencies for PK and PCK declined. The results suggest that preservice teachers repeatedly thought about the teaching strategies, as evidenced by the high frequency of PK, TPK, and TPACK thinking over the three months. Furthermore, the increase of TPK and TPACK over time depicts an increasing consideration of how technology fits with instructional strategies. The increased frequency of TPK and TPACK responses in the latter two months indicate a shift towards a more integrated thinking. The related decline in PK and PCK responses suggest that preservice teachers increasingly considered how technology supports instruction because of the enhancement and creation of course activities that integrated content, pedagogy, and technology.

Lu, Johnson, Tolley, Gilliard-Cook, and Lei (2011) also evaluated preservice teachers' growth of TPACK as evident in reflective writings. Viewing coverage of TPACK constructs as indicators of growth, their study concluded that preservice teachers' TPK, PK, TPACK, and TK grew because these constructs had the most coverage in reflective writings. Similarly, in this study, TPK (36.36%) and TPACK (33.33%) coverage during month 3 was greater than coverage in month 1. Additionally, coverage of CK, PK, PCK decreased from month 1 (4.76%, 33.33%, 14.29%) to month 3 (0.00%, 6.06%, 0.00%).

Ozgun-Koca, Meagher, and Edwards (2010) similarly identified growth in TPACK. Participant reflections in their study depicted a shift "from thinking of technology as a reinforcement tool to a tool for developing mathematical concepts" (Ozgun-Koca et al., 2010, p.13). Mishra, Koehler, and Yahya (2007) identified similar shifts when conducting a discourse analysis of design-related discussions between a faculty member and a group of students. They noted that early discussions focused solely on technology before "technology ceased to be treated in isolation and was discussed mainly in relationship to pedagogy" (Mishra, Koehler, & Yahya, 2007, p. 751).

The implementation of the ITM in this study created similar shifts in thinking. Results from the content analysis revealed an increased thinking about the role of technology in relation to pedagogy. The frequency of TPK excerpts increased from Month 1 (n=7, 33.33%) to Month 2 (n=15, 65.22%) while the frequency of TPACK excerpts increased from Month 2 (n=2, 8.7%) to Month 3 (n=11, 33.33%). Preservice teachers' TPACK grew as their thinking moved "towards a more transactional and co-dependent construction that indicated a sensitivity to the nuances of technology integration" (Koehler, Mishra, & Yahya, 2007, p. 758).

Lesson design and implementation evaluations. Throughout the semester, participants created a unit plan by designing three different types of lesson plans revolving around the same topic. In addition, the participants implemented each of these lessons in local elementary schools. The researcher selected a random sample of participants and compared their performances on the design of the first and final lesson plan to measure changes in TPACK. The researcher similarly compared performances on the first and final implemented lesson.

The *Technology Integration Assessment Rubric* was designed to "assess the quality of technology integration in lesson plans" (Harris, Grandgenett, & Hofer, 2010, p. 324), given that lesson plans are written in enough detail that raters can appropriately score the rubrics using four criteria. The methods course in this study required participants to write robust lesson plans using a template provided by the methods instructor. Three raters evaluated the lesson plans and mean rubric scores for each criterion were calculated. Differences in scores from the first to the final designed lesson were analyzed to determine any changes. Criterion scores for most participants were lower on the final lesson plan than on the first. A few participants showed little to no change in scores. The rubrics' scores indicated a lack of growth in TCK, TPK, and TPACK.

Evaluation of implemented instruction was completed using the *Technology Integration Observation Rubric* (Hofer, Grandgenett, Harris, & Swan, 2011). The instrument was designed to "assess enacted TPACK in observed lessons taught by either preservice or inservice teachers" (Hofer et al., 2011, p. 4357). The methods instructor, who routinely observes the implementation of these lessons, observed and evaluated the first and final implemented lessons for a sample of participants. She scored both the first and final instructional episode for each of the participants identified by lesson plan raters. Criterion scores for two participants decreased for all criterions from the first to the final implemented lesson. Criterion scores for the other participant did not change. Differences in scores between the first and final implemented episode revealed a lack of growth in TK, TCK, TPK, and TPACK.

Differences in rubric evaluation scores for both the designed and implemented lesson plans did not reflect a growth in any constructs of the TPACK framework. The results of these two data sources do not support the growth indicated in participants’ survey responses or reflective writings. However, several critical factors affected the evaluation and measurement of TPACK changes evidenced in lesson plans and observed instruction. Participants frequently commented during class meetings about the limited access to technology resources in their field placements. Secondly, the methods course required teachers to write three different types of lesson plans (concept, skill, generalization). The analysis of rubric scores from the first and final lesson plans tracked the growth of TPACK from a participant’s concept lesson plan to their generalization lesson plan. The methods instructor commented that preservice teachers typically struggle with designing a generalization lesson plan. Finally, participants designed their three lesson plans within weeks of each other and implemented their lessons over a course of three days. Thus, there is concern that insufficient time was allowed for teachers to develop and deepen their TPACK. As a result, findings from the lesson plan and observation rubrics were inconclusive for measuring the impact of TPACK development.

One goal of the ITM was to provide an opportunity for preservice teachers to implement ideas and strategies they learn during design experiments into authentic contexts (Graham, Cox, Velasquez, 2009). In this study, preservice teachers were required to implement lessons in local elementary schools. Niess (2005) affirmed the implementation of lessons that incorporate technology as a critical TPACK development experience. Niess also noted the limited technologies available to preservice teachers in their field placements as well as insufficient guidance from cooperating teachers regarding technology integration. Participants in this study frequently commented in class about the dearth of technology available in their assigned classroom placement as well as the unwillingness and resistance of mentor teachers to integrate technology. These variables potentially affected the ability of participants to demonstrate their TPACK in designed or implemented lessons.

Research Question 2

The second research question focused on identifying specific course experiences preservice teachers believe contributed to the development of their TPACK. Abbitt (2011) cited the need to determine "which teacher preparation experiences influence either the perceived knowledge, or the demonstrated ability, of preservice teachers to meaningfully integrate technology into teaching" (p. 297). Seven items on the post-survey administered during the final class meeting asked preservice teachers to rate the effectiveness of course activities created or enhanced by the application of the ITM. Preservice teachers also reported the activity that they believe contributed most significantly to their TPACK development. The researcher analyzed descriptive statistics to identify trends for the group.

First, the preservice teachers believed that all seven course activities created or enhanced by the application of the ITM were effective for developing TPACK. Mean scores for these activities ranged from 3.26 to 3.69. Since the four-point rating scale (Not Effective, Minimally Effective, Effective, Very Effective) for these items used a rating of "3" for activities reported as effective, the mean scores indicated that preservice teachers believe the activities were effective for developing TPACK, a conclusion supported by TPACK literature.

Weekly class meetings. Four of the course activities took place during weekly class meetings. Brush and Saye (2009) asserted that preservice teachers can develop TPACK by observing and participating in modeled lessons (*M* = 3.50) because they "engage in classroom activities that they potentially could use in their own classrooms" (p.50). Koh and Divaharan (2011) also included pedagogical modeling as an essential component in their TPACK-Developing Instructional Model. Almost a third of the participants (n = 13, 31%) indicated that this weekly course activity contributed most significantly to the development of their TPACK.

