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An Evaluation of Professional Development Methods and their Effects on Teachers' Technological Pedagogical Content Knowledge and Technology Use

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An Evaluation of Professional Development Methods and their Effects on Teachers' Technological Pedagogical Content Knowledge and Technology Use

by

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Abstract

An Evaluation of Professional Development Methods and their Effects on Teachers' Technological Pedagogical Content Knowledge and Technology Use

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Although technology is becoming more common in schools, effectively integrating technology into the classroom can be a challenge for teachers. Teachers must understand how technology interacts with their content and pedagogical strategies to enhance student learning outcomes. Various theory-based training methods have been proposed to increase the technological pedagogical content knowledge (TPACK) of teachers (Mishra & Koehler, 2006). In-service teachers have an established teaching style, or preference for specific pedagogical activities, which may influence how they respond to trainings either congruent or dissimilar to their own teaching practices. This study uses MANCOVA to investigate how middle school math teachers' teaching styles

preferences influence their technology integration in a lesson plan following three different types of training.

The implications for the proposed study suggested future evaluation of a fourth professional development method to integrate teachers' teaching styles and offer more prolonged support and reflection during the training process. This fourth method, lesson study, allows teachers to reflex on different ways of teaching as a group and may lead to change in teaching style beyond that possible in the first three methods. The final chapter of this report includes an evaluation plan for the proposed lesson study professional development.

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Introduction

The amount of technology available to teachers is increasing and with it, the pressure to integrate technology in the classroom in meaningful ways. Ninety-seven percent of teachers in the United States had at least one computer in their classroom in 2009 (Gray, Thomas, Lewis & Tice, 2009). In addition, over half of the teachers had the ability to bring extra computers into the classroom when necessary for instruction (Gray et al., 2009). However, a third of teachers still reported "never" or "rarely" using the technology often in their teaching and there was a wide variety in the ways that technology was being integrated (Gray et al., 2009).

Over the past few decades, a number of different types of professional development have been used to help teachers integrate technology. These approaches include providing technological equipment without any training, instructing teachers on affordances and constraints of technology, building technology according to specific pedagogical theories, and teacher education courses (Cuban, 1986; Harris, Mishra, and Koehler, 2009). Most of these methods are technology, rather than teacher or student centered.

To address this lack of teacher and learning focus, Mishra and Kohler (2006) developed the concept of Technological Pedagogical Content Knowledge, TPACK, as a way to describe the knowledge that teachers need in order to integrate technology effectively in their instruction. They emphasize teacher knowledge and understanding of the interactions between technology, content, and pedagogy, rather than awareness of each of the domains independently. Starting originally in university teacher training courses, two main strategies have been adopted to increase teacher's TPACK: activity types based training and learning by design (Harris, Mishra, & Koehler, 2009; Koehler & Mishra, 2005a).

Traditional technology professional development tended toward information processing strategies of lecturing, but did not result in much change in instruction or student achievement (Cuban, 1986; Macmillan, Liu, &Timmons, 1997; McCannon & Crews, 2000). Therefore, it would be wise to explore why these inventions did not lead to technology integration. One possible reason is a mismatch between the training, the teacher's own teaching style, and they way they implemented technology use. Newer methods are based on social cognitive and socio-constructivist principles. Since TPACK includes a teacher's understanding of pedagogy and its interaction with their content and the technology, teacher beliefs and practices are an important factor when considering the effectiveness of professional development.

Grasha (1994) created an inventory that classified teachers into one of four clusters based on their teaching practices. Each of his clusters aligns with a pedagogical orientation. This study proposes to measure the effectiveness of three types of technology professional development on technology integration in teachers' lesson plans. Grouping the teachers by teaching style preference also allows this investigation to consider an interaction between the teachers' own personal style and the training they receive.

INTEGRATIVE ANALYSIS AND INTERPRETATION

Chapter One: Theoretical Framework

Approaches to Technology Integration in Schools

Five major approaches have dominated attempts to increase technology integration in schools (Harris, Mishra, and Koehler, 2009):

- Software-focused initiatives

  Software initiatives focus on developing educational computer programs that monitor and track individual student progress to create a student-centered learning experience without confronting teacher beliefs or practices.

- Demonstrations of sample resources, lessons, and projects

  The demonstration approach is a response to teachers' demands for classroom-based examples. The assumption is that sample lessons and projects can be modified for use in a variety of classrooms. One problem with this approach is that while samples are provided, there is usually little information given about how to modify the resources to fit various instructional contexts.

- Technology-based educational reforms efforts

  Technology- based reforms often concentrate on simply giving teachers access to computers or other technologies. The thought is that teachers do not use technology because of a lack of availability, and with ample technology access, teacher will begin to integrate the tools into their teaching practices on their own. However studies found that simply supplying teachers with new technologies did not lead to an increased technology use in the classroom (Cuban, 1986; Sandholtz, Ringstaff, & Dwyer, 1997; Macmillan, Liu & Timmons, 1997; Windschitl & Sahl, 2002; Zhao, Pugh, Sheldon & Byers, 2002).

- Structured/standardized professional development workshops

  Another approach to technology integration is structured or standardized professional development workshops. Often, this training instructs teachers to use the technological tools focusing on the affordances and constraints of the technology rather than their ability to facilitate learning. This approach has also had limited results in its ability to affect change in the technology use in the classroom (Valanides & Angeli, 2006).

- Technology- focused teacher education courses

  The final approach to technology integration includes education courses provided by colleges or universities. While many undergraduate pre-service teacher programs are requiring technology courses, the courses are also available to in-service teachers as stand-alone classes or as part of a graduate level degree.

All five of these approaches focus on the technology first, rather than on how the technology helps accomplish subject matter objectives or how it enhances pedagogical techniques.

Newer approaches to technology integration focus on how to effectively integrate various technologies into content specific situations. In cases of in-service teachers, Hughes (2005) found that content based learning experiences generated more content-based technology integration. Activity Type Training and Learning by Design are two approaches that focus on Technological Pedagogical Content Knowledge (TPACK) and are presented as alternatives to the traditional technology professional development.

Technological Pedagogical Content Knowledge (TPACK)

Mishra & Koehler (2006) developed the concept of Technological Pedagogical Content Knowledge (TPACK) which emphasizes the importance of teachers having an integrated understanding of how technology, content, and pedagogical methods work together to increase learning within their particular content discipline (Figure 1). The TPACK framework is structured after Schulman’s (1986) idea of pedagogical content knowledge which asserts that in order to be an effective teacher one must not have separate knowledge of content and pedagogy, but rather an awareness of the ways pedagogy can be used to support teaching and learning of specific content. In the same way, TPACK represents the intersections between the three major knowledge domains of technology, pedagogy, and content creating seven knowledge domains: Content Knowledge (CK), Pedagogical Knowledge (PK), Technological Knowledge (TK), Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), Technological Pedagogical Knowledge (TPK), and Technological Pedagogical Content Knowledge (TPACK). Figure 1 shows the seven domains and their relationship to each other.

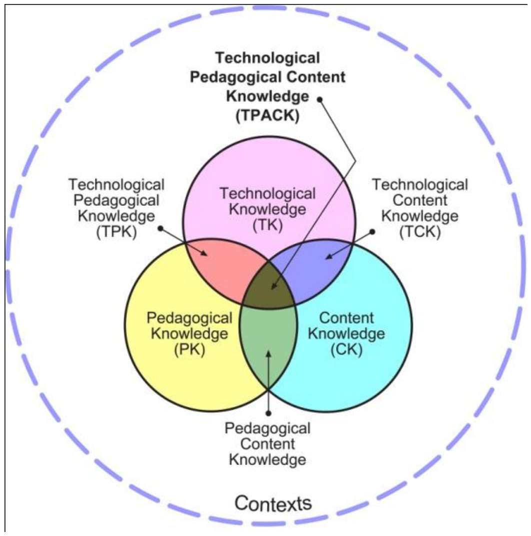


Figure 1: Technological Pedagogical Content Knowledge http://tpack.org/

Content knowledge.

Content knowledge (CK) deals with the teacher's knowledge of the subject matter. Content knowledge (CK) includes understanding of the facts, concepts, and inquiry methods within the field. Since these can vary greatly according to subject and level, it is important that teachers are competent in the area that they are teaching.

Pedagogical knowledge.

Pedagogical knowledge (PK) is the understanding of the theories and principles related to teaching and learning. This knowledge domain includes understanding how to support student learning with a variety of methods. Although Mishra & Koehler (2006) focus only on pedagogical knowledge, there is a great deal of overlap between teacher's knowledge and beliefs about pedagogy (Kagan, 1992). Due the intertwined nature of pedagogical beliefs and knowledge, this paper will focus on teacher's actions in the classroom to identify teacher's pedagogical preferences.

Technological knowledge.

In the TPACK framework, technological knowledge (TK) refers to technology in the broad sense of the word including technology from blackboards to computers. The skills necessary to install and operate digital technologies fall into this domain. Technology standards are also part of technological knowledge. Since the field of technology is rapidly changing, technological knowledge may be more unstable than either content or pedagogical knowledge. This domain is the focus of most technology tutorials and workshops.

Prior to the TPACK model, Margerum-Lays and Marx (2003) referred to this knowledge as content knowledge of educational technology. They argue that this knowledge "allows teachers to envision instances in which technology might be appropriately used in their teaching and to allow them to initiate those visions" (Margerum-Lays & Marx, 2003, p. 140). However, they also point out that there are differences between personal technology use and knowledge of technology for teaching and learning purposes. Because of this, a strong technological competence does not directly translate to increased technology integration in the classroom (Hughes, 2005). Newer teachers tend to have more exposure to technology, but are not always able to transfer that knowledge into effective learning situations for their students (Hughes, 2005; Lee & Tsai 2007; Niess, 2005).

A teacher technology use survey conducted in 2002 (Russell, Bebell, O'Dwyer & O'Connor, 2003) showed that while teachers with less than five years of experience reported feeling more confident with technology and using technology more for professional use outsides the classroom, they were less likely than teachers with six to fifteen years to use technology during class time. New teachers may be lacking a strong understanding of pedagogical content knowledge which prevents them from fully integrating technology into the classroom despite having a strong technology knowledge base. Without a framework for effective teaching, newer teachers may not understand how to adapt their current technology knowledge into a teaching tool.

Pedagogical content knowledge.

Initially proposed by Schulman (1986), pedagogical content knowledge (PCK) is the knowledge of how to teach information within a specific content area. A teacher's knowledge of the structure of their content and the misconceptions that learners may have about the subject is part of PCK. Another component of PCK is an understanding of which pedagogical strategies are most effective in addressing learner difficulties.

Technological content knowledge.

The intersection between technology and content consists of the knowledge about how technology affects a specific content matter. Technology has changed the way that information is constructed or discovered in many fields. For example, computer programs now allow complicated mathematic calculations to be performed more quickly than ever. The advancements in technology have driven scientific discoveries and have changed the way that many professionals work in the field. At the same time, content matter and established assumptions and knowledge structures guide the development of new technologies. Knowledge of this reciprocal interaction comprises the domain of technological content knowledge (TCK).

Technological pedagogical knowledge.

Just as content and technology interact and change each other, so do the domains of technology and pedagogy. Technological Pedagogical Knowledge (TPK) involves understanding how technology can be used to support and enhance pedagogical strategies. Technological advancements have provided metaphors for human learning that shaped the evolution of educational theories. At the same time, theories about how people learn continue to direct the development of new technologies.

Technological pedagogical content knowledge.

Technological Pedagogical Content Knowledge (TPACK) forms the core of the TPACK framework integrating technology, content, and pedagogy. Knowledge in this domain involves recognizing how technological tools, subject matter, and pedagogical techniques can work together to augment or hinder one another. The interrelatedness of the three domains is the main focus and the goal for the TPACK framework. According to the model, teachers use technology most effectively when they are able to plan their technology integration while simultaneously considering the content, pedagogy, and technology pieces of instruction. It is important to remember that TPACK knowledge is not proficiency in each of the three main domains separately, but the ability to realize and appreciate the connections between those three domains. Because of this, simply gaining knowledge in one knowledge area does not automatically increase a teacher's TPACK (Angeli & Valanides, 2005; Valanides & Angeli, 2008a 2008b).

Traditional Technology Workshops: An Information Processing Approach

While there has been a recent push toward student-centered learning strategies, teacher-directed learning is still prevalent in most classrooms today. In the early 1970s, learning theorists began a shift away from behaviorist theories and began to focus more on the brain as a processing center. The invention of the computer facilitated this movement by acting as a model for the brain, frequently referred to as an "information processing" model of learning. The "modal model" of the brain proposes that three parts: the sensory register, short-term memory, and long-term memory work together for learning to occur (Atkinson & Shiffrin, 1968). In this model, information that is sensed by the brain and attended to moves into the short term memory. The short term memory has a limited capacity so information must move into the long-term memory if it is to be remembered at a later time. In order for new knowledge to become long term memories, it must be organized and connected to one's current knowledge. Learning occurs when the new information is integrated into the person's long-term memory. Although learning theories have begun to look at more complex models of the brain and how learning occurs, the ideas of attention and memory capacity are still relevant in current learning psychology.

Instruction under the information processing theory centers on the expert teacher presenting information to students. The Select-Organize-Integrate model (Mayer, 1999) outlines a three step process for teachers to present information in a way that is learningfriendly. First, the teacher is responsible for selecting the key concepts that students need to learn. Mayer (1999) offers several ways that teachers can cue students that this information is important. Secondly, Mayer (1999) stresses that the teacher should present the information in an organized way so that students will be able to understand the connections between new and old material. Finally, teachers should provide examples to tap into student's long-term memory so that new material will become integrated into the student's existing knowledge. This approach is teacher-centered because it places most of the responsibility for learning on the instructor. The focus is on the teacher's actions and how well they convey the information, rather than on what the students are doing.

Traditional technology training which focuses on the constraints and affordances of the technology itself tends to be presented in an information processing format. Yildirm (2000) measured the attitudes toward computers and the computer competency of pre-service and in-service teachers enrolled in an educational computing course. Four of the five course objectives identified in the syllabus are related to understanding how to use various aspects of computer-based technologies, and only the last objective related to the application of technology to content areas. Analysis found that teachers with low levels of pre-course computer competence had the largest increase in positive attitudes toward technology following the course (Yildirm, 2000). Additional, qualitative interviews supported the idea that while novice technology users felt that the courses contributed to their professional development as a teacher, teachers with higher levels of technology competence were unsatisfied with the depth of the course (Yildirm, 2000).

This study did not look at the affects of the course on actual technology integration into teaching.