The identification and matching of observed teaching strategies with learning activity types (*M* = 3.26) followed other TPACK researchers' recommendation to provide preservice teachers with a completed list of activity types to effectively expose teachers to content-specific teaching strategies with recommended technologies (Graham, Cox, & Velasquez, 2009). Graham et al. (2009) affirm the effectiveness of mini-design experiments with technology during each class meeting (*M* = 3.45), as the activity enables preservice teachers with "little technological and pedagogical knowledge to explore content-specific pedagogies and technologies uses" (p. 4083). After observing and participating in a model lesson, matching strategies and learning activity types, and completing mini-design experiments, weekly class reflection prompts (*M* = 3.26) asked preservice teachers to think about how they might use strategies emphasized through the class meeting to help students learn. While the reflective exercise used a guiding prompt and occurred during the last five to ten minutes of the class meeting, Niess (2008) states that a "reflective expectation with each experience is essential for their development of TPACK" (p.249).

The two most frequently identified activities reported by participants as contributing most significantly to the development of their TPACK were observation of modeled lessons (*n* = 13, 31%) and the mini-design experiments (*n* = 14, 33%). Both activities occurred during weekly class meetings. The frequent selection of these two activities emphasizes the importance of enhancing courses with TPACK-developing activities.

Unit plan project. The other three course experiences enhanced by the ITM were related to the design and implementation of participants' unit plan. TPACK researchers have repeatedly recommended the design of lesson plans that incorporate technology for implementation in an actual classroom (*M* = 3.43) as an effective strategy for helping teachers develop integrated thinking about technology, instructional strategies, and specific content (Guzey & Roehrig, 2009; Jang & Chen, 2010; Niess, 2005; Ozgun-Koca, Meagher, & Edwards, 2009; Ozogul, Olina, & Sullivan, 2008). The implementation of designed lessons in local elementary schools (*M* = 3.69) provided opportunities for preservice teachers to experiment with strategies in authentic learning environments (Jang & Chen, 2010). Ozgun-Koca, Meagher, and Edwards (2009) consider similar implementation activities a "vital element in continuing the development of TPACK" (p.19). Finally, written reflections about designed and implemented lessons (*M* = 3.40) help preservice teachers "explicate, and further integrate their TPACK about students' learning difficulties, instructional strategies and technology" (Jang & Chen, 2010, p. 562).

Discussion

Koehler and Mishra (2008) describe the integration of technology into teaching and learning as a "complex and ill-structured problem involving the convoluted interaction of multiple factors" (p. 10). Dynamic technologies, varying classroom environments, and diverse learners present challenges for creating meaningful learning experiences with technology that predetermined solutions are incapable of solving. Therefore, the foundation for effective teaching with technology depends on the development of content knowledge, pedagogical knowledge, technological knowledge, as well as the knowledge bases that emanate from the interaction between these forms of knowledge (Mishra & Koehler, 2006; Koehler & Mishra, 2008). The resulting TPACK theoretical framework represents knowledge required to utilize technology in diverse and dynamic educational environments that are “contextually authentic and pedagogically appropriate” (Abbitt, 2011, p. 281; Mishra & Koehler, 2006). Mishra and Koehler (2006) encouraged application of the framework to design and evaluate integrated and design-infused approaches for developing the teacher knowledge needed to teach with technology.

In this study, the seven knowledge bases of the TPACK framework were measured to identify preservice teachers’ development of TPACK. The application of the ITM to a content-specific methods course created and enhanced learning experiences that increased preservice teachers’ self-assessed understanding of TPACK. In addition, preservice teachers engaged in a more integrated form of thinking regarding technology, pedagogy, and content. While contextual limitations affected the measurement of enacted TPACK, the ITM contributed to the development of each of the TPACK knowledge domains. The following sections discuss these contributions.

The Influence of the ITM on Preservice teachers Development of TPACK

The Integrated Triadic Model (ITM) ITM represents a new model to increase understanding of relationships between technology, pedagogy, and content. Mishra and Koehler (2006) believe that the development of this understanding “ought to be a critical goal of teacher education” (p. 1046). Learning by design (Mishra & Koehler, 2006; Koehler & Mishra, 2005) offers one approach for developing this type of knowledge, and many teacher educators have utilized this approach to develop TPACK (Bos, 2011; Lu, Johnson, Tolley, Gilliard-Cook, & Lei, 2011; Koehler, Mishra, Bouk, DeSchryver, Kereluik, & Shin, 2011).

Integrated approaches that include learning by design can appropriately prepare teachers to integrate technology in their instruction (Mishra & Koehler, 2006). Harris, Mishra, and Koehler (2009) also encourage the creation of new models, especially ones that incorporate content-based learning activity types. Abbitt (2011) recommended the creation and evaluation of new models that support the developing of TPACK in teacher education programs. Niess (2008) asserts that reflection is necessary for TPACK development, that a “reflective expectation with each experience is essential” (p. 249) to developing an integrated understanding of technology, pedagogy, and content. Harris, Mishra, and Koehler (2009) expressed the need to “invent, rise, expand, update, test, and otherwise explore the ways in which we understand and help teachers to develop TPACK” (p. 413). The construction and evaluation of the ITM in this study contributes to this call from researchers.

Some integrated TPACK development models (Koh & Divaharan, 2011; Jang & Chen 2010) emphasize both learning by design and reflection. However, the ITM combines the aforementioned approaches with learning activity types to offer a new model for creating learning experiences for teachers. The application of the model can enhance or develop learning experiences to build an understanding of the relationships between technology, content, and pedagogy. The following sections explain how the application of the ITM in this study contributed to the development of preservice teachers’ TPACK.

Technological knowledge (TK). To meaningfully incorporate technology into their teaching strategies and content representations, teachers need both knowledge of the affordances and constraints of available technologies as well as the skills needed to apply such technologies

(Mishra & Koehler, 2006). The dynamic nature of technology causes some tools and techniques to fade from use while other technologies evolve. As a result, teachers need learning experiences that continually expose them to emerging technologies and up-to-date strategies for using tools. The in-class, mini-design experiments created by the application of ITM allowed preservice teachers to further develop their technology knowledge. Teachers learned new techniques or discovered innovative technological tools. For example, when challenged to create a digital timeline of three events from the U.S. Civil Rights Movement, a large majority of teachers constructed a timeline using familiar productivity tools such as Microsoft Word and PowerPoint. However, they built and formatted timelines using pictures and shapes (i.e., rectangles, squares) instead of text-based narratives. Some teachers search for and utilized web-based time lining tools (i.e., TimeToast) to portray the events.

Preservice teachers shared how they created the timelines with their classmates while the researcher suggested additional tools and techniques for creating a timeline. The ITM did not specifically intend to boost technological knowledge through the mini-design experiments. Each experiment was framed by Koehler and Mishra’s (2005) learning technology by design approach. Preservice teachers actively solved a problem that contained multiple solutions or representations. Hence, experiment instructions did not specify which tools teachers needed to use nor did instructions delineate how the three events should be digitally represented. Furthermore, the experiments focused on content-relevant pedagogical strategies. Preservice teachers not only explored information associated with the Civil Rights Movements, but they experimented with the following learning activities from the Harris and Hofer’s (2011) Social Studies Learning Activity Types: sequence information, research, create a timeline. These experiments and subsequent sharing of solutions provided opportunities for the teachers to further develop their technological knowledge.

Content knowledge (CK). Mishra and Koehler (2006) define content knowledge as the intended subject matter to be taught by the teacher and learned by the students. The elementary methods course in this study emphasized the development of concepts, inquiry skills, generalizations (Sunal & Haas, 2011) for six disciplines of social studies (civics, government, economics, history, geography, and cultures and global awareness). The ITM did not specifically aim to improve preservice teachers' knowledge of the six disciplines of elementary social studies. However, the designing of a unit plan contributed to the development of content knowledge. When designing and implementing lessons in actual classrooms, preservice teachers researched their topics before designing the lesson. For example, one preservice teacher's lesson about the First Thanksgiving required a deeper understanding of the historical background of the event. The teacher spent time researching content matter needed for her lesson. Chai, Koh, and Tsai (2010) reported a similar growth in content knowledge when specific content is used to frame course activities for building TPACK. Lu, Johnson, Gulley, Gilliard-Cook, and Lei (2011) suggested that future studies should explore how TPACK approaches might better help teachers develop content knowledge.

Pedagogical knowledge (PK). Mishra and Koehler (2006) define pedagogical knowledge as "deep knowledge about the process and practices or methods of teaching and learning" (p. 1026). Teachers' knowledge about effective instructional strategies develops as they become aware of strategies, implement them into their instruction, and evaluate their effectiveness. The incorporation of learning activity types in the ITM brought about experiences where preservice teachers matched learning activity types with strategies they believe the methods instructor utilized during the model lesson. While the taxonomy of learning activity types included possible technologies, the matching of strategies with learning activity types created an awareness of strategies that contributed to participants' growth in pedagogical knowledge (Harris, Mishra, & Koehler, 2009).

Pedagogical content knowledge (PCK). Knowledge of the strategies and methods appropriate for teaching, given a specific content, is called pedagogical content knowledge (Mishra & Koehler, 2006; Shulman, 1986). PCK is concerned with knowing which teaching strategies are most useful for helping learners understand a targeted content. The design and teaching of a unit plan was conducive for building PCK. Preservice teachers asked their mentor teachers what topic they needed to teach about (i.e., historical landmarks) and then explored strategies and methods for designing instructional activities for that topic. The application of the ITM enhanced this project by requiring all lesson plans to include some form of technology. However, technology was not required in every step of a lesson. Therefore, preservice teachers made some instructional decisions that did not incorporate technology in a lesson plan. This decision-making contributed to their development of PCK.

Technological content knowledge (TCK). The understanding of how technology enables innovative representations of a specific subject matter is called technological content knowledge (Mishra & Koehler, 2006). The ITM did not aim to develop this understanding because all three TPACK development approaches in the ITM emphasize a consideration of pedagogical practices. The in-class design experiments focused on a learning activity type modeled by the methods instructor. Preservice teachers explored different ways to replicate that strategy with technology. Guiding questions for reflective writings asked preservice teachers how they used technology for instruction. Therefore, the inclusion and integration of the three approaches in the ITM make it very difficult to remove pedagogy from consideration. The lack of an identified TCK excerpt in the content analysis supports this assertion. However, the exposure to teaching strategies could have helped preservice teachers think about how social studies can be represented. For example, participants learned that the creation of concept maps or knowledge webs is a valuable strategy for assessing prior knowledge. The exposure to concept maps could have helped preservice teachers think about how they can graphically represent social studies content for learners.

Technological pedagogical knowledge (TPK). Mishra and Koehler (2006) define technological pedagogical knowledge as an understanding "of the existence, components, and capabilities of various technologies as they are used in teaching and learning settings" (p.1028). The content analysis of reflective writings revealed a high frequency of TPK excerpts in Month 1 (33.33%), Month 2 (65.22%), and Month 3 (36.66%) of the semester, containing the highest frequency of any TPACK construct for each month. Preservice teachers read through and reviewed the taxonomy of social studies learning activity types on a weekly basis. The taxonomy contains a table that lists teaching and learning strategies matched with suggested technologies for implementation. The weekly emphasis of an explicit and tangible list of technology-aligned teaching strategies contributed to the development of teachers' technology pedagogical knowledge.

Technological pedagogical content knowledge (TPACK). Not only did course experiences emanating from the ITM contribute to the development of other knowledge domains in the TPACK framework, but weekly class meetings and the unit plan project engaged preservice teachers in a simultaneous consideration of technology, pedagogy, and content. The mini-design experiments required preservice teachers to think about specific content and consider how to digitally represent that content. For example, during one class experiment, preservice teachers received a paper copy of a one-page story about the first Thanksgiving. The researcher challenged teachers to create a digital comic strip of that story. Teachers researched and evaluated available tools that were capable of representing an important national holiday. Weekly participation in these class activities influenced the development of TPACK because it initiated a "thoughtful interweaving of all three source of key knowledge: technology, pedagogy, and content" (Mishra & Koehler, 2006, p. 1029).

The unit plan similarly required preservice teachers to design and implement a series of lessons that incorporated technology. Teachers selected instructional strategies and related technologies that were useful for designing instruction that met the stated goals of a lesson. Equipped with a list of learning activity types and aware of the technologies available in the teaching context, teachers decided the best approach for representing the targeted content for their students. For example, one preservice teacher needed to teach her students the process of conducting an election. She had to consider how to represent this process to students and select teaching strategies for building this representation while repeatedly considering how they could be incorporated.

Improvements to the Integrated Triadic Model

Throughout the study, participants often approached the researcher for advice about integrating technology into their lesson plans. Participants would explain their ideas for the lesson and offer ideas for integrating technology. Some participants needed guidance in incorporating technology since its inclusion was a requirement for each lesson plan. To prevent bias, the researcher always directed to participants to seek help from the methods instructor. The research did not want to influence the quality of lesson plans used for analysis.

The participants also commented frequently about the lack of guidance they received in field placements from their mentor teachers. While most of the mentor teachers helped the participants with classroom management techniques and teaching the content, many participants felt that their mentor teachers provided little help regarding technology integration. Participants also felt uninformed about the technology available in their placements.

The Integrated Triadic Model (ITM) could be improved through the addition of a fourth approach to developing TPACK: mentoring. Shah and Lee (2010) concluded that a technological mentoring approach can initiate the “development of TPACK literacy skills and bring about instructional improvement” (p. 2070). An apprenticeship model (Shafer, 2008) has also proven to improve classroom instruction and development of several TPACK constructs (TK, TPK, and TPACK). The integration of a technology mentoring/apprenticeship model could improve the ITM for developing TPACK.

Limitations

This study contained several limitations in need of consideration. First, the application of the researcher-constructed ITM created learning experiences designed and implemented by the researcher. During weekly class meetings, the researcher led the matching activity with the taxonomy of learning activity types. He pointed out learning activity types modeled by the methods instructor that preservice teachers overlooked during the matching exercise. Additionally, the researcher shared technological suggestions not listed in the taxonomy of learning activity types. The researcher also developed the weekly in-class design experiments. At the conclusion of some experiments, the researcher explained how to use certain tools to replicate certain teaching strategies. This direct influence in course activities potentially influenced participants’ reflections and pre- and post-survey responses.