In 2000, a survey of 127 Georgia elementary school teachers looked at the availability and attendance of various types of technology professional development (McCannon & Crews, 2000). Word Processing trainings and trainings about operating systems were available to more than sixty- five percent of the teachers, while trainings concerning technology integration into curriculum were available to only fifty-two percent of teachers (McCannon & Crews, 2000). The word processing training was ranked as the most beneficial type of technology training, followed by the curriculum integration professional development. Despite the availability and attendance of technology trainings, only nineteen percent of the teachers reported using technology to enhance their lectures or presentations in class, indicating that while the training was beneficial for making teachers' administrative tasks more efficient, it was not having a large effect on their actual teaching practices (McCannon & Crews, 2000).

Activity Types Training: A Social Cognitive Approach

Social cognitive theory focuses more on the interaction between the learner, the environment, and the behavior and came about during the late 1970s as researchers began to notice that people could learn by watching others perform a task without having to be reinforced themselves. Because of this discovery, modeling and vicarious learning experiences are the major instructional strategies of social cognitive theory. According to this theory, learning occurs through reciprocal interaction between personal factors, the behavior being learned, and the environment.

Personal factors include one's perception of their ability to successfully complete the task or their self-efficacy. Self-efficacy has been shown to affect the amount of persistence a teacher has after a difficulty or failure (Gibson & Dembo, 1984). Teacher self-efficacy has even been associated with increased student learning (Tschannen-Moran, Woolfolk-Hoy & Hoy, 1998). Efficacy is largely dependent on the task. For example, one may have very high efficacy in mathematics, but low efficacy in sports. High technology self-efficacy has been associated with adoption of new technologies in the classroom (Lee & Tsai, 2007). In a study of Taiwanese K-12 teachers, Lee & Tsai (2007) found that teachers' web-self efficacy was positively correlated with their attitudes toward web technology in the classroom and their use of web technology in the classroom, but negatively correlated with years of teaching experience, indicating that more experienced teachers have lower technology self-efficacy than new teachers. Self-efficacy can be increased through personal success, persuasion of others, and vicarious success of others (Bandura, 1986).

As mentioned above, the personal factors are influenced by the nature of the behavior or task. Task difficulty and the perceived value of the task can impact a person's self-efficacy and their motivation to learn new behaviors. If the learner feels that a behavior is valuable, they are more likely to pursue learning and practicing that behavior despite setbacks (Atkinson, 1957). In the same way, teachers' value of technology as a teaching and learning tool can impact their commitment to technology professional development and technology integration in the classroom. Hughes (2005) noted that while the teachers were exposed to several types of technology, they only continued to learn and use technologies that they perceived as useful to themselves and their students.

The third component involved in learning is the environment, which includes both the physical structure and the social context in which the learning occurs. In schools, the physical structure includes the layout of the classroom as well as the inanimate objects or tools available to the students and teacher. The social context includes direct contact with others, indirect observations of others, and the behavioral norms and expectations within that context. People learn not only from the consequences of their behavior, but also from the consequences experienced by others. Rather than serving as reinforcement or punishment, consequences are thought to give students information and motivation about how they should behave in the future. Observing others perform a behavior and the resulting consequences can provide students with the same information and motivation as personal experience. Because of this, modeling is a key instructional tool under the social cognitive theory.

Modeling of behaviors can serve three functions for learning: response facilitation, inhibition/disinhibition, and observational learning (Bandura, 1986). In response facilitation and inhibition/disinhibition no new behaviors are being learned. Response facilitation occurs when one’s behavior prompts others to behave in a similar way. For example, when a teacher starts at a new school and sees all color coded behavior charts in all of the other teachers’ classrooms, she is likely to use a color coded behavior chart in her class as well. In inhibition or disinhibition known actions are either strengthened or weakened by watching the reactions to other people performing those behaviors. If during a staff meeting the principal recognizes a teacher for taking her students to the computer lab, other teachers may begin to take their students to the computer lab more frequently. Conversely, when a teacher is corrected for spending too much time with their students at recess, other teachers might start to have shorter recess periods for their students.

Observational learning is the only function of modeling where new behaviors are learned. In order for learning to occur, four processes must take place: attention, retention, production, and motivation (Bandura, 1986). Much like information processing, the first step is that the student's attention must be drawn to the key components or actions that comprise the new behavior. Secondly, the information must be retained. Retention can occur through practicing the behavior and by connecting the new knowledge to prior knowledge and experiences. The third process, production occurs when the learner moves from understanding the behavior into actually performing it themselves. During production, complex behaviors are perfected through guided practice with feedback. Although motivation is the final component of observational learning, it affects how the learner reacts during each of the other steps of the learning process. As previously stated, a person's motivation is affected by their value of the tasks and their perceptions about their ability to perform them. Learners are more likely to attend and retain behaviors that they value and feel that they can successful accomplish. Motivation also influences how much time and effort are put into production of the learned behavior.

One way to increase self-efficacy and motivation is by using a model that is similar to the learner (Schunk & Zimmerman, 2007). A learner is more likely to feel efficacious when they perceive that model has comparable skill level to their own (Schunk & Zimmerman, 2007). In the same respect, teachers are more likely to trust information and suggestions from fellow teachers. Corcoran et al. (2001) found that while district staff felt strongly about professional development being research based, school personal placed more importance on advice from other teachers and were ill-equipped to interpret scientific research or judge its significance.

Niess (2005) describes a one-year graduate level program designed to support the integration of technology into science and math teaching. At the beginning of the year, pre-service teachers were introduced to new technologies within the context of curriculum-based mathematics and science problems. This class was followed by a microteaching class in which pre-service teachers wrote and taught lessons to their peers. They were required to integrate technology into at least one of their lessons. This course allowed them to reflect on their own teaching as well as see peer models technology-integrated teaching. Next, the pre-service teachers were able to practice integrating technology during their semester student teaching. In a final course, the teachers examined their experiences with technology as an instructional tool. Fourteen of the twenty-two teachers in the program were judged to have adequate TPACK knowledge by the end of the program (Niess, 2005). Five case studies illustrated the TPACK development of the pre-service teachers. In all of the cases, the pre-service teachers' pedagogical, content, and technological content, as well as their beliefs about learning and the importance of technology in the classroom influenced how they ultimately used technology during their student teaching. One teacher, Denise, was comfortable both in her content knowledge (biology) and with technology, but had no background in teaching and struggled with pedagogical knowledge. Her pedagogical beliefs stemmed mostly from her personal experiences as a student and centered on lecturing with supplemental labs. She was reluctant to spend time teaching students how to use the technology and felt that was not part of her job as a biology teacher. She also found it difficult to modify pedagogical strategies that she had not yet mastered. Another teacher, Marissa, also had a grasp of science content knowledge. She, on the other hand, had some limited teaching experiences volunteering in classes and in after-school programs, but limited exposure to technology. In her student teaching, she took a more socio-constructivist approach to integrating technology. She expressed both in interviews and to her students that she was learning about the tools along with them. She also had the students work in groups to collect data first by hand and then using technological tools, so they would discover the benefits of technological tools in science. In each of these cases, the teachers' prior knowledge and beliefs shaped the way that they chose to integrate technology in the classroom.

Arizona State University also adopted a social cognitive approach to developing the technology skills of pre-service teachers (Brush et al., 2003). During their junior year, all elementary education majors complete a practicum which includes two technology integration modeling sessions. During these sessions, educational technology graduate students model technology integration is content-specific lessons. After attending the sessions, pre-service teachers must plan and implement a lesson of their own. Graduate students provide the pre-service teachers with "just in time" technological and pedagogical support during their teaching practicum. At the end of the technology unit, about ninety percent of the pre-service teachers agreed with a statement that they could develop ideas for integrating technology based on a learning objective and that they were confident about integrating technology into content area lessons (Brush et al, 2003). However a third of the pre-service teachers' lesson plans did not include any student use of technology. Interviews suggest that the two modeling sessions may not have been enough support to counter the negative attitudes and lack of instructional technology use modeled by mentor teachers during pre-service teachers' practicum experiences.

In the previous study, video cases were proposed as a solution to the lack of modeling experiences. Lee & Hollebrands (2008) created video cases that showed "the teacher when introducing the lesson and posing specific questions and, otherwise, [focused] mainly on students' work" (p. 330). Prior to viewing the cases studies, pre-service teachers used technology to complete the student activity introduced in the video and generated ideas about the types of questions and difficulties that middle school students might have with the exercise. In the first semester, pre-service teachers showed gains in probability and statistics content knowledge and technology knowledge, but not in pedagogy (Lee & Hollebrands, 2008). Pedagogy-focused scaffolding questions were added to the video case studies, and teachers in the following two semesters demonstrated growth in all three knowledge areas: content, pedagogy, and technology (Lee & Hollebrands, 2008). Unfortunately, integrated TPACK of the pre-service teachers was not measured.

Technology Integrated Activity Type professional development, another social cognitive method, uses modeling of specific pedagogical activities to teach appropriate context-specific uses of instructional technology (Harris, Mishra, & Koehler, 2009). Building on Putnam and Borko's (2000) ideas about teachers' situational and event-structured thinking, activity types professional development begins by identifying content specific learning activities. Research has shown that teacher planning centers on creating sequences of these "routinized activities" (Tubin & Edri, 2004; Yinger, 1979). In an in-depth study of one teacher's planning, Yinger (1979) found that the teacher's "planning could be characterized as decision making about the selection, organization, and sequencing of routines" (p.165). Instructional routines or activity types are learning activities that have clear processes, behavioral norms, and learning outcomes (Harris & Hofer, 2009; Yinger, 1979). In this technology integration approach, the activity types for a particular content area are identified, and then technology that supports those activities is chosen and incorporated. For example, a common mathematics activity is to have students interpret a representation (i.e. table, graph, chart). This is an example of an "activity type" geared at helping student understand the mathematical relationships depicted in the graph. Technologies such as databases and data visualization software can help teachers and students understand the concept (Grandgenett, Harris & Hofer, 2009). "Activity types" are organized by the learning objective and do not preference any one style or method of teaching (Harris 2008). In an activity type professional development, the integration of technology into a wide variety of activity types is modeled so that teachers see how their content and existing teaching strategies can be improved with technology.

Learning Technology by Design: A Socio-Constructivist Approach

Socio-constructivism is a third educational movement that stems from Vygotsky's theories of learning as a product of social interaction. Contrary to social cognitive theory where the learning is a result mainly of observing others, learning in socio-constructivism occurs through the negotiation of meaning with others. The learner is responsible for building connections between the new material and their prior knowledge rather than the burden being on the teacher. Learning is situated, social, and distributed among the group of learners (Putnam & Borko, 2000). In socio-constructivism, the teacher serves as a facilitator or mentor of learning rather than the director of the students' learning.

According to Vygotsky (1978), learning occurs in the zone of proximal development (ZDP) with the aid of scaffolding. The ZPD is the distance between a learner's independent ability and their ability with the help of a more skilled person or instructional tool (Wertsch, 1991). Scaffolding is the process by which an instructor or peer mentor supports the learner to increase their understanding. Asking questions, offering hints, and elaborating are some strategies that can be used to scaffold learning. Not only does the less knowledgeable peer learn from this pairing, but both learners work to create a shared understanding of the concepts (Roschelle, 1992; Tudge, 1992).

"Communities of Practice" are another key component of the socio-constructivist theory. In the communities of practice model, novices start at the periphery of a community and move into a more central role as they learn through mentoring process

(Lave & Wenger, 1991). In this situation, both the learners and the expert/mentors in the community learn as a result of the interactions. In a study of grant funded teachers implementing technology projects, Zhao et al. (2002) found that teachers who were more "socially aware" had more successful completion of their projects. The "socially aware" teachers looked to others within their school or district for support when they encountered problems. They were also aware of the school context/culture and expectations and constraints of that setting (Zhao et al., 2002).

A final component of socio-constructive theory is that all learning is situated in context. According to Vygotskian principles, "mental functioning is inherently situated in social interactional, cultural, institutional, and historical contexts" (Bonk & Cunningham, 1998 p. 35). Because of this principal, "learning is most effective when it approximates real-world situations or problem scenarios" (Wertsch, 1991). Putnam and Borko (2000) propose a number of methods for situated teacher training including: in-school or classroom based professional development, pre-service apprenticeships with experienced teachers, and teacher discourse communities.

Problem-based learning is another one instructional strategy that has been used to encourage socio-constructive learning in the classroom. In problem-based learning, students are given a real-world dilemma that does not have one right answer. As a group, students use their own knowledge and additional resources to develop a solution for the problem. Collaborative learning experiences have also been used in some teacher professional development. Desimone et al (2002) found a significant difference in teacher trainings designed to improve math and science teaching that used collective participation.

Da Ponte, Oliveira, and Varandas (2002) describe a pre-service teacher technology course that uses a socio-constructivist approach to increasing prospective teachers' technology knowledge. In the course, middle school and secondary pre-service mathematics teachers worked in groups to development content focused web pages. Qualitative analysis of an open ended questionnaire indicated that pre-service teachers felt that while the course was very time-consuming, they learned a lot about technology and the internet. They also described feeling much more comfortable with technology at the end of the course (Da Ponte, Oliveira, and Varandas, 2002). Despite struggles during the learning process, students also recognized the merits of "learning by doing" and discovering things on their own.

Learning Technology by Design (Koehler & Mishra, 2005a, 2005b; Koehler, Mishra & Yahya, 2007) is similar technique used in teacher technology courses to facilitate technology integration in the classroom. The approach "is a constructivist approach that sees knowing as being situated in action and co-determined by individual-environment interactions" (Koehler & Mishra, 2005a, p. 134). In one study, technology graduate student groups were paired with education faculty to develop new online education courses. The masters level course provided technology design students with a real-world problem and faculty with technology support to transition to an online learning environment. Students and faculty met weekly throughout the semester to create the online courses. At the beginning of the process, groups spent much of their time discussing ideas and defining their goals. This later turned into production of a product, but initially the graduate students felt that they were not working very hard. At this stage, the students rated the course as less enjoyable then they did in later surveys (Koehler & Mishra, 2005a). End of the semester surveys showed that students' beliefs about technology integration were significantly different than the beginning of the semester (Koehler & Mishra, 2005a). By then, the students recognized that teaching and designing an online course was different than a face- to- face class, and requires a change in teaching methods.

Collaborative Lesson Design, a similar process to Learning by Design, was used with pre-service teachers in Singapore (So & Kim, 2009). In this study, pairs of pre-service teachers worked together to create a problem based learning (PBL) lesson plans that integrated technology. At the end of four weeks, pre-service teacher pairs submitted their lesson plans and completed a survey about their perceptions of the project, PBL, and technology use in the classroom. While the teachers was correctly able to identify and explain the majors components of PBL on the survey, they had difficulty integrating technology effectively, creating ill-structured questions, and incorporating scaffolding into their lesson plans (So & Kim, 2009). Since the pre-service teachers demonstrated understanding of PBL structure, they themselves may have needed more scaffolding in how to generate appropriate questions and support PBL with technology.