Next, the researcher's selection of two sections of the course resulted in smaller sample sizes. Smaller sample sizes can impact statistical analysis and related conclusions. The researcher found it difficult to adequately triangulate the four sources of data because of the differing sample sizes used in each analysis. Statistical analysis of survey responses included a sample large enough for conducting statistical analysis. However, smaller sample sizes prevented the researcher from conducting statistical analysis of preservice teachers' lesson plan and implemented instruction evaluation scores. Consequently, the differing sample sizes problematized the triangulation of self-assessment survey responses and data obtained from performance artifacts.

Third, preservice teachers' enacted TPACK, as identified in lesson plans and implemented instruction, were measured using instruments recently developed by TPACK researchers. While statistically valid and reliable, the researcher's measurement of performance-based data with both instruments represented one of the preliminary uses for identifying and tracking teachers' TPACK.

Fourth, raters for the lesson plan analysis, lesson observations, and content analysis were selected and trained by the researcher. The researcher also served as a rater for both the evaluation of lesson plans and the content analysis of written reflections. He was directly involved in the evaluation of data.

Finally, the study was conducted in a methods course during a fifteen week semester. The researcher evaluated lesson plans and instructional episodes taught within days of each other. Furthermore, the designed and implemented lessons included all levels of elementary education. Therefore, evaluation and analysis could have been affected by the levels randomly selected for analysis. Comparisons could have been made between a first grade and a fifth grade lesson plan.

Implications

Teacher Education

The findings of this study suggest that teacher education programs need to evaluate all components of their preparation program and consider how each learning experience contributes to the growth of a teacher's TPACK. Mishra and Koehler (2006) reiterate that "developing TPACK ought to be a critical goal of teacher education" (p.1046). Abbitt (2011) called for the development and evaluation of teacher preparation models that best develop teachers' understanding of the relationship between technology, pedagogy, and content. The ITM has the potential to enhance many components of a teacher education program.

Methods courses. While other researchers have attempted to develop TPACK in stand-alone instructional technology courses (Chai, Koh, & Tsai, 2010; Graham, Borup, & Smith, 2012; Lu, Johnson, Tolley, Gilliard-Cook, & Lei, 2011; Ozogul, Olina, & Sullivan, 2008), Niess (2008) argues that teaching methods courses provide the most natural environment for building TPACK in preservice teachers. Researchers have incorporated TPACK approaches to enhance existing methods courses (Jaipal & Figg, 2010; Ozgun-Koca, Meagher, & Edwards, 2009) while others have applied TPACK models (Jang & Chen, 2010; Koh & Divaharan, 2011) to reframe a methods course. The application of the ITM to a content-specific teaching methods course contributed to preservice teachers' development of TPACK and justifies the continued integration of technology and methods instruction. Graham, Cox, and Velasquez (2009) bridged the gap by creating design experiences for preservice teachers dually enrolled in a methods and instructional technology course. This study bridged the gap even further and provides a model for developing TPACK in a content-specific teaching methods course.

Instructional technology courses. Teacher education programs should also consider application of the ITM in instructional technology courses. The ITM can be used to reframe learning activities by introducing learning activity types through design experiments that involve technology. Most instructional technology courses focus on the affordances and constraints of specific tools without consideration of their pedagogical application and usefulness for representing a specific content (Mishra & Koehler, 2006). Furthermore, many instructional technology courses contain a diverse student population with regards to teaching fields. The variety of content-specific learning activity taxonomies and their usefulness for linking teaching strategies with appropriate technologies provide a valuable tool for engaging preservice teachers in a simultaneous consideration of technology, pedagogy, and content (Harris, Hofer, Schmidt, Blanchard, Young, Grandgenett, & Van Olphen, 2010).

Field experiences. Preservice teachers often complete a variety of field experiences while enrolled in a teacher education program. Most experiences require teachers to implement a lesson or series of lessons. The ITM could enhance these experiences by providing teachers with "curriculum-specific, technology enhanced learning activity types as the building blocks" for lessons in their field experiences (Harris & Hofer, 2009, p. 100). Hofer and Harris (2010) suggest that teachers can use individual or combinations of learning activity types to construct lesson and unit plans of instruction. When selecting items for the taxonomy that match their target content, teachers evaluate technological options as depicted in the taxonomy. Harris and Hofer (2011) found that in-service teachers planned more student-centered lessons that reflected "deliberate decisions for more educational technology use" (p. 211) after engaging a professional development initiative that emphasized content-specific learning activity types. As a result, the development of preservice teachers' TPACK could benefit from a more intentional use of learning activity types when planning lessons during field experiences.

Learning activity types. The findings of this study justify further exploration of learning activity types as an approach to developing preservice teachers' TPACK in teacher education programs. Harris and Hofer (2011) stated the need to vet the activity types through empirical-based studies. The preservice teachers in this study indicated that matching activity with taxonomy of social studies learning activity types was effective for developing TPACK. Hofer and Harris (2010) recommend that teacher educators scaffold learning experiences with learning activity types, where preservice teachers first learn about the structure and components of a lesson plan before they think about how they are used to address curricular goals using different combinations of learning activity types. Harris, Hofer, Schmidt, Blanchard, Young, Grandgenett, and Olphen (2010) recommend the introduction and use of learning activity types throughout all methods courses. Graham, Cox, and Velasquez (2009) asked preservice teachers to examine example lesson plans and develop their own original taxonomies. Hofer and Harris (2010) assert that "the comprehensive taxonomies of learning activity types in the LAT approach help to augment and extend, rather than compete with" (p. 3860) the learning goals of methods courses.

The application of the ITM offered one approach for incorporating social studies learning activity types. Taxonomies now exist for the following subject areas: K-6 Literacy, Mathematics, Music, Physical Education, Science, Secondary English Language Arts, Social Studies, Visual Arts, and World Languages (Activity types, 2013). Teacher education programs should experiment with innovative uses of these curriculum-specific, technology-aligned lists of teaching strategies.

TPACK Research

Since the TPACK framework was constructed in 2006, researchers have expressed concern over how to efficiently and accurately measure this integrated form of knowledge (Mishra & Koehler, 2006) using valid and reliable methodologies. While reviewing methods and instruments for measuring TPACK, Abbitt (2011) noted that “teacher knowledge of technology in teaching and learning is dynamic and is heavily influenced by the context in which the activity takes place” (p. 288). For this reason, researchers need to utilize multiple methods to triangulate changes in TPACK (Mishra & Koehler 2006; Abbitt, 2011). This study answered this call by gathering preservice teachers’ beliefs about TPACK using data from a self-report survey, two performance measures (lesson plan, implemented instruction), and reflective writings. The collection and analysis of data using these instruments yield several implications for further TPACK research.

As encouraged by instrument designers, the researcher adapted the Survey of Preservice Teachers’ Knowledge of Teaching and Technology (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009) to strengthen validity and reliability. First, Schmidt et al. (2009) suggested that researchers tailor the instrument to “specifically address measuring secondary teachers’ self-assessment in the content areas of mathematics, science, social studies, and English” (p. 137). Since the original instrument was designed to measure self-assessed TPACK for elementary teachers, all four subjects were included in the survey. However, since the course chosen for this study was an elementary social studies methods course, the researcher decided to replace the four subject areas the six disciplines of social studies highlighted in the course. This led to the additional items designed to measured preservice teachers’ CK, TCK, PCK, and TPACK. Schmidt et al. (2009) said the inclusion of additional items for these constructs would strengthen the instrument’s validity and reliability. Therefore, the researcher-adapted version offers an elementary subject-specific TPACK self-assessment instrument.

This study also utilized two emerging instruments for identifying and measuring TPACK evidence in performance. Abbitt (2011) stated that TPACK building approaches develop and measure both the perceived knowledge and demonstrated ability to effectively and appropriately teach with technology. The researcher-adapted survey and reflective writings captured the preservice teachers’ perceived knowledge. The study utilized two performance evaluation instruments to measure demonstrated ability regarding technology integration. The researcher and two raters evaluated lesson plans using the Technology Integration Assessment Rubric (Harris, Grandgenett, & Hofer, 2010). The methods instructor observed participants’ implementation of lesson plans and rated their performance using the Technology Integration Observation Rubric (Hofer, Grandgenett, Harris, & Swan, 2011). Both instruments were useful for identifying and assessing the quality of technology integration portrayed in full-length lesson plans and implemented instructional episodes.

The application of the ITM in a semester-long methods course presented difficulties for tracking development of TPACK from one lesson plan to the next. Preservice teachers designed lesson plans within weeks of one another. More time is needed between lesson designs so that preservice teachers can receive feedback and reflect upon their decision making. These accommodations could allow for a more accurate measurement of TPACK development.

Furthermore, researchers should evaluate similar types of designed and implemented lessons. The incorporation of three types of lesson plans affected researcher’s comparisons while analyzing data. In the absence of similar types of plans, research could consider using a benchmark from which to compare teacher’s performance. Research might consider comparing lessons plans with similar plans designed in previous semesters or learning experiences.

Recommendations for Future Research

Recommendation #1

Future research should replicate this study in other content-specific teaching methods courses. Studies should alter the research design so that researchers evaluate the same type of lesson plan. Additionally, research designs should allot sufficient time between lesson plan designs for teachers to build their TPACK. Instead of using social studies learning activity types, future research should incorporate Harris and Hofer’s (Activity types, 2013) subject-specific taxonomies that match the content of the methods course. Furthermore, future research should consider a qualitative approach to more adequately triangulate changes in TPACK. Research should consider collecting and analyzing data for a group of two to three students and tracking their development by collecting the four types of data collected in this study.

Recommendation #2

Future experimental studies should compare the impact of the ITM in a methods course (experimental) versus a methods course not enhanced by the application of the ITM (control). Research should determine the extent that preservice teachers’ TPACK changes in each format.

Recommendation #3

Due to the limitations of identifying and measuring TPACK in a fifteen week semester, future research should examine the development of TPACK over a longer period of time. Researchers have similarly concluded the need for longitudal studies (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009; Schmidt, Seymour, Sahin, & Thompson, 2008). Future research could utilize a variety of instruments to measure TPACK development beginning with preservice teachers’ enrollment in a teacher education program and continue the tracking into their first years as an in-service teacher.

Recommendation #4

Future research could apply and examine the impact of the ITM on in-service teacher professional development experiences that currently focus on technology instruction. Research could examine how the ITM can be applied to enhance traditional tool-based workshops. Similarly, research could consider how the ITM can be used to frame the professional development experiences in a professional learning group of in-service teachers.

Recommendation #5

Future research could identify which learning experiences significantly contribute to the development of teachers’ TPACK. This study only examined teachers’ beliefs about which experiences were effective. Future studies might consider using regression analysis to determine which learning experiences significantly contribute to the development of teachers’ TPACK.

Summary

This study applied the researcher-constructed Integrated Triadic Model (ITM) to an elementary social studies teaching methods course and measured the extent that preservice teachers’ technological pedagogical content knowledge (TPACK) changed throughout the semester. The study also gathered preservice teachers’ beliefs about the effectiveness of ITM-based course activities for developing TPACK. Participants’ self-assessment and reflective writings indicated an increase in preservice teachers’ understanding of the relationships between technologies, instructional strategies, and social studies content. Although performance-based data did not support similar growth, contextual limitations of the study were not conducive for accurately measuring a change in participants’ enacted TPACK.

The application of the ITM created and enhanced course activities that contributed to the development of preservice teachers’ TPACK. The ITM represents a new model that combines three TPACK development approaches to prepare teachers to effectively and appropriately teach with technology. The incorporation of learning activities types into the ITM augments existing models that feature learning by design and reflection. Teacher education programs can use the ITM to evaluate and re-design learning experiences in instructional technology courses, methods courses, and field placements to better prepare preservice teachers to integrate technology into teaching and learning activities. Future research should apply the ITM in both preservice and in-service preparatory experiences to engage teachers in a deeper, simultaneous consideration of technology, pedagogy, and content. Research should track teachers’ development of TPACK over time using longitudal studies.

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APPENDICES

Appendix A

Survey of Preservice Teachers' Knowledge of Teaching Elementary Social Studies and Technology

Technology is a broad concept that can mean a lot of different things. For the purpose of this questionnaire, technology is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. 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."

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1. I know how to solve my own technical problems.					
2. I can learn technology easily.					
3. I keep up with important new technologies.					
4. I frequently play around the technology.					
5. I know about a lot of different technologies.					
6. I have the technical skills I need to use technology.					
7. I have sufficient knowledge about civics.					
8. I can view a(n) issue/topic (e.g. voting rights) from a civics perspective.					
9. I have various ways and strategies of developing my understanding of civics.					
10. I have sufficient knowledge about government.					
11. I can view a(n) issue/topic (e.g. voting rights) from a government perspective.					
12. I have various ways and strategies of developing my understanding of government.					
13. I have sufficient knowledge about economics.					
14. I can view a(n) issue/topic (e.g. voting rights) from a economics perspective.					
15. I have various ways and strategies of developing my understanding of economics.					
16. I have sufficient knowledge about history.					
17. I can view a(n) issue/topic (e.g. voting rights) from a historical perspective.					
18. I have various ways and strategies of developing my understanding of history.					
19. I have sufficient knowledge about geography.					
20. I can view a(n) issue/topic (e.g. voting rights) from a geographical perspective.					
21. I have various ways and strategies of developing my understanding of geography.					
22. I have sufficient knowledge about cultures/global awareness.					
23. I can view a(n) issue/topic (e.g. voting rights) from a cultural/global awareness perspective.					
24. I have various ways and strategies of developing my understanding of cultures/global awareness.					
25. I know how to assess student performance in a classroom.					
26. I can adapt my teaching based-upon what students currently understand or do not understand.					
27. I can adapt my teaching style to different learners.					
28. I can assess student learning in multiple ways.					

29. I can use a wide range of teaching approaches in a classroom setting.					
30. I am familiar with common student understandings and misconceptions.					
31. I know how to organize and maintain classroom management.					
32. I can select effective teaching approaches to guide student thinking and learning in civics.					
33. I can select effective teaching approaches to guide student thinking and learning in government.					
34. I can select effective teaching approaches to guide student thinking and learning in economics.					
35. I can select effective teaching approaches to guide student thinking and learning in history.					
36. I can select effective teaching approaches to guide student thinking and learning in geography.					
37. I can select effective teaching approaches to guide student thinking and learning in cultures/global awareness.					
38. I know about technologies that I can use for understanding and doing civics.					
39. I know about technologies that I can use for understanding and doing government.					
40. I know about technologies that I can use for understanding and doing economics.					
41. I know about technologies that I can use for understanding and doing history.					
42. I know about technologies that I can use for understanding and doing geography.					
43. I know about technologies that I can use for understanding and doing cultures/global awareness.					
44. I can choose technologies that enhance the teaching approaches for a lesson.					
45. I can choose technologies that enhance students' learning for a lesson.					
46. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.					
47. I am thinking critically about how to use technology in my classroom.					
48. I can adapt the use of the technologies that I am learning about to different teaching activities.					
49. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.					
50. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.					
51. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.					
52. I can choose technologies that enhance the content for a lesson.					
53. I can teach lessons that appropriately combine civics, technologies and teaching approaches.					
54. I can teach lessons that appropriately combine government, technologies and teaching approaches.					
55. I can teach lessons that appropriately combine economics, technologies and teaching approaches.					
56. I can teach lessons that appropriately combine history, technologies and teaching approaches.					