Angeli & Valanides (2009) propose a process called technology mapping to guide pre-service teachers toward creating technology integrated lessons. During a semester course, pre-service teachers were taught and practiced an instructional design model that guided them in developing a technology integrated learning activity. The first step in the model involves brainstorming several difficult topics within a content area. Secondly, the teachers identify specific learning objectives that target students' misconceptions of those topic areas. Technology integration begins during the third step of the process, where pre-service teachers map technological affordances onto these content areas. Mapping is the "process of establishing connections among affordances of a tool, content, and pedagogy" (Angeli & Valanides, 2009, p. 161). At this point in the process, both peer and self assessment of the topic chosen and the effectiveness of the technology occurred. Based on this feedback, students revised their lessons before they were graded by the professor. While this is a guided approach to creating a lesson, this type of training follows the socio-constructivist approach of starting with an ill-structured problem and collaborating with others to arrive at a solution. Over three separate semesters, pre-service teachers showed a significant improvement in technology integration from the first to the second lesson plans they created (Angeli & Valanides, 2009). In qualitative feedback, students identified four important steps to the process: 1) gathering initial information, 2) engaging in real-world authentic tasks, 3) sharing and reflecting with peers, and 4) discussing their solutions with experts (Angeli & Valanides, 2009). These steps further support the socio-constructivist nature of this type of technology training.

Assessing Technology Integration

Previous studies of teacher technology use focused mainly on self-report teacher surveys about the types, frequencies, and purposes of their educational technology use, as well as the use of it by their students (Cuban, 1986; Gray, Thomas, Lewis & Tice, 2009;

Russell, Bebell, O'Dwyer & O'Connor, 2003). Researchers use these studies to support claims that if the teachers are using only particular types of technology or only using technology for planning purposes, then they are not effectively integrating technology in the classroom. While these studies can give a picture of the type of technology use occurring in schools, they do not measure the quality of that technology use as an instructional tool.

Ferdig (2006) discusses the importance of judging technology based on the context and the purpose of the innovation. Instructional technology must be evaluated with the educational objectives at the forefront. Ferdig (2006) also argues that since technology evaluation is context specific, the role of the teacher is important when assessing a technological innovation. He proposes technological pedagogical content knowledge as a way to assess a teacher's technology integration in the classroom.

Assessing technological pedagogical content knowledge.

Because of the relatively new nature of technological pedagogical content knowledge, researchers are still trying to determine the best way to measure teachers' development within this construct. The majority of researchers use qualitative measures to give rich descriptions of teachers' TPACK and their knowledge development through various types of technology professional development experiences (Hervey, 2010; Hughes, 2005; Koehler, Mishra, & Yahya, 2007; Niess, 2005; Niess et al., 2009; Richardson, 2009). Many of these studies focus on pre-service teachers or graduate level teacher programs where researchers have prolonged access and multiple measures of the teachers' growth. Niess et al. (2009) proposed an iterative model of five TPACK developmental stages: recognizing, accepting, adapting, exploring, and advancing. Due to the varied and changing nature of technology, teachers can be in different stages of the continuum in regards to different technological tools. While Niess et al. (2009) proposed a number of TPACK standards for mathematics teachers, no instrument has been developed to identify a teacher's stage in the TPACK development model.

More recently, attempts have been made to quantify and measure TPACK. During a graduate level educational design course, Koehler & Mishra (2005) surveyed faculty members and technology design graduate students about their perceptions of the course, their thoughts about online education, and their level of TPACK. The survey was administered four times during the semester to track changes and growth throughout the semester. Archambault and Crippen (2009) also created a self-report survey for online teachers to measure their TPACK. A third self-report scale for K-6 pre-service teachers was validated by Schmidt et al. in 2009. On this instrument, teachers rate their ability to teach various content areas and their understanding of technological tools. Despite the validation of these measures, they all rely on teacher self-report data rather than assessing knowledge of the seven components of TPACK or the actual integration of technology in the classroom.

Harris, Grandgenett & Hofer (2010) propose a rubric based-approach to assessing technology integration. Their rubric corresponds to the four technology-related knowledge areas in the TPACK framework: technology knowledge, technological content knowledge, technological pedagogical knowledge, and technological pedagogical content knowledge. The rubric allows researchers and teacher educators to appraise actual technology integration in a lesson plan instead of relying on teacher self-report data. In addition, the rubric provides a model for evaluating TPACK in the context of multiple pedagogical orientations rather than regarding any specific educational theory over another (Harris, Grandgenett & Hofer, 2010). For this reason, this rubric will be used the measure for technology integration in this study.

Training In-Service Teachers

Because of both higher levels of technology access and prolonged pre-service teacher access through courses and degree programs, much of the technology integration research has focused on pre-service teacher training. However in order to reach students currently in the classroom, more technology professional development is needed for in-service teachers. Resources, institutional support, subject culture, attitudes/beliefs, knowledge/skills, and assessment have all been identified as barriers to technology integration (Hew & Brush, 2006). Hew and Brush (2006) identified 123 barriers from empirical studies about technology integration and found that teacher's lack of technological knowledge and skills was second only to lack of resources. Recently, a national survey conducted by the U.S. Department of Education found that ninety-seven percent of teachers had at least one computer in their classroom, and fifty-four percent were able to bring computers into their classrooms for technology focused lessons (Gray, Thomas, Lewis & Tice, 2009). Despite this access to computers, only forty percent of the teachers reported that their students used technology "often" during instructional time and the types of technology and level of its integration varied widely across the participants (Gray et al., 2009). In the same survey, fifty-three percent of the teachers attended only 1 to 8 hours of technology professional development in the past year (Gray et al., 2009). Due to the busy schedules of in-service teachers, technology professional development must be targeted to achieve the most growth in a limited timeframe.

Another difference between pre-service and in-service teachers is their level of teaching experience. In case studies of teachers with six or more years of teaching experience, Hervey (2009) found that teachers' attitudes about technology as an instructional tool greatly influenced the ways they incorporated technology in their classes. She found that each of the three teachers' technology use was consistent with the beliefs they stated during interviews (Hervey, 2009). Case studies also revealed that experienced teachers may have more stable pedagogical content knowledge which makes it more difficult to integrate technology that is incongruent with beliefs or instructional preferences. Ertmer (2005) proposes that since initial experiences both teaching and with technology shape ones future interactions, "personal theories and beliefs are rarely sufficiently revised and, thus over time, become deeply personal, highly engrained, and resistant to change" (p. 30). All new information and technology that teachers encounter is colored by their prior beliefs, and these beliefs play a considerable role in whether or how technology is adopted into a teacher's practices. Kagan (1992) argues that most of teacher knowledge is better classified as beliefs and summarizes multiple qualitative studies where teachers' beliefs are reflected in their instructional practices. She also states that "as a teacher's experience in classrooms grows, his or her professional knowledge grows richer and more coherent, forming a highly personalized pedagogy-a belief system that constrains the teacher's perception, judgment, and behavior" (p. 74).

Niess (2006) called for professional development that “recognize[s] and emanate[s] from the teacher’s experiences and provide[s] them with extended experiences in teaching mathematics with technology” (p.198). Teachers’ belief systems are complex and often contradictory. Their stated beliefs may even seem counter to their actual teaching practices (Ertmer, 2005). While beliefs are difficult to uncover, teaching styles can be determined by observing teachers or surveying them about their teaching practices.

“Teaching style” has been defined and classified in many ways including type of personality, theoretical orientation, and teaching behaviors. In this study, teaching style will be defined by the types of instructional activities that a teacher employs regularly in the classroom. Yinger (1979) found that teachers tended to use a limited number of activities and routines repeatedly when planning for lessons. The routines were “used to establish and regulate instructional activities and simplify planning” and “to increase the predictability and to reduce the complexity of the teaching environment” (Yinger, 1979, p. 165). It is these regular routines and activities that make up an individual teacher’s teaching style.

Grasha (1994) created an instrument to measure college faculty teaching styles using five subscales: expert, formal authority, personal model, facilitator, and delegator. Ratings on these scales sort teachers into one of four teaching style clusters. The clusters reflect the view that teachers often use multiple approaches or styles in classroom interactions, and therefore can be high on multiple subscales. While Grasha does not name the clusters or connect them with any theoretical framework, each of the four clusters aligns closely with one of four major educational theories: information processing, social cognitive, constructivism, and socio-constructivism. Cluster 1 teachers have high ratings on both the expert and formal authority scales, and use teacher-centered methods such as lectures and other forms of direct instruction. This cluster parallels a typical information processing model where knowledge is transmitted from a knowledgeable source to the learner. Teachers high in personal model, expert, and formal authority fall into Cluster 2, which aligns closely with social cognitive theories of learning. These teachers use techniques such as modeling and coaching in their classes. Socio-constructivist teaching methods of group guided inquiry and group discussions are seen in Cluster 3 teachers who ranked highly on the facilitator, personal model, and expert scales. Lastly, Cluster 4 teachers seem to take more of a constructivist approach to teaching. These teachers who rank highly on delegator, facilitator, and expert tend to use techniques such as individual research projects and student reflective journals. For this study Clusters 3 and 4 will be collapsed into one group. While Cluster 4 employs a few independent learning activities, most of their constructivist techniques involve group interaction and could therefore also be classified as socio-constructivist learning exercises.

Understanding teacher's preferred teaching style may help adapt technology training to teachers. Grasha & Yangarber-Hicks (2000) surveyed college faculty about their teaching style in two courses: one traditional course and one course that used technology. In the technology courses, faculty reported using an average of four different types of technologies (Grasha & Yangarber-Hicks, 2000).There were no significant differences between teacher responses in the technology course and the traditional course on any of the five teaching style subscales, indicating that technology use did not change teachers teaching style practices (Grasha & Yangarber-Hicks, 2000). Additionally, Zhao et al. (2002) found that teachers who proposed technology grant projects that were aligned with their pedagogical beliefs and practices were more likely to be successful in those projects than those who did not align their projects with their beliefs. One teacher in particular was inspired by a workshop to take on a new pedagogical approach, but was still unable to fully implement her technology project due to a lack of fully understanding the new theory and its underlying assumptions, and to lack of commitment to the theory in the face of challenges (Zhao et al., 2002).

For many teachers, teaching with technology can be a new and challenging experience. Even experienced teachers may revert to novice teaching habits when faced with new technology (Pierson, 2001). Matching professional development to a teacher's routinized knowledge or preferred teaching style may decrease the level of anxiety and increase the likelihood that they will adopt the technology.

In addition to a teacher's style and pedagogical preferences, his or her beliefs about technology and various technological tools can influence their adoption or rejection of specific technological tools. Hughes (2005) noted that while the teachers were exposed to several types of technology, they only continued to learn and use technologies that they perceived as useful to themselves and their students. In a case study of three teachers, Pierson (2001) found that how teachers chose to use technology in their classroom was closely tied to their personal beliefs about the uses and affordances of technology. For example, one teacher's beliefs about the entertainment value of technology led him to use computer time a reward for good behavior, rather than as a means to teach content. On the other hand, another teacher saw technology as another tool that could be used to effectively teach content matter. She thought critically about her objectives for her students and integrated technology when she felt that it would improve her student's learning (Pierson, 2001). Although some studies have suggested that over time technology leads to adoption of more constructivist strategies (Sandholtz, Ringstaff & Dwyer, 1997), Windschitl and Sahl (2002) found that although some teachers did adopt more constructivist practices during a two year laptop initiative, those changes seemed to be driven be a shifting in their beliefs independent of the computers. This conclusion was further supported by the fact that teachers who did not alter their teacher-centered learning attitudes during the two- year period (Windschitl & Sahl, 2002).

PROPOSED RESEARCH STUDY

Chapter Two: Statement of the Problem

As the use of technology outside of the school grows, the push for technology integration in schools is also increasing. Many advances have been made in pre-service teacher training, but there still is a need for time-efficient and effective technology professional development for in-service teachers. The study proposes a comparison of three workshop styles to increase the TPACK knowledge. The three workshops are modeled after different types of pre-service instruction based on three educational theories: information processing, social cognitive theory, and socio-constructivism.

In 2000, the National Council of Teachers of Mathematics (NCTM) stressed the important of technology integration into mathematics learning. Although technology is important in all content areas, this study will focus specifically on middle school mathematics. Focusing on one content area allows the technology trainings and examples used in them to be situated in the context of the teachers' subject matter expertise.

Due to time constraints, this study will take a narrow view of technology knowledge focusing primarily on the use of Google Applications. Unlike many other types of software, most Google Applications are free for use by teachers and students. Google also provides help tools and tutorials for many of its applications. For a fee, schools and other educational institutions can get additional security options and technical support. Another benefit of Google is the variety and flexibility of applications. Teachers will be able to use these applications to support learning in a number of ways.

In this study, I hope to answer the following questions about technology professional development:

Research Question 1:

Which type of professional development workshop leads to the highest increase in technology knowledge overall?

Hypothesis 1:

Both the information processing intervention group and the social cognitive intervention group will have a larger increase in technology knowledge than the socio-constructivism intervention group. The social cognitive intervention group will have the large increase in technology knowledge.

Rationale 1:

Both the information processing intervention and the social cognitive intervention have a more directed focus on the Google tools than the socio-constructivism intervention group. The structure of both of those interventions ensure that the teachers are exposed to all of the tools equally, however in the socio-constructivism group, it is possible for the teachers to focus on only one or two tools that they are already familiar with using.

The social cognitive intervention has the added benefit of modeling specific procedures to the students and allowing them to practice on their own computers. This hands-on practice will give them a more concrete understanding of the technology tools.

Research Question 2:

Which type of professional development workshop leads to the best technology integration rated according to the TPACK framework?

Hypothesis 2:

Both the social cognitive and the socio-constructivist intervention groups will have better post-intervention technology integration scores than the information processing group.

Rationale 2:

The social cognitive group and the socio-constructivist interventions both allow teachers to practice technology integration in a supported environment, either through facilitated models or group participation. This integration is what is needed in order to achieve technological pedagogical content knowledge (Hervey, 2010; Hughes, 2005; Koehler, Mishra, & Yahya, 2007; Niess et al., 2009; Pierson 2001).

Research Question 3:

Is there an interaction between teachers' own teaching styles and the type of professional development that they receive on their integration of technology in their lesson plans?

Hypothesis 3:

Teachers who received an intervention that was congruent to their teaching style will have better technology integration in their lesson plans than teachers in interventions that did not match their teaching style.

Rationale 3:

Teachers' beliefs and teaching practices tend to be stable over time. The addition of technology does not change a teacher's beliefs or teaching style (Grasha & Yangarber-Hicks, 2000; Hervey, 2009). Hervey (2009) indicated that experience teachers may find it difficult to integrate technology in a way that is inconsistent with their instructional practices. Matching the instructional practices of the training with that of the teachers should therefore lead to easier acquisition of TPACK and integration of technology in to a content focused lesson.