57. I can teach lessons that appropriately combine geography, technologies and teaching approaches.					
58. I can teach lessons that appropriately combine cultures/global awareness, technologies and teaching approaches.					

Appendix B

Survey of Preservice Teachers' Knowledge of Teaching Elementary Social Studies and Technology

Technology is a broad concept that can mean a lot of different things. For the purpose of this questionnaire, technology is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. 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."

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1. I know how to solve my own technical problems.					
2. I can learn technology easily.					
3. I keep up with important new technologies.					
4. I frequently play around the technology.					
5. I know about a lot of different technologies.					
6. I have the technical skills I need to use technology.					
7. I have sufficient knowledge about civics.					
8. I can view a(n) issue/topic (e.g. voting rights) from a civics perspective.					
9. I have various ways and strategies of developing my understanding of civics.					
10. I have sufficient knowledge about government.					
11. I can view a(n) issue/topic (e.g. voting rights) from a government perspective.					
12. I have various ways and strategies of developing my understanding of government.					
13. I have sufficient knowledge about economics.					
14. I can view a(n) issue/topic (e.g. voting rights) from a economics perspective.					
15. I have various ways and strategies of developing my understanding of economics.					
16. I have sufficient knowledge about history.					
17. I can view a(n) issue/topic (e.g. voting rights) from a historical perspective.					
18. I have various ways and strategies of developing my understanding of history.					
19. I have sufficient knowledge about geography.					
20. I can view a(n) issue/topic (e.g. voting rights) from a geographical perspective.					
21. I have various ways and strategies of developing my understanding of geography.					
22. I have sufficient knowledge about cultures/global awareness.					
23. I can view a(n) issue/topic (e.g. voting rights) from a cultural/global awareness perspective.					
24. I have various ways and strategies of developing my understanding of cultures/global awareness.					
25. I know how to assess student performance in a classroom.					
26. I can adapt my teaching based-upon what students currently understand or do not understand.					
27. I can adapt my teaching style to different learners.					
28. I can assess student learning in multiple ways.					

29. I can use a wide range of teaching approaches in a classroom setting.					
30. I am familiar with common student understandings and misconceptions.					
31. I know how to organize and maintain classroom management.					
32. I can select effective teaching approaches to guide student thinking and learning in civics.					
33. I can select effective teaching approaches to guide student thinking and learning in government.					
34. I can select effective teaching approaches to guide student thinking and learning in economics.					
35. I can select effective teaching approaches to guide student thinking and learning in history.					
36. I can select effective teaching approaches to guide student thinking and learning in geography.					
37. I can select effective teaching approaches to guide student thinking and learning in cultures/global awareness.					
38. I know about technologies that I can use for understanding and doing civics.					
39. I know about technologies that I can use for understanding and doing government.					
40. I know about technologies that I can use for understanding and doing economics.					
41. I know about technologies that I can use for understanding and doing history.					
42. I know about technologies that I can use for understanding and doing geography.					
43. I know about technologies that I can use for understanding and doing cultures/global awareness.					
44. I can choose technologies that enhance the teaching approaches for a lesson.					
45. I can choose technologies that enhance students' learning for a lesson.					
46. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.					
47. I am thinking critically about how to use technology in my classroom.					
48. I can adapt the use of the technologies that I am learning about to different teaching activities.					
49. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.					
50. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.					
51. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.					
52. I can choose technologies that enhance the content for a lesson.					
53. I can teach lessons that appropriately combine civics, technologies and teaching approaches.					
54. I can teach lessons that appropriately combine government, technologies and teaching approaches.					
55. I can teach lessons that appropriately combine economics, technologies and teaching approaches.					
56. I can teach lessons that appropriately combine history, technologies and teaching approaches.					

57. I can teach lessons that appropriately combine geography, technologies and teaching approaches.					
58. I can teach lessons that appropriately combine cultures/global awareness, technologies and teaching approaches.					
59. For the items listed below, rate the effectiveness of each course activity for developing your TPACK.	**Not effective**	**Minimally Effective**	**Effective**	**Very Effective**	
Matching methods with Learning Activity Types					
Observing instructors teaching strategies					
Design experiments during class meetings					
Reflecting about class activities					
Designing lesson plans					
Reflecting on decisions in lesson plans					
Implementing lessons plans in elementary classrooms					
60. Which course activity listed above do you believe contributed ***most*** significantly to the development of your TPACK?					

Appendix C
Technology Integration Assessment Rubric

Criteria	**4**	**3**	**2**	**1**	**Score**
Curriculum Goals & Technologies (Curriculum-based technology use)	Technologies selected for use in the instructional plan are strongly aligned with one or more curriculum goals.	Technologies selected for use in the instructional plan are aligned with one or more curriculum goals.	Technologies selected for use in the instructional plan are partially aligned with one or more curriculum goals.	Technologies selected for use in the instructional plan are not aligned with any curriculum goals.	
Instructional Strategies & Technologies (Using technology in teaching/ learning)	Technology use optimally supports instructional strategies.	Technology use supports instructional strategies.	Technology use minimally supports instructional strategies.	Technology use does not support instructional strategies.	
Technology Selection(s) (Compatibility with curriculum goals & instructional strategies)	Technology selection(s) are exemplary, given curriculum goal(s) and instructional strategies.	Technology selection(s) are appropriate, but not exemplary, given curriculum goal(s) and instructional strategies.	Technology selection(s) are marginally appropriate, given curriculum goal(s) and instructional strategies.	Technology selection(s) are inappropriate, given curriculum goal(s) and instructional strategies.	
"Fit" (Curriculum, pedagogy and technology together)	Curriculum, instructional strategies and technology fit together strongly within the instructional plan.	Curriculum, instructional strategies and technology fit together within the instructional plan.	Curriculum, instructional strategies and technology fit together somewhat within the instructional plan.	Curriculum, instructional strategies and technology do not fit together within the instructional plan.	

*Curriculum refers to the goals and objectives as stated in the lesson plan.

Appendix D
Technology Integration Observation Rubric

Unique ID Number:

Primary Learning Goals:

<u>Directions:</u>
Please record the key curriculum topics addressed, instructional strategies/learning activities observed, and digital and non-digital technologies used by the teacher and/or students in the lesson.

Curriculum Topic	Key Instructional Strategies/Learning Activities	Digital & Non-Digital Technologies

What, if anything, do you know about influences upon what you have observed in this lesson? Examples might include students' learning needs, preferences, and challenges; access to technologies; cultural, language and/or socioeconomic factors.