Research Question 4:

What impact does the type of training have on the teaching method used when teachers are asked to integrate technology into an instructional lesson plan?

Hypothesis 4:

Teachers whose teaching style was similar to the intervention they received will have higher technology integration scores and will integrate technology in a way that is consistent with that orientation. Teachers who received an intervention that does not match their individual teaching style will have lower technology integration scores and will integrate technology in a way that is consistent with their personal teaching style.

Rationale 4:

Grasha and Yangarber-Hicks (2000) found that university faculty members teaching styles did not differ between class in which they used technology and courses where they did not use technology. Niess (2005) found that even after a year-long technology masters program, teachers tended to integrate technology in ways that were consistent with their beliefs about teaching and learning upon entering the program. Since the interventions in this study are one day workshops and do not focus on conceptual change in the teacher’s beliefs, they will use technology in a way that is consistent to their classroom practices prior to the training.

Chapter Three: Methods

Participants

The participants of this study will be certified teachers teaching middle school mathematics, grades six to eight. A power analysis, calculated using GPower, determined that 196 teachers were needed for the study to have a power of 0.80 the final 3 X 3 ANCOVA. For this calculation, an effect size of .25 and an alpha level of 0.05 were set to make sure the study had sufficient power to find a significant difference, while still protecting the Type 1 error rate. The power may be further increased by covariates depending on their correlation with the dependent variables. Since there are no accurate estimates of these correlations, they were not included in the power analysis.

After IRB approval, participants will be recruited by contacting principals and teachers in the Austin Independent School District. Participation in the research study will be voluntary and teachers will be allowed to stop participating at any time. Also names will be replaced with participant identification numbers.

Instruments

Input variables.

Teaching style inventory.

It is important to note that while teachers use a variety of teaching techniques and strategies, they seem to have some strategies or methods that they prefer and use often. These methods are what make up a teacher's teaching style preference. Grasha (1996) developed the "Teaching Style Inventory" to identify college teachers teaching style preferences based on five different scales: expert, formal authority, personal model, facilitator, and delegator. This instrument is serving as a grouping measure to create groups with similar diversity of teaching styles.

On this instrument, teachers rate their level of agreement with 40 statements about their teaching practices in a particular course on a 7-point Likert scale. Typical items include, “What I say and do models appropriate ways for students to think about issues in the content” and, “Activities in this class encourage students to develop their own ideas about content issues” (Grasha, 1996). The complete instrument can be found in Appendix A. While it is possible to classify teachers based only on their highest subscale score, Grasha (1996) clusters teachers based on all of their subscale scores in the “high range” based on test norms (Table 1). For example, if a teacher received a high score on expert, a low score on formal authority, a high score on personal model, a high score on facilitator, and a medium score on delegator, then that teacher would fall under Cluster 3 (Appendix B). Grasha based each of the four clusters on classrooms observations and interviews with faculty members. Each of the clusters displays distinct patterns of instructional methods that have both advantages and disadvantages for learning (Grasha, 1994, 1996). For this reason, none of the teaching styles are viewed as superior to the others, although some teaching styles may produce better results than others in certain contexts.

Table 1
Teaching Style Inventory Table of Norms

	Low Scores	Moderate Scores	High Scores
Expert	1.0-3.2	3.3-4.8	4.9-7.0
Formal Authority	1.0-4.0	4.1-5.4	5.5-7.0
Personal Model	1.0-4.3	4.4-5.7	5.8-7.0
Facilitator	1.0-3.7	3.8-5.3	5.4-7.0
Delegator	1.0-2.6	2.7-4.2	4.3-7.0

Grasha (1996), p.164

Grasha (1993, 1996) established content validity by observing and interviewing university faculty around the U.S. He also used member checking in order to solidify the instructional strategies associated with each of the clusters. Member checking involves presenting your qualitative findings to members of the research population in order to establish the validity and generalizability of your theory. Faculty members involved in training workshops confirmed that the list of instructional strategies proposed by Grasha (1996) fit with their instructional practices.

In a study of 381 faculty members from colleges and universities across the United States, 92 percent of the participants fit into one of the four clusters based on their responses (Grasha, 1996). Cluster 1 (Information Processing teachers) represented the largest number of faculty with 38 percent. The social cognitive teaching style made up another 22 percent of the faculty respondents. Cluster 3 and 4 were represented by 17 percent and 15 percent, respectively, of the faculty members. Although all of the survey items deal with generic teaching practices that are not specific to college teaching, slight revisions have been made to the survey directions to reflect a middle school context (Appendix A). Prior to this study, the instrument should be validated for use with K-12 teachers.

Covariates.

Aside from teaching style, several factors influence the impact that technology training will have on in-service teachers. Using the TPACK framework as a guide, math content knowledge, technology knowledge and one's beliefs about technology as an instructional tool are important variables to measure when assessing the effectiveness of technology professional development for teachers. The Google Application Skills Test will be taken pre- and post-workshop and serve both as a covariate (pre-) and an outcome (post-) measure. It will be discussed with the outcome measures rather than this section.

***Praxis middle school math*.**

The Praxis II series of tests consists of over 120 different subject area and teaching skills tests used throughout the U.S. to determine teacher certification eligibility. The subject assessments "measure general and subject-specific teaching skills and knowledge" (Educational Testing Services, 2010a, para.1). Unlike some of the other Praxis tests which assess both content knowledge and pedagogical content knowledge, Middle School Math Test focuses only on mathematics content knowledge. The test measures teacher knowledge of mathematics content in fives areas: arithmetic and basic algebra; geometry and measurement; functions and their graphs; data, probability, and statistical concepts; and problem-solving exercises (Educational Testing Services, 2010a). Forty multiple-choice and three self-constructed response items make up the test. Sample items are shown in Appendix C.

For this study, a retired Praxis middle school math test will be used to assess teachers' pre-existing mathematic content knowledge. Although the training protocols do not seek to increase math content knowledge in any way, content knowledge may affect how well teachers are able to see connections between technology and their own subject matter.

Participating teachers will complete a retired Praxis middle school math test online two weeks prior to training. One limitation to administering this instrument online is that teachers may be tempted to use outside resources to answer the items. As with the actual examine, imposing a two hour time limit on teacher-participants will reduce their ability to use outside sources. They will be able to use calculators when completing the items. Scores will be calculated using the norms and conversation tables provided by ETS.

Technology beliefs survey.

The Technology Beliefs and Competencies Survey was developed to assess pre-service and in-service teachers participating in the Preparing for Tomorrow's Teachers to Use Technology (PT3) initiative as part of a teacher preparation program at Arizona State University (Brinkerhoff, Ku, Glazewski, & Brush, 2001). Two different versions of the instrument were developed for pre-service and in-service teachers, but both versions included an identical section addressing the teachers' beliefs about technology as an educational tool. In teacher training, as with any learning, motivation is an important factor. If teachers do not see technology as an important instructional tool, this will affect their ability to effectively integrate technology into their own classroom. This scale will be used as a covariate measure to control for differences in teacher's beliefs about the ability of technology to increase learning.

The Technology Beliefs Survey was comprised of eleven self-report Likert scale items. Teachers rated their level of agreement with items such as “Incorporating technology into instruction helps students learn” and, “Content knowledge should take priority over technology skills” (Brinkerhoff, Ku, Glazewski, & Brush, 2001, p. 4). The full instrument is included in Appendix D. The Cronbach Alpha for this section was 0.86 for pre-service teachers (n=111) and 0.82 for in-service teachers (n=13) (Brinkerhoff, Ku, Glazewski, & Brush, 2001).

Outcome variables.

Google application skills test.

The Google Application Skills Test is a researcher developed multiple choice instrument designed to measure participant-teachers’ technology knowledge about the Google Applications addressed in the technology workshops. The 25- item instrument consists of 5 items related to each of five Google Tools: Google SketchUp, Google Wave, Google Maps, Google Sites, and Google Docs. Five sample items are found in Appendix E. The instrument will be completed both pre- and post- intervention as measure of technology knowledge. Like math content knowledge, technology knowledge is a building block of TPACK and can influence a teacher’s response to technology training. Due to the variation in technology of the participants prior to the study, pre-workshop scores will be used as a covariate when measuring the impact of the trainings on teachers’ technology knowledge and integration. Prior to the training, the survey should be validated with in-service teachers.

Technology integration assessment rubric.

Harris, Grandgenett, & Hofer (2010) developed the Technology Integration Assessment Rubric as a way to assess the quality of technology integration in a way that does not make judgments about the pedagogical approach, but rather evaluates the "fit" of technology within a lesson. The rubric evaluates lesson plans on four criteria using a four point rating scale: curriculum goals and technologies, instructional strategies and technologies, technology selections, and "fit" (Harris, Grandgenett & Hofer, 2010). Appendix F shows the complete rubric. Each of the criteria corresponds to one of the four technology-related knowledge areas within the TPACK framework. The Technology Integration Assessment Rubric will be used to determine the quality of technology integration in the in-service teacher lesson plans. Prior to rating the lesson plans, all raters will be trained using the rubric and interrater reliability will be calculated for this study.

The rubric was reviewed and edited by six educational technology scholars at different institutions to assess its construct and face validity. Then seven experienced technology-using teachers and district-based teacher educators independently graded three pre-service teacher lessons plans (from a total of fifteen different lesson plans) to provide feedback and determine the reliability of the rubric. Each of the raters attended a rubric training session on the rubric prior to grading the lesson plans. After revisions, a second group of eight raters were trained and rated the pre-service teachers' lesson plans. One month after their original ratings, all of the raters were asked to rerate their three lesson plans to establish test-retest reliability.

A total rubric intraclass correlation coefficient of 0.857 was calculated for the second group of raters using the revised rubric (Harris, Grandgenett & Hofer, 2010). Intraclass correlations for each of the rubric criterion were also calculated separately: curriculum goals and technologies (ICC= 0.817), instructional strategies and technologies (ICC= 0.803), technology selections (ICC=0.830), and “fit” (ICC= 0.782) (Harris, Grandgenett & Hofer, 2010). Raters’ percent agreements on all of the criteria were high as well, ranging from 84.1 percent on the total rubric to 93.5 percent on the curriculum goals and technologies criterion (Harris, Grandgenett & Hofer, 2010). The internal consistency of the final rubric was 0.911 and test-retest reliability was 87 percent (Harris, Grandgenett & Hofer, 2010).

Data Collection

Participating teachers will have two weeks to complete four online surveys: Grasha’s Teaching Style Inventory (1996), a practice version of the Praxis II Middle School Mathematics Test, the Technology Beliefs section of the Technology Beliefs and Competencies Survey (Brinkerhoff, Ku, Glazewski, and Brush, 2001), and a Google Application Skills Test. Teachers will be able to take each survey individually or complete them in one sitting, however once surveys responses have been submitted, the teachers will not be allowed to review or change their answers.

Stratified random assignment will be used to assign an equal number of each teaching style cluster in each of three separate technology trainings. Each training group will have 65 or 66 teachers.

Each of the day long training workshops will last from 8:30 AM to 4:30 PM, and will focus on the use of Google tools and applications in the classroom, but will be taught according to three distinct educational theory protocols. Each type of training is described in-depth in the following sections. At the end of the training session, each of the teachers will retake the Google Application Skills Test. Two weeks after the training workshop, teachers will electronically submit a detailed mathematics lesson plan that integrates technology. All lessons plans will be graded by two raters using a rubric (Appendix E). Interrater reliability will be calculated for the rubrics. Since lesson plan formats can vary, follow up interviews will be used when necessary to gather more information about a teacher's lesson. Interviews will only be used when both raters are unable to determine a rubric score based solely on the written lesson plan.

Training Protocols

Teachers will be assigned to one of three training protocols that will focus on the use of Google SketchUp, Google Wave, Google Maps, Google Sites, and Google Docs. Each of the trainings will consist of one full workshop and each teacher will receive an identical training manual. The training manuals will include an overview of each of the Google Applications, including a chart of their affordances and constraints and links to online training modules, a description of the mathematic activity types and corresponding technologies (Grandgenett, Harris & Hofer, 2009), and a technology mapping guide (Angeli &Valanides, 2009). All of the workshops will be conducted by a Google Apps for Education Certified Trainer. To become certified, individuals must pass an online test, provide references of previous educational technology use or professional development, and submit training artifacts and a video demonstrating their ability to train teachers to use Google tools.

Information processing workshop protocol.

The information processing workshop will be conducted in a lecture format that explains how to use each of the five Google Applications. The workshop will be divided into five sections that are approximately an hour and fifteen minutes long. During each session, the trainer will demonstrate how to use each of the tools and describe two or three mathematics instructional activities using the tool. When available, the trainer will use Google made instructional videos to demonstrate the tools.

Social cognitive workshop protocol.

Similarly to the information processing workshop, this training will be divided into five sections. However rather than the sections focusing on Google Applications, each section will focus on a particular "produce" mathematics activity types (Grandgenett, Harris & Hofer, 2009). Activity types are discrete classroom activities that focus on obtaining a specific learning outcome. For mathematics, these activity types are grouped into seven categories based on the level of the learning goal: consider, practice, interpret, produce, apply, evaluate, and create (Grandgenett, Harris & Hofer, 2009). Due to the limited time of the workshop, this intervention will focus only on one mid-level category: produce activity types. The "produce" mathematics activity types include: doing a demonstration of a math concept or procedure, generating text to demonstrate conceptual understanding, describing an object or concept mathematically, producing a mathematical representation, and developing a mathematical problem. During each session, the trainers will guide in-service teachers through a mathematics learning activity using Google tools. Video cases of middle school math teachers using Google Applications will also be shown during the workshop sessions.

Socio-constructivist workshop protocol.

The socio-constructivist training workshop will last the same amount of time as the other workshops, but will not be broken into segments. The session will begin with a brief overview of the Google Applications and the resources that teachers can find in the training manual and online. After the overview the trainer will divide the in-service teachers into groups based on grade level that they teach and their technology knowledge measured by Google Application Skill Test. Groups will be predetermined to form groups of teachers teaching the same grade level, but with a variety of technology skill levels. Each of the groups will be directed to use all of the resources available to produce a technology integrated math lesson plan. During the last hour of the day, groups will have ten minutes each to present their lesson plans to the other teachers.

Analysis

Research Question 1:

Which type of professional development workshop leads to the highest increase in technology knowledge overall?

Statistical Analysis:

Using a one-way Analysis of Covariance (ANCOVA), the affect of the workshop on the teacher's level of technology knowledge will be examined. The pre-workshop score on the Google Applications Skills Test will serve as the covariate to reduce the error and increase the power of the statistical analyses. The dependent variable for this analysis will be the post-workshop Google Applications Skills test. An alpha level of .05 will be used at the criterion for statistical significance.

A significant difference is expected, and the post hoc Tukey procedure will be used to test for differences between each of the three workshops. The Tukey procedure protects the overall α, while still providing a powerful test to look at each of the paired comparison by "simultaneous creating confidence intervals for each pair of population means" (Stevens, 2007, p. 69). Since all of the groups will be relatively equal in size, the Tukey-Kramer adjustment is not needed for this analysis.

Research Question 2:

Which type of professional development workshop leads to the best technology integration rated according to the TPACK framework?

Research Question 3:

Is there an interaction between teachers' own teaching styles and the type of professional development that they receive on their integration of technology in their lesson plans?

Statistical Analysis:

A two- way analysis of covariance will address both the overall impact of three types of professional development on the teacher's technology integration in their lesson plans and the interaction between a teacher's teaching style and the training they receive. Due to stratified random assignment, the three treatment groups will be approximately equal in size, so even if there is not homogeneity of variance there will not be a strong impact on the actual α level. Also the different styles of teachers will be equally distributed among the three training types.

Technology integration is predicted to be influenced by the teaching subject matter content, level of technology knowledge, beliefs about technology as a teaching tool, and the teacher's teaching style preference. For this reason, pre-workshop scores on the Praxis Middle School Math Test, the Google Application Skills Test, and the Technology Beliefs Survey will be used as covariates in the analysis. Teaching style differences in each group will be assumed to be equal due to stratified random assignment. The teachers' scores on the Technology Integration Assessment Rubric will be the dependent variable in this ANCOVA. Prior to running the 3 X 3 ANCOVA, statistical analysis will be run to test for a linear relationship between the dependent variable and the covariates and to check that the homogeneity of hyperplanes assumption is met.

Table 2
3 X3 ANCOVA design

	Workshop Types		
Teaching Styles	**Information Processing**	**Social Cognitive**	**Socio-Constructivist**
Information Processing	X_1	Y_1	Z_1
Social Cognitive	X_2	Y_2	Z_2
Socio-Constructivist	X_3	Y_3	Z_3

If significant, a one-way ANCOVA will be used to main effect of the trainings on technology integration. There is predicted to be a significant difference on this main effect, so post hoc t-tests will be used to test for pairwise differences. Following this analysis, four planned comparisons will be used to better understand the significance. Hypotheses state that there will be an interaction between these variables and that when teaching styles and training styles are congruent, the teacher will demonstrate higher ability in her exam years. Planned comparisons using the adjusted means will be conducted to test the following hypotheses:

1. H_0: $\mu_{X1} = (\mu_{X2} + \mu_{X3})/2$
2. H_0: $\mu_{Y2} = (\mu_{Y1} + \mu_{X3})/2$
3. H_0: $\mu_{Z3} = (\mu_{Z1} + \mu_{Z2})/2$
4. H_0: $(\mu_{X1} + \mu_{Y2} + \mu_{Z3})/3 = (\mu_{X2} + \mu_{X3} + \mu_{Y1} + \mu_{X3} + \mu_{Z1} + \mu_{Z2})/6$

Each of these comparisons tests the overall hypothesis that congruence between one's teaching style and the technology professional development method is associated with higher levels of technology integration. A Bonferroni correction will be used for the above post hoc t-tests and planned comparisons, causing the alpha level to be 0.007 for each of seven above analyses.

Research Question 4:

What impact does the type of training have on the teaching method used when teachers are asked to integrate technology into an instructional lesson plan?

Analysis:

Qualitative analysis will be used to analyze whether the methods that teachers used when integrating technology in their lessons plans is aligned with either their own teaching style preference, the style of the workshop, or some other source. The teaching method used in the teachers' lesson plans will be coded by two investigators independently, and then the two investigators will compare their coding. Researchers will employ the constant-comparative method to look for patterns of discrepancy amongst the teachers with different teaching styles, or those that attended different types of training (Corbin & Strauss, 2008).

Chapter Four: Discussion

Conclusions

As the availability of computers and internet access increases in schools, teachers are becoming more and more responsible for integrating those technological tools into their own content area. This study compares three methods of technology professional development and their impact on teachers' acquisition of technology knowledge and their integration of technology into the classroom. Literature supports the hypothesis that while there will be overall differences in the trainings both on technology knowledge and integration, the impact of a training on those two outcome variables may be divergent. In other words, the information processing technology training may increase teacher's technology knowledge, but not be associated with a high level of technology integration. The socio-constructivist technology training, on the other hand, may not have much impact on teacher's technology knowledge, but should show higher levels of technology integration in the lesson plans.

In addition, the interaction between a teacher's practices and the pedagogical method of workshop delivery are investigated. Teacher's beliefs and practices are engrained in their identity as a teacher. Rather than trying to alter these persistent attitudes and behaviors, this research attempts to examine the impact of matching a teacher's style with the technology training delivery method. It is hypothesized that this paired combination of teaching style and training method will be related to the highest levels of technology integration in teacher lesson plans.

Limitations and Future Research

The first and most apparent limitation of this study is the short length of time spent in the professional development workshops. Stand alone workshops, while the most common form of teacher professional development, have been shown to be less effective than other more sustained types of teacher training. This study focuses on a workshop format that is frequently used rather than proposing a longer intervention for the teachers. Increasing the length of the workshop could impact the effect on the teachers, but may the number of teacher willing to participate. Future studies should investigate the impact of long term professional development such as mentoring and learning communities centered on teaching with technology.

A second limitation is due to the restriction of teachers based on only a single content area. While the idea that technology training is most effective when it is delivered in a manner that is similar to a teacher's own teaching style should be generalizable across content areas, the population for this study does not allow such generalizability. Future researchers should explore the connection between teaching style preference and method of delivery of professional development both in other content areas (i.e., Science, English) and other teaching skills (i.e., collaborative learning).

Much of the technology integration professional development strives to cause conceptual change in teachers. These trainings, however do not seek to change the beliefs or teaching styles of teachers. The goal of the workshops is not to persuade teachers to use any particular teaching style, but rather to familiarize them with Google tools and help them think about how they can best adapt the technology to fit with their current practices to enhance student learning. This goal may be achieved either by adapting preexisting lessons or creating new ones. Researchers and teacher professional developers with a distinct preference for a particular pedagogical orientation may see this as a limitation of the workshops.

Teacher motivation is another variable that can affect how teachers react to and adopt new teaching strategies or tools. While the current study focused on more overt learning and behaviors, researchers should also look at the impact that method of delivery of professional development has on teacher motivation. Allowing teachers to choose their method of delivery, rather than being placed by teaching style could also impact the teachers' motivation and learning.

Finally, the goal of all teacher professional development is to affect student learning. This study stops at the analysis of the lesson plans, rather than measuring actual classroom teaching or student learning outcomes. Classroom observations are time consuming and are outside the scope of this study, but should be pursued as the next step in this line of research. Teachers should be observed frequently and randomly rather than at scheduled time to ensure that it is not the presence of a researcher that is altering their teaching or use of technology. Due the number of factors influencing student learning, it is difficult to control all of the contributing variables and focus specifically on the impact of the teacher's actions, or a change in those actions. Despite these challenges, researchers that hope to influence teacher education should always consider the impact that their training has not only on teachers, but also their students and the learning process.

Implications for Practice

A variety of training is offered for teachers today, but workshops are the most frequent form of professional development for practicing teachers. This study seeks to improve technology training by adapting existing methods of pre-service training to workshops that are accessible to in-service teachers. Comparisons between various methods can inform school and district administrators as they judge various options for supporting teachers with the integration of technology in schools. If, as hypothesized, there is an interaction between teaching style and workshop delivery, districts may want to consider offering training in various styles and either placing teachers in or giving them a choice of delivery method.

EVALUATION PLAN

Chapter Five: Proposed Program Description

The lesson study is a professional development technique originating in Japan (Fernandez, 2002) during which teachers work collaboratively to create, implement, revise, and reflect on a specific lesson or objective that needs to be taught. Beginning in 1999, the process began gaining popularity in the U. S. for training math pre-service and in-service teachers (Lewis, Perry, & Hurd, 2009). The lesson study cycle allows teachers with differing levels of knowledge and experience to learn from one another through modeling and dialogue. The final step in the lesson study process involves writing a reflective report documenting the lesson, the materials used, and insights into what the group learned through the process. Integrating a technology component into the lesson study professional development will provide teachers a collaborative and safe way to explore the use of technology in their classroom. Adoption of technology is not a single occurrence, but a process that happens over a period of time (Fullan, 2007; Roger, 2003). Lesson studies are different than more traditional workshop forms of teacher training because they provide sustained support over an extended period of time. This professional development also offers teachers an opportunity to try out new technologies in a low stakes situation and observe other classroom teachers implement technology in their classes. Both of these aspects, experimentation and observation, are important in the adoption of new technology (Rogers, 2003).

Lesson study professional development combines the modeling of activity type training with the design aspects of learning by design. Additionally, lesson plan study is school-based and therefore offers a more sustained network for support both during and after the process. Reflection is another component of lesson study that is not found in the other types of technology professional development.

There are four essential components to a lesson study cycle: a shared long-term goal, important lesson content, careful study of students, and live observations of lessons (Lewis, 2002).

1. The shared long-term goal is typically a school-wide goal that can span one or more years. In Japan, the goals tend to be very broad goals, visions, or mission statements rather than specific, measurable objectives (Lewis, 2002).
2. The content area is usually chosen by the teachers based on weaknesses in student learning, teaching difficulties, changes in the curriculum, or content areas that are associated with large amounts of instructional time (Lewis, 2002). Both in Japan and the U. S., lesson studies are used most often in mathematics instruction (Lewis, 2002), but are suitable for use in all content areas.
3. The third component, careful study of students, is based on the idea that during the planning, observing, and revising of the lesson, the focus should be on the student behaviors and learning rather than on specific teaching behaviors. In the lesson study process, the teachers are refining a specific lesson in response to student cues rather than evaluating "good teaching".
4. In order for this to be accomplished, the teachers must have the opportunity to observe students as they experience the lesson. In the live observations, teachers can gather data about "students' engagement, persistence, emotional reactions,

quality of discussion with-in small groups, *tsubuyaki* (under-breath exclamations), inclusion of groupmates, degree of interest, and so forth" (Lewis, 2002, p. 11).

In the lesson study process, these four components are realized through a collaborative process with several steps. The group first establishes or reviews a shared long-term goal and chooses an appropriate content area. In the second phase, the teachers work together to create a detailed lesson plan (Fernandez, 2002). This stage allows teachers to share ideas and best practices with each other. It also allows for the critical discussion and reflection on different instructional methods. The "research lesson" includes not only what the teacher will do, but also anticipated student responses. After the lesson is created, one teacher volunteers to enact the research lesson with real students. This is where live observations occur. All other group members observe the sample lesson with a special interest in the students' answers, engagement, and reactions to the lesson. Again, the focus here is not on the teacher, but on the lesson itself and how students respond to the different components within it (Lewis, 2002). In the debriefing after the research lesson, the group may decide to keep the lesson as is, make slight modifications to the lesson, or revise the lesson completely. If the lesson is significantly altered, a second lesson enactment should be done. When the group is satisfied with their lesson plan, they work together to create a written reflective document. The report describes the process that the group followed and what they learned as a result of the lesson study (Fernandez, 2002). The report should also contain a final version of the research lesson.

Reflection is also an essential component of the lesson study where the group meets to discuss ways to improve the lesson or unit and teaching practices. The process is similar to inquiry or action research (e.g., Hughes, Kerr, & Ooms, 2005), but is always focused on a particular lesson and happens within a group rather than individually, as is sometimes the case in inquiry research. Lesson studies also contain aspects of teacher observations, but are pushed a step further because the teachers have developed the lesson together, rather than the novice teachers simply observing a master teacher. Lewis (2009) presents a case study that shows evidence of increases in pedagogical knowledge as well as changes in interpersonal relationships and teachers' attitudes toward learning and improving after participation in a lesson study.

With all of its components, lesson study meets all five criteria for effective professional development: supportive, job-embedded, instructionally-focused, collaborative, and ongoing. (Hunzicker, 2010). The members of the lesson study group provide support for each other as they design and implement the lesson plan. This support is especially important when teachers are working to change their beliefs and practices. Lesson study is school-based and relates directly to the critical needs of teachers and students. The focus on student learning during the "research lesson" helps ensure that the process of lesson study is instructionally-focused. The cyclical process of lesson study provides ongoing opportunities for continued improvement in teaching. And finally, the group works in collaboration to create a lesson and reflective document that can be used in future collaboration with teachers outside of the lesson study group. Integrating technology into teaching often requires a change in their beliefs and practices.

Because of the robust nature of lesson study professional development, it may be very effective in helping teachers incorporate technology.

Technology-Infused Lesson Study

Technology-infused lesson study is the same as regular lesson study except that the research lesson is required to include student use of technology. The type and amount of technology use is decided by the lesson study group. As previously mentioned, adding a technology aspect to the lesson study process accomplishes all of the goals of effective professional development. The technology-infused lesson study also aligns with Guskey's process of teacher change (2002). Figure 2 shows the alignment of the steps in teacher change with the steps of technology-infused lesson study.

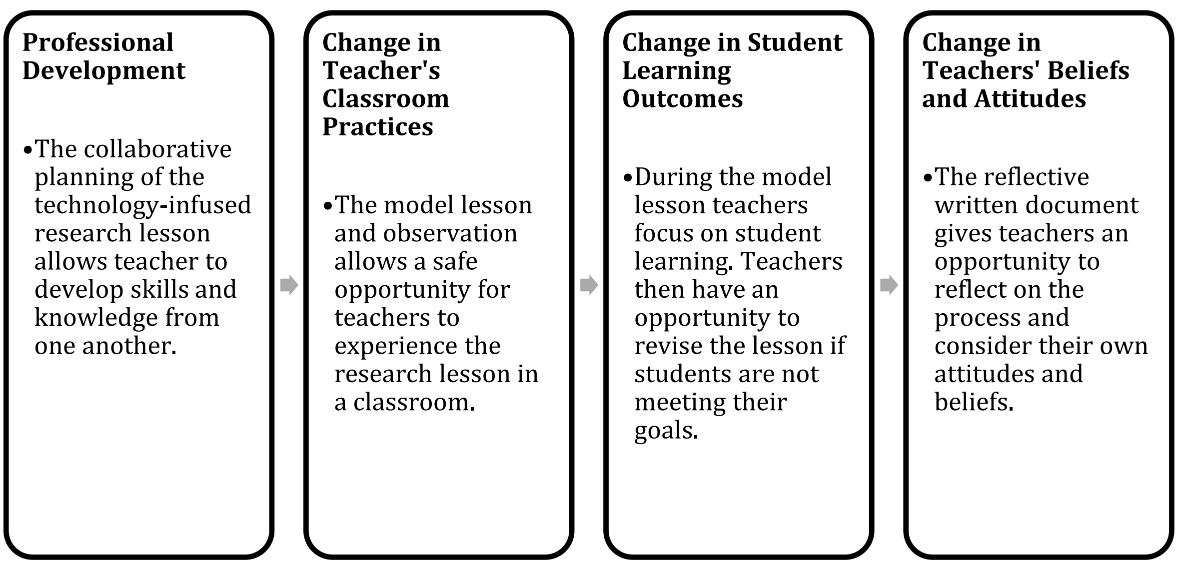


Figure 2: Model for teacher change in technology-infused lesson study.