Criteria	**4**	**3**	**2**	**1**	**Score**
Curriculum* Goals & Technologies (Curriculum-based technology use)	Technologies selected for use in the instructional plan are strongly aligned with one or more curriculum goals.	Technologies selected for use in the instructional plan are aligned with one or more curriculum goals.	Technologies selected for use in the instructional plan are partially aligned with one or more curriculum goals.	Technologies selected for use in the instructional plan are not aligned with any curriculum goals.	
Instructional Strategies & Technologies (Using technology in teaching/ learning)	Technology use optimally supports instructional strategies.	Technology use supports instructional strategies.	Technology use minimally supports instructional strategies.	Technology use does not support instructional strategies.	
Technology Selection(s) (Compatibility with curriculum goals & instructional strategies)	Technology selection(s) are exemplary, given curriculum goal(s) and instructional strategies.	Technology selection(s) are appropriate, but not exemplary, given curriculum goal(s) and instructional strategies.	Technology selection(s) are marginally appropriate, given curriculum goal(s) and instructional strategies.	Technology selection(s) are inappropriate, given curriculum goal(s) and instructional strategies.	
"Fit" (Curriculum, pedagogy and technology together)	Curriculum, instructional strategies and technology fit together strongly within the instructional plan.	Curriculum, instructional strategies and technology fit together within the instructional plan.	Curriculum, instructional strategies and technology fit together somewhat within the instructional plan.	Curriculum, instructional strategies and technology do not fit together within the instructional plan.	
Instructional Use (Using technologies effectively for instruction)	Instructional use of technologies is maximally effective in the observed lesson.	Instructional use of technologies is effective in the observed lesson.	Instructional use of technologies is minimally effective in the observed lesson.	Instructional use of technologies is ineffective in the observed lesson.	
Technology Logistics (Operating technologies effectively)	Teachers and/or students operate technologies very well in the observed lesson.	Teachers and/or students operate technologies well in the observed lesson.	Teachers and/or students operate technologies adequately in the observed lesson..	Teachers and/or students operate technologies inadequately in the observed lesson.	

*Curriculum refers to the goals and objectives as stated in the lesson plan.

Comments:

Appendix E
Social Studies Learning Activity Types (Hofer & Harris, 2011)

Knowledge Building Activity Types

Activity Type	Brief Description	Possible Technologies
Read Text	Students extract information from textbooks, historical documents, census data, etc.; both print-based and digital formats	Digital archives, Web sites, electronic books, audiobooks
Read Maps, Charts and Tables	Students extract and/or synthesize information from maps, charts and/or tables	Textbook supplements, Web-based datasets (e.g., CIA World Factbook)
View Presentation	Students gain information from teachers, guest speakers, and peers; synchronous/asynchronous, oral or multimedia	Presentation software, videoconferencing, video creation software (e.g. Movie Maker, iMovie), concept mapping software
View Images	Students examine both still and moving (video, animations) images; print-based or digital format	Presentation software, word processor, video creation software (e.g. Movie Maker, iMovie), image sharing sites (e.g. Flickr.com)
Listen to Audio	Students listen to audio recordings of speeches, music, radio broadcasts, oral histories, and lectures; digital or non-digital	Digital audio archives, podcasts (e.g., “Great Speeches in History,” etc.), audiobooks
Take Notes	Students record information from lecture, presentation, and/or group work	Word processor, wiki, concept mapping software
Discuss	In small to large groups, students engage in dialogue with their peers; synchronous/asynchronous, structured or unstructured	Discussion fora, discussion in wikis and blogs
Debate	Students discuss opposing viewpoints; formal/informal; structured/unstructured; synchronous/asynchronous	Discussion fora, discussion or commenting in blogs and wikis

Experience a Field Trip	Students travel to physical or virtual sites; synchronous/asynchronous	Virtual fieldtrips, presentation, video creation software and/or Google Earth to develop their own virtual tours
Sequence Information	Students sequence information, data and/or documents in chronological order	Timeline creation software, video creation software (e.g. Movie Maker, iMovie)
Consider Evidence	Students explore a variety of types of evidence (e.g., historical documents, photographs, data) related to a topic or question	Digital archives, extant data sets (e.g., U.S. Census data), Historical Scene Investigation (HSI)
Compare/Contrast	Students interrogate information to understand multiple characteristics, evidence, and/or perspectives on a topic	Concept mapping software, word processor, spreadsheet, digital archives
Engage in a Simulation	Students engage in paper-based or digital experiences focused on a content topic which mirror the complexity of the real world	Content-specific simulation (e.g. Fantasy Congress, Stock Market Game)
Conduct an Interview	Face to face, via audio/videoconference, or via email students question someone on a chosen topic; may be digitally recorded and shared	Video creation software (e.g. Movie Maker, iMovie), audio recorder, digital camera
Research	Students gather, analyze, and synthesize information using print-based and/or digital sources	Digital archives, word processor, concept mapping software to structure
Engage in Artifact-Based Inquiry	Students explore a topic using physical or virtual artifacts, including data, text, images, etc.	Digital archives
Engage in Data-Based Inquiry	Using student-generated data or print-based and digital data available online, students pursue original lines of inquiry	Digital archives, extant data sets (e.g., C.I.A. World Factbook, U.S. Census data, Thomas), student-collected data, spreadsheet

Convergent Knowledge Expression Activity Types

Activity Type	Brief Description	Possible Technologies
Answer Questions	Students respond to questions using traditional question sets or worksheets, or through the use of an electronic discussion board, email or chat	Word processor, concept mapping software, discussion fora, student response systems (SRS)
Create a Timeline	Students sequence events on a printed or electronic timeline or through a Web page or multimedia presentation	Timeline creation software, presentation software, concept mapping software, word processor
Create a Map	Students label existing maps or produce their own; print-based materials or digitally	Scanner, outline maps available online, Google Earth, presentation software
Complete Charts/Tables	Students fill in teacher-created charts and tables or create their own in traditional ways or using digital tools	Word processor, concept mapping software
Complete a Review Activity	Students engage in some form of question and answer to review content; paper-based to game-show format using multimedia presentation tools	Student response systems (SRS), interactive whiteboard review games (e.g., Jeopardy), survey tools
Take a Quiz/Test	Students demonstrate their knowledge through paper-based, traditional format to computer-generated and scored assessments	Online quizzes

Written Divergent Knowledge Expression Activity Types

Activity Type	Brief Description	Possible Technologies
Write an Essay	Students compose a structured written response to a prompt; paper and pencil or word processed; text-based or multimedia	Word, concept mapping software, wiki (to track contributions from multiple authors)
Write a Report	Students author a report on a topic in traditional or more creative format using text or multimedia elements	Word processor, presentation software, Web authoring software, wikis
Generate a Narrative	Using primary documents and secondary source information, students develop their own story of the past	Word processor, wiki or collaborative word processor (to track contributions from multiple authors), blog
Craft a Poem	Students create poetry; paper and pencil or word processed, text-based or multimedia	Video creation software (e.g., Movie Maker, iMovie), presentation software
Create a Diary	Students write from a first-hand perspective about en event from the past; paper and pencil or digital format	Blog, word processor