To date, little research has been done on the impact of the complete lesson study cycle on technology integration. Mouza and Wong (2009) used a case development strategy in a graduate level course. This process is similar to lesson plan study in that teachers take real class lessons, reflect upon them, refine them, and then create a reflective case study to share with other teachers. However there are two main differences, the case study approach is done individually and retrospectively. Teachers do not get the opportunity to learn from others or the benefits of strategically planning their lesson. In 2005, Hughes, Kerr, and Ooms studied teachers in inquiry groups, but these teachers supported each other through individual lessons and projects rather than working together to design one research lesson. Observation was another component of lesson study missing in the inquiry groups. Even without that shared planning, teachers in the group felt that they learned from each other and considered new technologies suggested by their peers (Hughes et al., 2005). One of the teachers did dismiss their peer's suggestions about the appropriateness of technology. Researchers speculated that more emphasis on data-based decision making might counteract that problem (Hughes et al., 2005). The observation of the "research lesson" in lesson study is one way that teachers could gather data to support their suggestions or critiques.

Tee & Lee (2011) describe a problem-based learning professional development in Australia that resulted in an increase in TPACK for 24 in-service teachers enrolled in a 14-week course. During the first section of the course, teachers developed problems related to teaching with technology. The teachers then developed and piloted their solution. The final part of the course was dedicated to writing a wiki chapter about their experience and sharing it with the class. In self-report surveys and interviews, teachers expressed an increase in TPACK following the course. Teachers were also able to move from a mindset of "blaming the students" for the problems to redefining the issue as the teacher's problem (Tee & Lee, 2011, p. 98). This approach is closer to the lesson study process, but is still removed from the school context where the teachers work. Calvin (2008) discusses the use of technology-infused lesson study with pre-service teachers. Unfortunately, since the pre-service teachers are currently teaching, they are only able to have microteaching observations of the research lessons, reducing the impact of real classroom observations.

In mathematics education, technology-infused lesson study has been used to help teachers understand the possibilities of mathematics software. One study described the process of researchers who created a math lesson using TI-Nspire calculators to solve quadratic equations and then implemented it in nine classrooms (Pierce & Stacy, 2009). Here, the researchers, rather than the teachers were the ones participating in the lesson study. The teachers involved did not develop the lesson and served only as the model teachers for the class observations. At the end of the process, the researchers felt that technology could be helpful in teaching math if it was focused on content goals and technology distractions were reduced (Pierce & Stacy, 2009). Data were not collected from the teachers involved in the process.

In addition to the strengths of lesson study as a professional development activity, Groth, Spickler, Bergner, Bardzell (2009) proposed using the data from a technology-infused lesson study as a way to qualitatively assess teachers' TPACK. Groth et al. (2009) highlighted the rich set of data sources that is created during a lesson study cycle. This includes lesson plans, observation notes, and reflective documents. The evaluation in the current study will focus on an elementary school site that is implementing technology-infused lesson study. The data collected from two complete technology-infused lesson study cycles will be used to understand the teachers' experiences as well as any changes in their TPACK or teaching practices. Participants will be public elementary teachers participating in a school-wide technology integration initiative. Approximately 20-30 teachers will be participating in grade level teams to complete the lesson study process at least once, with 6 -10 of the teachers completing two lesson study cycles over the course of the semester.

Program Outcomes

There are three main areas of outcomes related to a technology-infused lesson study: technology attitudes and behaviors, shift from teacher to student focus, and a sense of community. In the area of technology attitudes, one of the first order outcomes is an increase in positive attitudes toward using technology in the classroom. Another first order outcome is an increase in technology self- efficacy. The final first-order outcome is an increase in use of technological pedagogical content knowledge when planning. The second-order outcome in this area is an increase in technology use during core subject matter teaching. Third-order outcomes would include an increase in student learning and increase in student technology efficacy. Due to the difficulty of collecting student information and the inability to control factors that might influence these outcomes, the third order outcomes will not be assessed in this evaluation plan.

The second group of outcomes centers on the idea that teachers in lesson-study will become more student focused. The first-order outcome is that teachers will increase their focus on student behavior and student learning in the classroom. The second-order outcome is that teachers will begin to use more constructivist and socio-constructivist teaching methods in their classes. As with the technology area, an increase in student learning is the third-order outcome. As mentioned above, only first- and second-order outcomes will be assessed in this plan.

The final area of outcomes deals with teacher collaboration. The first order-outcome here is that teachers will become more positive about collaborating and planning with their grade-level colleagues. A second-order outcome is that teachers will plan more with teachers on their grade level. Finally, a third-order outcome is that teachers will become more collaborative across grade levels and throughout the school. Only first and second order outcomes will be assessed in the evaluation plan.

Evaluation Criteria

This evaluation will take a combined decision-oriented and value-oriented approach. Decision-oriented evaluations focus on collecting and analyzing data that will be useful to leaders when they are deciding between alternative programs (Borich & Jemelka, 1982). Since school districts, principals, and teachers have several options for technology professional development, any evaluation needs to include information to help those groups chose the best option for their situation. One limitation of this approach is that while lots of data can be collected, it tends to focus on short term, quantifiable measures. Additionally the data collection focuses solely on the information deemed relevant by the decision-maker, rather than the evaluator. Using only this method may lead to an evaluation overlooking important information.

For this reason, a valued-oriented approach will also be included in the evaluation plan. This perspective places the responsibility of making value judgments on the evaluator rather than the decision-makers. According to this definition of evaluation the objectives of the program are based on societal needs and values. It is these needs and values that inform the evaluation questions and the data collected. This perspective allows for more qualitative data to be included in the evaluation of a program. In this case, several national and state organizations (ISTE, 2007, 2008, 2009; Partnership for 21st Century Skills, 2009; National Educational Technology Plan, 2010) have called for technology integration that focuses on student use of technological tools in constructivist and socio-constructivists ways to support subject matter learning. Additionally many of these organizations have created teacher competencies or standards surrounding technology integration. These are indications that there is a societal need and value placed in an increase in technology use in schools.

This combined approach to evaluating technology-infused lesson study professional development will lead to more robust data collection methods and provide information to decision makers and to the teachers, students, and parents who are also invested in this program.

Chapter Six: Program Decomposition

In order for this program to be successful, there are several inputs that must be in place. All of the teachers on a given grade level must have a common planning time so they can have sufficient time to complete the lesson study process as a group. Additionally, the teachers will need substitutes to cover their students during the observation lesson. Finally, each group will need one teacher that will facilitate the lesson study process.

The constraints related to this professional development center on the teachers in each group and their prior experiences. Since the teachers in the group will work together to create and implement a lesson, their attitudes and beliefs both about teaching and about technology will influence the trajectory of the group and the outcomes that it achieves. Additionally, attitudes about collaborating with other teacher and attitudes about the effectiveness of professional development may affect teacher participation in the groups. Finally, most of the teachers have only 3-4 computers in their classroom. This will constrain how the teachers organize their research lesson.

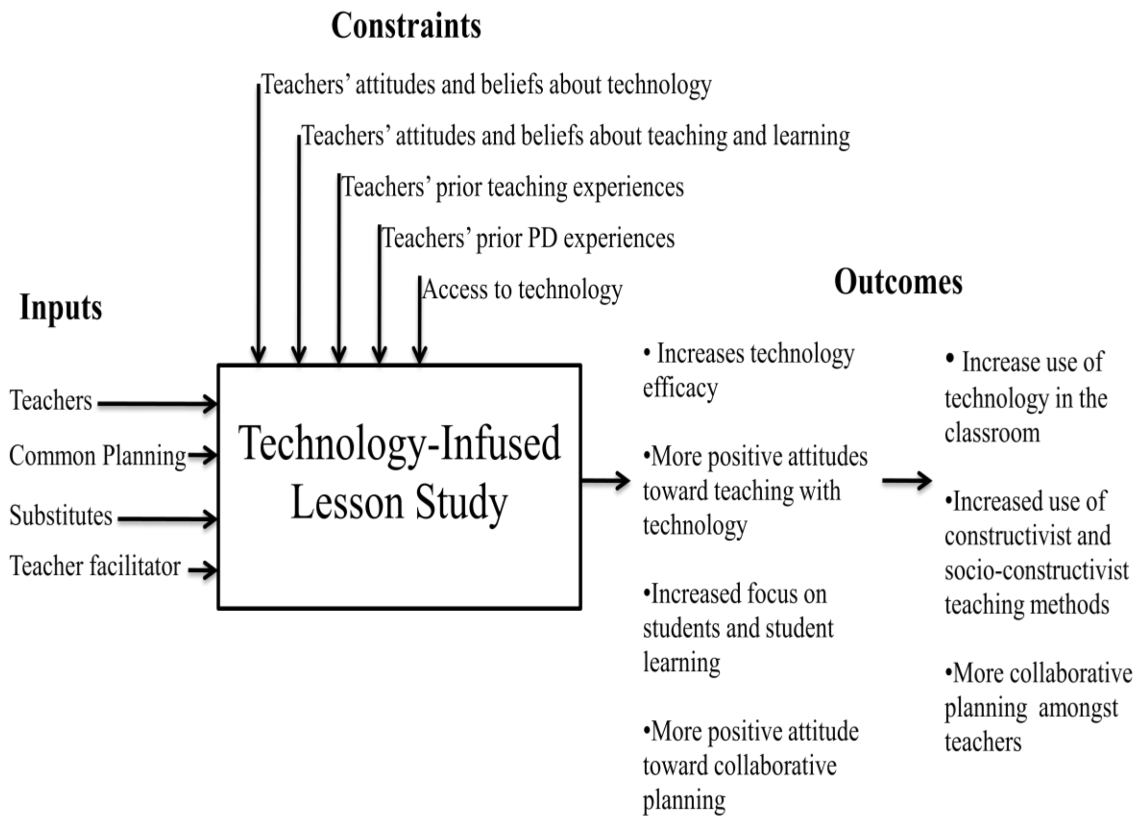


Figure 3: Overview of the program with inputs, constraints and outcomes.

Transactions are the major steps involved in a program. Technology-infused lesson study has four major transactions. In the first transactions teachers meet to decide on a focus for the model lesson. This process includes looking at previous student data and reflecting on prior teaching experience to choose a difficult or hard to teach objective. After a focus is chosen, the teachers work together to create a lesson plan on that objective or set of objectives. In the second transaction, one teacher volunteers to enact the research lesson in her classroom while the other teachers observe. Each of the teachers is given a specific student-focused observation task. Following the model lesson, the teachers meet to reflect on the lesson and make any necessary changes to the lesson plan. In the third transaction all of the teachers teach the revised lesson in their own class. The final transaction involves the teachers meeting to write a reflective report on the lesson study process. This report includes a description of the lesson objectives, the detailed lesson plan, rationale for any changes made to the original lesson, the final lesson plan, and teacher reflections on the lesson and the process. After the lesson study cycle is completed, teachers should have increased technology efficacy, positive attitudes toward technology, an increased focus on students, and a positive attitude toward collaborative planning.

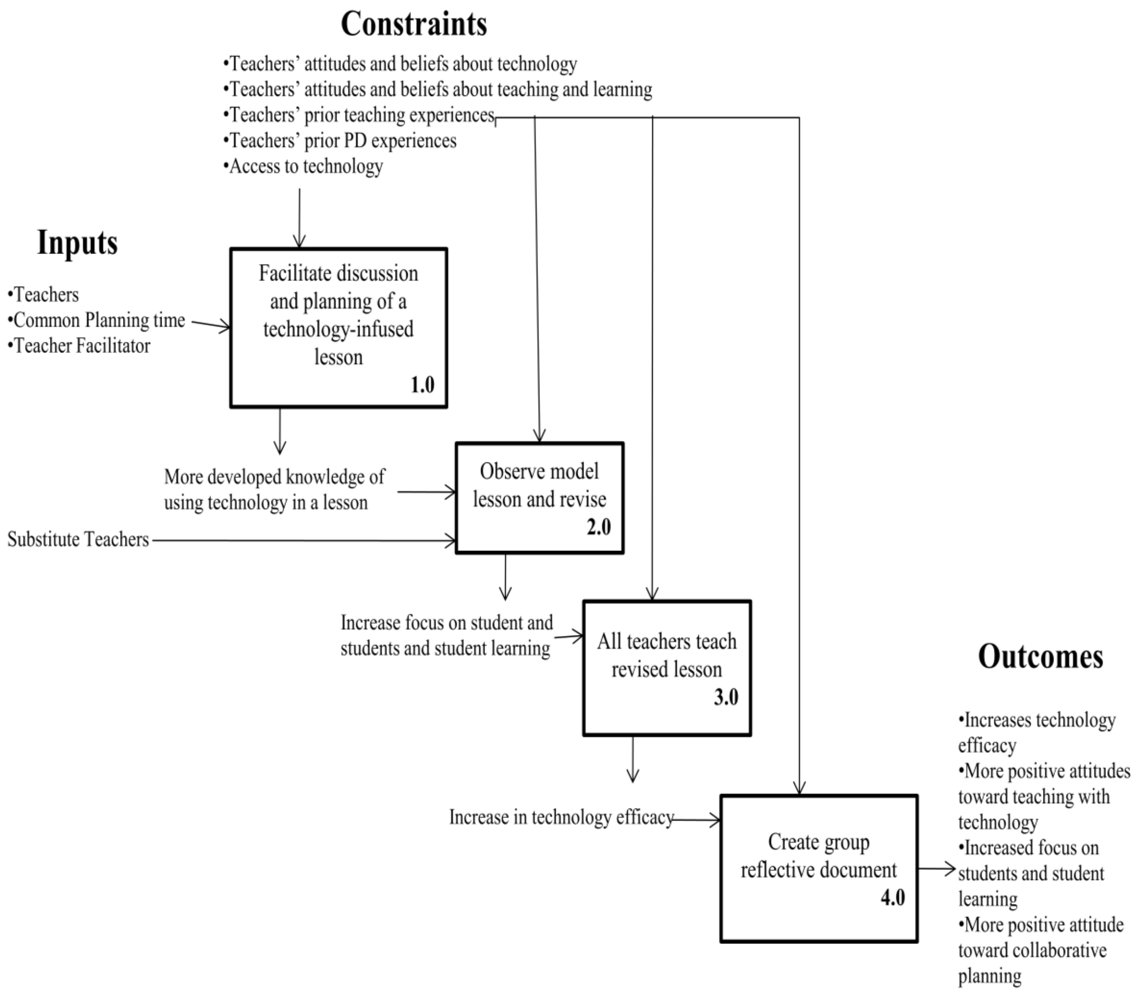


Figure 4. The program's primary transactions with inputs, constraints, outcomes, and enabling outcomes.