Visual Divergent Knowledge Expression Activity Types

Activity Type	Brief Description	Possible Technologies
Create an Illustrated Map	Students use pictures, symbols, and/or graphics to highlight key features to creating an illustrated map	Outline maps available online, Google Earth, presentation software, scanner
Create a Picture/Mural	Students create a physical or virtual image or mural	Drawing software, scanner
Draw a Cartoon	Students create a drawing or caricature using a paper and pencil or digital format	Comic creation software, drawing software, scanner

Conceptual Divergent Knowledge Expression Activity Types

Activity Type	Brief Description	Possible Technologies
Develop a Knowledge Web	Using teacher or student created webs, students organize information in a visual/spatial manner; written or digital format	Concept mapping software, presentation software, word processor
Generate Questions	Students develop questions related to course material/concepts	Word processor, wiki
Develop a Metaphor	Students devise a metaphorical representation of a course topic/idea	Word processor, concept mapping software, drawing software

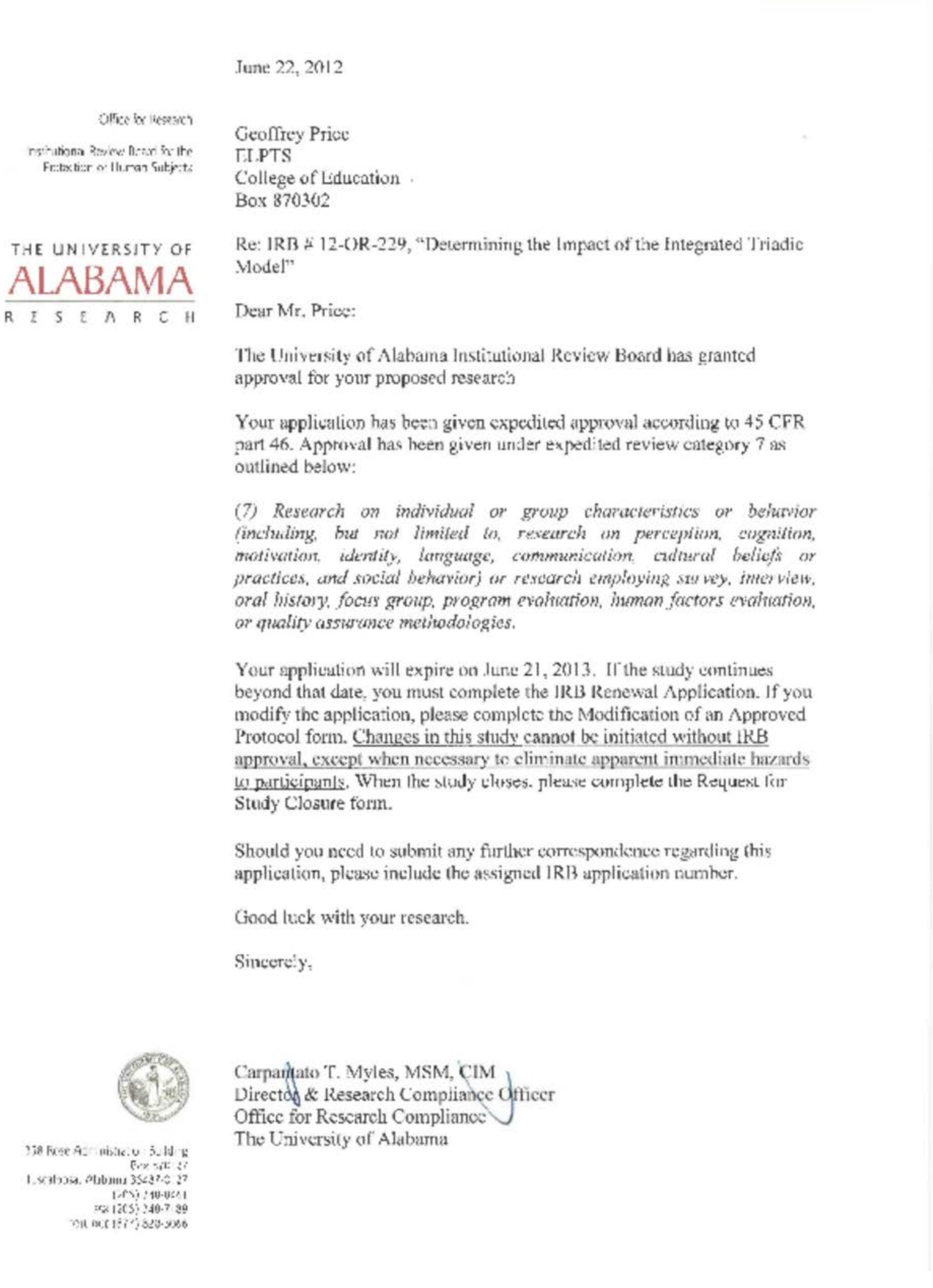
Product-Oriented Divergent Knowledge Expression Activity Types

Activity Type	Brief Description	Possible Technologies
Produce an Artifact	Students create a 3-D or virtual artifact	Imaging tools, drawing software
Build a Model	Students develop a written or digital mental model of a course concept/process	Concept mapping software, presentation software, spreadsheets
Design an Exhibit	Students synthesize key elements of a topic in a physical or virtual exhibit	Wikis, presentation software, video creation software (e.g., Movie Maker, iMovie)
Create a Newspaper/News Magazine	Students synthesize course information in the form of a periodical; print-based or electronic	Word processor, wiki, Web authoring software
Create a Game	Students develop a game, in paper or digital form, to help other students learn content	Puzzlemaker, interactive presentation software, imaging tools, Web authoring software
Create a Film	Using some combination of still images, motion video, music and narration students produce their own movies	Video creation software (e.g., Movie Maker, iMovie), digital video camera

Participatory Divergent Knowledge Expression Activity Types

Activity Type	Brief Description	Possible Technologies
Present	Students share their understanding with others; oral or multimedia approach, synchronous or asynchronous	Presentation software, video creation software (e.g., Movie Maker, iMovie), digital video camera
Role play	Students take on a character, role, or persona to experience or experiment with a concept or event, live, video-taped, or recorded	Video creation software (Movie Maker, iMovie), digital video camera
Perform	Students develop a live or recorded performance (oral, music, drama, etc.)	Video creation software (e.g., Movie Maker, iMovie), digital video camera
Engage in Civic Action	Students write government representatives or engage in some other form of civic action	Blog, email, videoconferencing, ThinkQuest

Appendix F



June 22, 2012

Office for Research

Institutional Review Board for the
Protection of Human Subjects

THE UNIVERSITY OF
ALABAMA
RESEARCH

Geoffrey Price
ELPTS
College of Education
Box 870302

Re: IRB # 12-OR-229, "Determining the Impact of the Integrated Triadic Model"

Dear Mr. Price:

The University of Alabama Institutional Review Board has granted approval for your proposed research

Your application has been given expedited approval according to 45 CFR part 46. Approval has been given under expedited review category 7 as outlined below:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your application will expire on June 21, 2013. If the study continues beyond that date, you must complete the IRB Renewal Application. If you modify the application, please complete the Modification of an Approved Protocol form. Changes in this study cannot be initiated without IRB approval, except when necessary to eliminate apparent immediate hazards to participants. When the study closes, please complete the Request for Study Closure form.

Should you need to submit any further correspondence regarding this application, please include the assigned IRB application number.

Good luck with your research.

Sincerely,

Carpantato T. Myles, MSM, CIM
Director & Research Compliance Officer
Office for Research Compliance
The University of Alabama

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