The most important transaction is the observation of the model lesson and revision based on that feedback. A further breakdown of the second transaction shows the steps involved in that part of the professional development. At this point the teachers have already written a lesson. They must first choose one teacher to teach the lesson with a class of regular students. This is typically the teacher's own class. Next the group assigns observation roles to all other teachers. These roles are focused on observing the students reactions to the lesson, not the actions of the teacher. One example of an observation role would be to record all student questions during the lesson. After the roles are assigned, teachers observe the lesson. Within a day, the teachers meet again to discuss the observation feedback. Finally the teachers revise the lesson and prepare to teach it in their own classes.

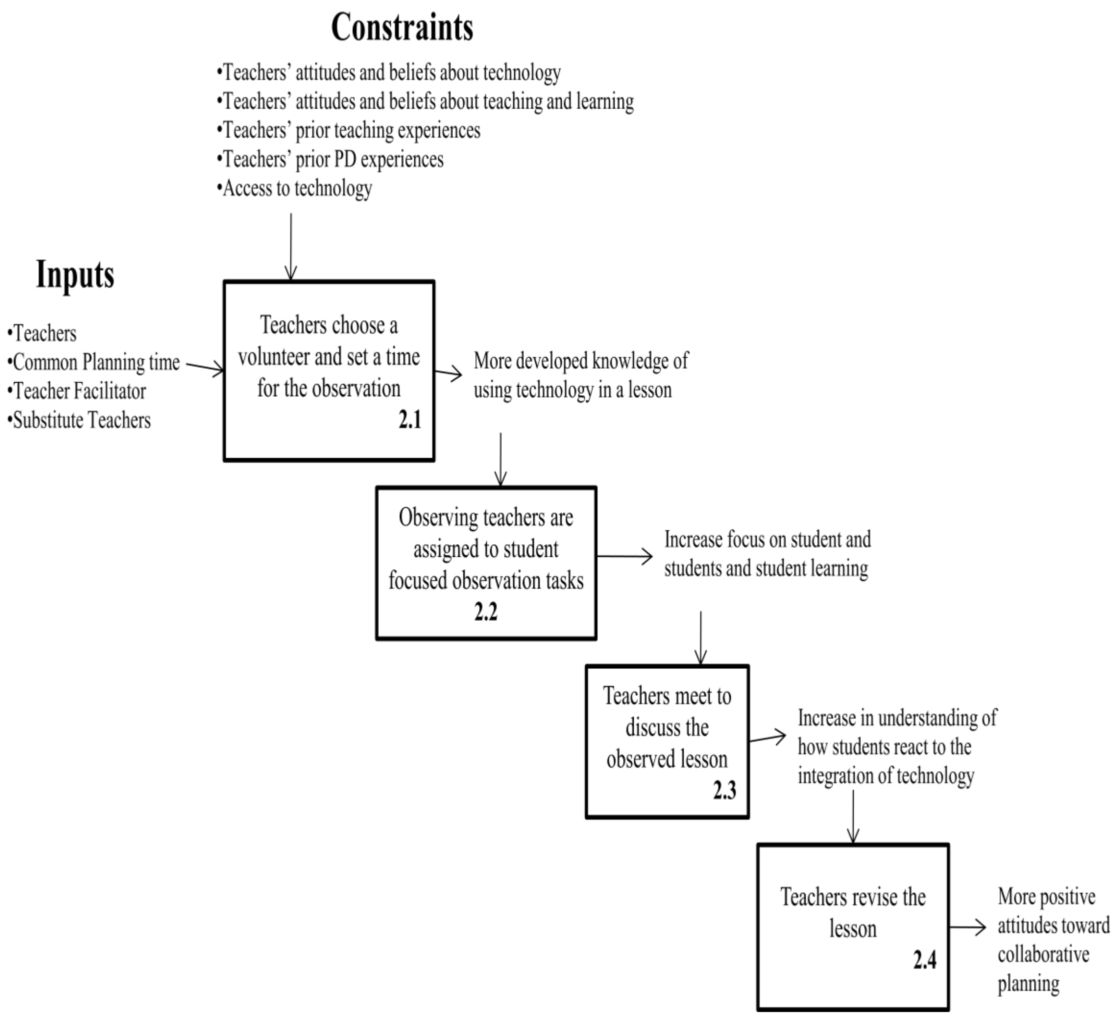


Figure 5: The program's second primary transaction (2.0) of observing and revising the model lesson with inputs, constraints, outcomes, and enabling outcomes.

Chapter Seven: Stakeholders and Evaluation Questions

Stakeholders are all of the people who have questions or concerns about the program in question. This can include the participants of the program, the implementers of the program, the funders of the program, and any other person or group affected by the implementation of the program. For technology-infused lesson study, there are four main groups of stakeholders that will be considered for this evaluation: principal, teachers, technology support personnel, and students. It is possible that there are other groups that have concerns or questions about the program, but these categories include the people who will be the most affected by the program.

Principal/ School Administrators

Since this is a school-based professional development, the principal and other school administrators are the decision makers for this program. Without their support, the professional development will not be implemented at the school. However, because they have many options for professional development, they have several questions about the costs and benefits of the program.

A. How much time will teachers need to spend outside of their class?

This is one of the more straight forward evaluation questions. Substitutes will be needed in order for teachers to observe the model lesson. The amount of substitute time devoted to covering class for a lesson study observation will be collected. Additionally, teacher information will be collected about the amount of time spent out of their class due to lesson study. Descriptive statistics will be used show the average, maximum, and minimum times that a teacher spent outside of class.

B. Will this professional development increase the amount of teachers using technology in their teaching?

Teacher lesson plans will be collected prior to the professional development and after the professional development has ended. The number of times that technology was used will be counted. Descriptive statistics and t-tests will be used to look at the differences in the amount of technology used pre-and post intervention.

Teachers

The teachers are the participants of this program and will be the most affected by its implementation. This program is unique in that teachers serve both as the participants and the facilitators of the program. Because of this, their concerns are very important.

A. How much extra time will this take me to complete?

Teachers have lots of competing demands and so time is always an important stakeholder question for this group. As mentioned above, the amount of time spent away from students will be collected, but the amount of time spent in meetings will also be collected. This information will be analyzed using descriptive statistics.

B. What will I gain from this professional development?

The program does require a significant amount of time on the part of the teachers, so they will want to know what they will gain from the professional development. Several pre/post surveys and interviews will be collected to answer this question. Teachers will take surveys on their teaching style (Appendix A), their teaching beliefs (Appendix D), and their digital technology self-efficacy (Appendix G). They will also answer pre-intervention interview questions (Appendix H) and post questions (Appendix I). The survey data will be compared using a t-test. The qualitative data will be analyzed to look for changes or growth over time. Interview questions data will also be used to understand the positive and negative implications of the professional development for the teachers.

C. Will I become better at using technology in the classroom?

Teacher lesson plans will be collected both pre- and post-, and pop-in classroom observations will be conducted during the lesson study process. The lesson plans and the observations will be assessed using the Technology Integration Assessment Rubric (Appendix F). This rubric looks at the fit of the technology component with the objectives and pedagogy being used to teach that class. Pre- post- data will be used to qualitatively compare teachers from the beginning to the end of the professional development cycle.

Technology Support Personnel

The technology support personnel both at the district level and the school level may be involved in aiding the teachers during their planning meetings, training teachers on specific types of digital technologies by request of the team, and providing technical support when needed. This group will also be invested in the evaluation of this program.

A. How will this change my job responsibilities? How much time will this take?

In order to answer this question, the technology specialists on campus will complete a log of their work schedule and tasks prior to the beginning of the professional development. Throughout the professional development process, the technology personnel will continue to log their job tasks. They will be asked to specify any tasks they feel are directly related to the lesson study professional development of the teachers. The tasks and frequencies of those tasks will be calculated. A graph will be created to show the types of tasks being performed over time. This will show any change in job responsibilities.

Post interviews will also be conducted with technology support personal to gain a better understanding of whether the change in responsibilities is positive or negative. In the interview they will be asked to describe the changes to their work schedule and explain if they feel that was a positive or negative change. The interview data will be analyzed by counting the number of positive and negative responses from all of the support personnel.

B. Will the teachers be using and requesting more digital technology tools or support?

Using the same job log, technology support specialists will be able to track the type of support the teachers are requesting. The types of technology support requested will be categorized through qualitative analysis. Changes in the types will be organized by time of the request to look at any changes in the types of request over time.

Students

Students are not directly involved with the professional development, but they could benefit from increased use of technology in the classroom. Students will also be involved in the model lesson observation portion of the professional development.

A. Will I get to use more digital technology in school?

The lesson plans will again be used to look at an increase in the use of technology. In addition to lesson plans students will be asked to report the number of times that they use technology each week. Descriptive statistics will be used to see if there are any changes over time.

B. Will my classes be more interesting and engaging?

A combination of student report data and classroom observations will also be used to answer this question. The student report data will be class data that is collected by the teachers during the model lesson and the following lessons. The data will include student work and informal feedback questionnaires about the student's engagement during class. Observation of the classes pre- and post- will give information about the student engagement before and after the professional development.

Looking at these various questions and data sources will give decision-makers and all other stakeholders the information needed to compare this professional development to other similar professional development methods.

Appendix A: Teaching Styles Inventory
(Grasha, 1996)

To complete the *Teaching Styles Inventory* you will need to use a 6th to 8th grade mathematics class that you have taught within the past 6-9 months.*

Primary Grade Level of This Course

6th grade ______ 7th grade______ 8th grade _______

What is the average enrollment? ________

How many times have you taught this class? ____________

Respond to each in the items below in terms of how they apply to the course you listed above. Try to answer as objectively as you can. Resist the temptation to respond as you believe you "should or ought to think or behave" or in terms of what you believe is the "expected or proper thing to do." Use the following scale when responding to each item.

1	2	3	4	5	6	7
Strongly Disagree		Somewhat Disagree	Neither Disagree of Agree	Somewhat Agree		Strongly Agree
Very Unimportant Aspect of my Approach to Teaching this Class						*Very Important Aspect of my Approach to Teaching this Class*

1. Facts, concepts, and principles are the most important things that students should acquire.
2. I set high standards for students in this class.
3. What I say and do models appropriate ways for students to think about issues in the content.
4. My teaching goals and methods address a variety of student learning styles.
5. Students typically work on course projects alone with little supervision from me.
6. Sharing my knowledge and expertise with students is very important to me.
7. I give students negative feedback when their performance is unsatisfactory.

8. Students are encouraged to emulate the example I provide.
9. I spend time consulting with students on how to improve their work on individual and/or group projects.
10. Activities in this class encourage students to develop their own ideas about content issues.
11. What I have to say about a topic is important for students to acquire a broader perspective on the issues in that area.
12. Students would describe my standards and expectations as somewhat strict and rigid.
13. I typically show students how and what to do in order to master course content.
14. Small group discussions are employed to help students develop their ability to think critically.
15. Students design one of more self-directed learning experiences.
16. I want students to leave this course well prepared for further work in this area.
17. It is my responsibility to define what students must learn and how they should learn it.
18. Examples from my personal experiences often are used to illustrate points about the material.
19. I guide students' work on course projects by asking questions, exploring options, and suggesting alternative ways to do things.
20. Developing the ability of students to think and work independently is an important goal.
21. Lecturing is a significant part of how I teach each of the class sessions.
22. I provide very clear guidelines for how I want tasks completed in this course.
23. I often show students how they can use various principles and concepts.
24. Course activities encourage students to take initiative and responsibility for their learning.
25. Students take responsibility for teaching part of the class sessions.
26. My expertise is typically used to resolve disagreements about content issues.
27. This course has very specific goals and objectives that I want to accomplish.

28. Students receive frequent verbal and/or written comments on their performance.
29. I solicit student advice about how and what to teach in this course.
30. Students set their own pace for completing independent and/or group projects.
31. Students might describe me as a "storehouse of knowledge" who dispenses the fact, principles, and concepts they need.
32. My expectations for what I want students to do in this class are clearly defined in the syllabus.
33. Eventually, many students begin to think like me about course content.
34. Students can make choices among activities in order to complete course requirements.
35. My approach to teaching is similar to a manager of a work group who delegates tasks and responsibilities to subordinates.
36. There is more material in this course than I have time available to cover it.
37. My standards and expectations help students develop the discipline the need to learn.
38. Students might describe me as a "coach" who works closely with someone to correct problems in how they think and behave.
39. I give students a lot of personal support and encouragement to do well in this course.
40. I assume the role of a resource person who is available to students whenever they need help.

Grasha (2006) p. 161-164
*Directions slightly altered to fit a middle school context

Appendix B: Teaching Style Clusters

<table>
<tr><th colspan="2">Teaching Methods Associated with Each Teaching Style Cluster</th></tr>
<tr><th>Cluster 1</th><th>Cluster 2</th></tr>
<tr><td>Primary Styles
Expert/ Formal Authority
Secondary Styles
Personal Model/Facilitator/Delegator</td><td>Primary Styles
Personal Model/Expert/Formal Authority
Secondary Styles
Facilitator/Delegator</td></tr>
<tr><td>• Exams/ Grade Emphasized
• Guest Speakers/ Guest Interviews
• Lectures
• Mini-Lectures + Triggers
• Teacher-Centered Questioning
• Teacher-Centered Discussions
• Term Papers
• Tutorials
• Technology-Based Presentations</td><td>• Role Modeling by Illustration
o Discussing Alternate Approaches
o Sharing Thought Processes Involved in Obtaining Answers
o Sharing Personal Experiences
• Role Modeling by Direct Action
o Demonstrating Ways of Thinking/Doing Things
o Having Students Emulate Teacher
• Coaching/Guiding Students</td></tr>
<tr><th>Cluster 3</th><th>Cluster 4</th></tr>
<tr><td>Primary Styles
Facilitator/Personal Model/Expert
Secondary Styles
Formal Authority/ Delegator</td><td>Primary Styles
Delegator/Facilitator/Expert
Secondary Styles
Formal Authority/Personal Model</td></tr>
<tr><td>• Case Studies
• Cognitive Map Discussion
• Critical Thinking Discussion
• Fishbowl Discussion
• Guided Readings
• Key Statement Discussions
• Kineposium
• Laboratory Projects
• Problem Based Learning
o Group Inquiry
o Guided Design
o Problem Based Tutorials
• Role Plays/ Simulations
• Roundtable Discussion
• Student Teacher of the Day</td><td>• Contract Teaching
• Class Symposium
• Debate Formats
• Helping Trios
• Independent Study/Research
• Jigsaw Groups
• Laundry List Discussions
• Modular Instruction
• Panel Discussion
• Learning Pairs
• Position Papers
• Practicum
• Round Robin Interviews
• Self Discovery Activities
• Small Group Work Teams
• Student Journals</td></tr>
</table>

Grasha (2006) p. 158

Appendix C: Praxis Middle School Math Sample Items

(Educational Testing Services, 2010b)

The sample questions that follow illustrate the kinds of questions in the test. They are not, however, representative of the entire scope of the test in either content or difficulty. Answers with explanations follow the questions.

Directions: Each of the questions or statements below is followed by four suggested answers or completions. Select the one that is best in each case.

X	Y
-4	-2
-3	-32
-2	-1
-1	-12
0	0

1. Which of the following is true about the data in the table above?

a) As x decreases, y increases.
b) As x increases, y does not change.
c) As x increases, y decreases.
d) As x increases, y increases.

2. The average number of passengers who use a certain airport each year is 350 thousand. A newspaper reported the number as 350 million. The number reported in the newspaper was how many times the actual number?

a) 10
b) 100
c) 1,000
d) 10,000

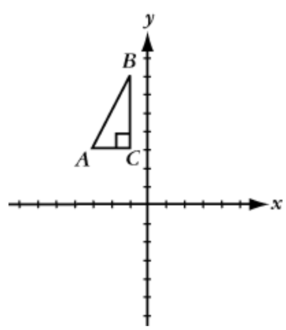
3. If there are exactly 5 times as many children as adults at a show, which of the following CANNOT be the number of people at the show

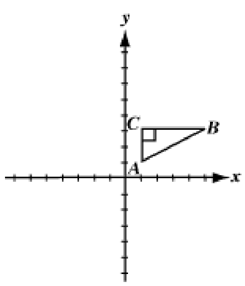
a) 102
b) 80
c) 36
d) 30

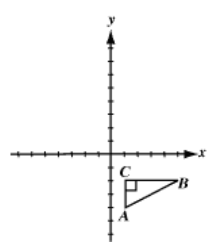
4. The original price of a certain car was 25 percent greater than its cost to the dealer. The actual selling price was 25 percent less than the original price. If c is the cost of the car and p is the selling price, which of the following represents p in terms of c?

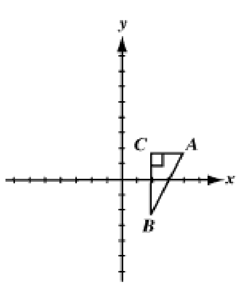
a) p = 1.00c
b) p = 1.25c
c) p = 0.25(0.75c)
d) p = 0.75(1.25c)

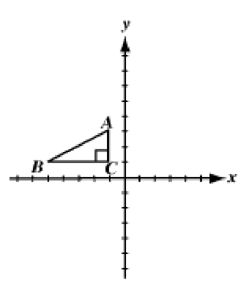
5. Which figure below results if right triangle ABC above is flipped (reflected) across the y-axis and then turned (rotated) clockwise about point C by 90 degrees?



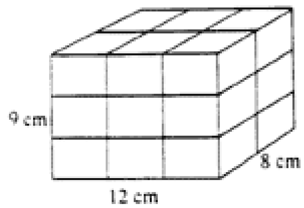
a) 

b) 

c) 

d) 

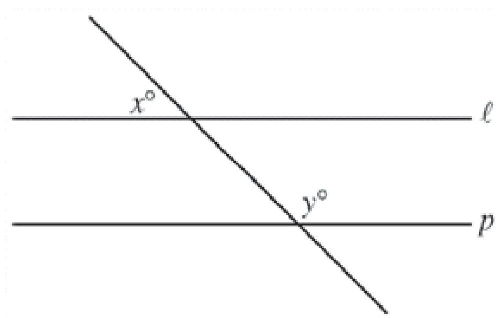
6.



The large rectangular block pictured above was made by stacking smaller blocks, all of which are the same size. What are the dimensions in centimeters of each of the smaller blocks?

a. $3 \times 2 \times 3$
b. $3 \times 3 \times 3$
c. $3 \times 4 \times 3$
d. $4 \times 4 \times 3$

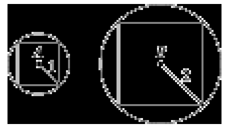
7.



In the figure above, line l and line p are parallel and y = 3x. What is the value of x ?

a) 30
b) 45
c) 60
d) 75

8.



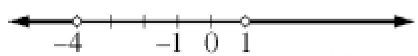
A square is inscribed in each of the circles above. The radius of circle A is 1, and the radius of circle B is 2. What is the ratio of the area of the square inscribed in circle A to the area of the square inscribed in circle B?

a) 1: 2
b) 1:2
c) 1:22
d) 1:4

9. Which of the following defines y as a function of x ?

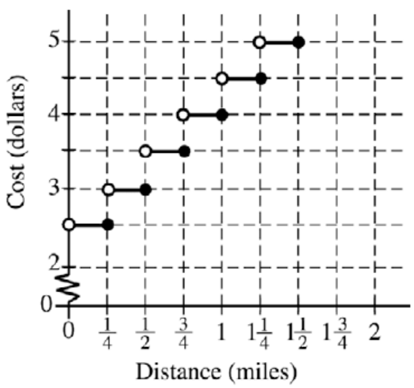
a. x – y2 = 4
b. x2 + y2 = 4
c. y = x2 + 2
d. y < x + 1

10. The graph shown on the number line above represents the set of values of x that satisfy which of the following inequalities?

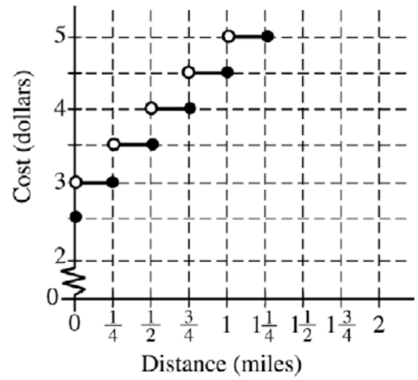


a) (x – 1)(x + 4) < 0
b) (x – 1)(x + 4) > 0
c) (x + 1)(x – 4) < 0
d) (x + 1)(x – 4) > 0

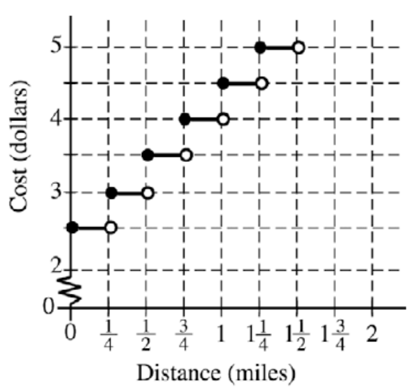
11. A taxi ride costs $2.50 for the first 14 mile or fraction thereof plus $0.50 for each additional 14 mile or fraction thereof. Which of the following graphs represents the total cost of a ride as a function of distance traveled?



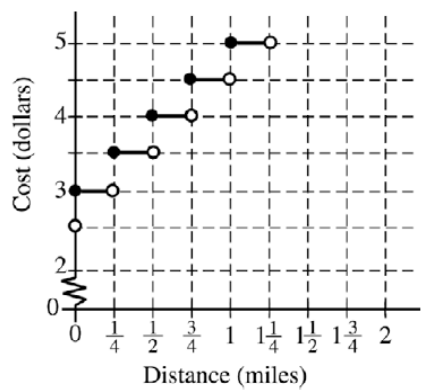
a)



b)



c)

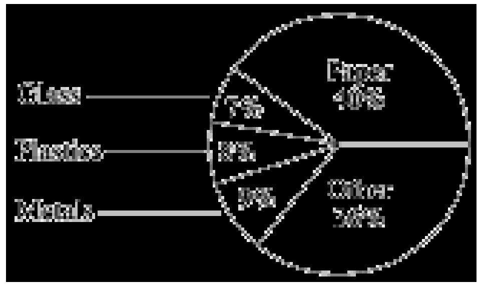


d)

12. In a class of 29 children, each of 20 children has a dog and each of 15 has a cat. How many of the children have both a dog and a cat?

a) None of the children necessarily has both.
b) Exactly 5
c) Exactly 6
d) At least 6 and at most 15

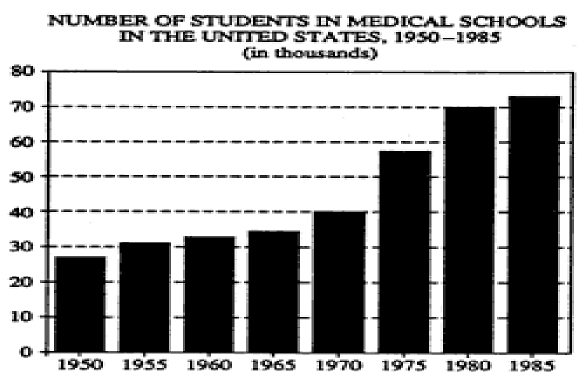
13.



The graph above shows the distribution of the content, by weight, of a county's trash. If approximately 60 tons of the trash consists of paper, approximately how many tons of the trash consists of plastics?

a) 24
b) 20
c) 15
d) 12

Questions 14-15 refer to the following graph.



14. In how many of the years shown were there more than twice as many students in medical schools as there were in 1950?

a) None
b) One
c) Two
d) Three

15. The number of students in medical schools increased by approximately what percent from 1970 to 1980?

a) 75%
b) 60%
c) 50%
d) 45%

16. In order to estimate the population of snails in a certain woodland, a biologist captured and marked 84 snails that were then released back into the woodland. Fifteen days later the biologist captured 90 snails from the woodland, 12 of which bore the markings of the previously captured snails. If all of the marked snails were still active in the woodland when the second group of snails were captured, what should the biologist estimate the snail population to be, based on the probabilities suggested by this experiment?

a) 630
b) 1,010
c) 1,040
d) 1,080

17. If a student takes a test consisting of 20 true-false questions and randomly guesses at all of the answers, what is the probability that all 20 guesses will be correct?

a) 0
b) (12)20
c) 12(20)
d) 12

18.

ROBIN'S TEST SCORES					
88	86	98	92	90	86

In an ordered set of numbers, the median is the middle number if there is a middle number; otherwise, the median is the average of the two middle numbers. If Robin had the test scores given in the table above, what was her median score?

a) 89
b) 90
c) 92
d) 95

Education Testing Services (2010).
http://www.ets.org/Media/Tests/PRAXIS/taag/0069/mc_questions.xhtml

Appendix D: Technology Beliefs Survey
(Brinkerhoff, Ku, Glazewski, & Brush, 2001)

1	2	3	4
Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree

1. I support the use of technology in the classroom.
2. A variety of technologies are important for student learning.
3. Incorporating technology into instruction helps students learn.
4. Content knowledge should take priority over technology skills.
5. Most students have so many other needs that technology is a low priority. *
6. Student motivation increases when technology is integrated into the curriculum.
7. Teaching students how to use technology isn't my job.*
8. There isn't enough time to incorporate technology into the curriculum.*
9. Technology helps teachers do things with their classes that they would not be able to do without it.
10. Knowledge about technology will improve my teaching.
11. Technology might interfere with "human" interactions between teachers and students.*
12. Technology facilitates the use of a wide variety of instructional strategies designed to maximize learning.

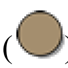
____

Brinkerhoff, Ku, Glazewski, & Brush (2001) p. 30
*reverse scored items

Appendix E: Sample Google Applications Skills Test

1. Google Docs can export files in all of the following formats except:
    a. .DOC
    b. .PDF
    c. .RTF
    d. .JPEG

2. When using Google Wave, you can invite collaborators to your session by clicking on which button?
    a. A light bulb
    b. A plus sign
    c. A smiley face
    d. A envelope

3. To create a circle in Google Sketch Up, choose the **Circle Tool** () from the ________ menu.
    a. Tools
    b. Camera
    c. Draw
    d. Edit

4. In Google Maps, you can upload custom icons as place markers. What is the largest size that you icon can be before it is scaled down?
    a. 64 X 64 pixels
    b. 32 X 32 pixels
    c. 128 X128 pixels
    d. 96 X 96 pixels

5. When editing a Google Site, you would use the "Layout" menu to do which of the following?
    a. Change the font use in the header of your website
    b. Reorganize images displayed on your website
    c. Change the background color on your website
    d. Reduce the number of columns on your website

Appendix F: Technology Integration Assessment Rubric

(Harris, Grandgenett, & Hofer, 2010)

Criteria	*4*	*3*	*2*	*1*
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" (Content, pedagogy and technology together)	Content, instructional strategies and technology fit together strongly within the instructional plan. .	Content, instructional strategies and technology fit together within the instructional plan.	Content, instructional strategies and technology fit together somewhat within the instructional plan.	Content, instructional strategies and technology do not fit together within the instructional plan

Harris, Grandgenett, & Hofer (2010), p.8

Appendix G: Digital Technology User Self-Efficacy Scale

(adapted from Cassidy & Eachus, 2002)

The purpose of this questionnaire is to examine attitudes toward the use of computers. This question is about Digital Technology, which are electronic computers, computer software, handheld computing devices, and online applications that convert, store, protect, process, transmit, and retrieve information.

Below you will find a number of statements concerning how you might feel about computers. Please indicate the strength of your agreement/disagreement with the statements using the 6-point scale shown below. Check the box (i. e. , between 1 and 6) that most closely represents how much you agree or disagree with the statement. There are no *correct* responses; it is your own views that are important.

1. Most difficulties I encounter when using digital technologies, I can usually deal with.
   strongly disagree 1 2 3 4 5 6 strongly agree

2. I find working with digital technology very easy.
   strongly disagree 1 2 3 4 5 6 strongly agree

3. I am very unsure of my abilities to use digital technology.
   strongly disagree 1 2 3 4 5 6 strongly agree

4. I seem to have difficulties with most of the software or online applications I have tried to use.
   strongly disagree 1 2 3 4 5 6 strongly agree

5. Digital Technology frighten me.
   strongly disagree 1 2 3 4 5 6 strongly agree

6. I enjoy working with digital technology.
   strongly disagree 1 2 3 4 5 6 strongly agree

7. I find that digital technology get in the way of learning.
   strongly disagree 1 2 3 4 5 6 strongly agree

8. Digital technology doesn’t cause many problems for me.
   strongly disagree 1 2 3 4 5 6 strongly agree

9. Digital technology make me much more productive.
   strongly disagree 1 2 3 4 5 6 strongly agree

10. I often have difficulties when trying to learn how to use a new software or online application..

strongly disagree 1 2 3 4 5 6 strongly agree

11. Most of the digital technology I have had experience with, have been easy to use.

strongly disagree 1 2 3 4 5 6 strongly agree

12. I am very confident in my abilities to make use of digital technology.

strongly disagree 1 2 3 4 5 6 strongly agree

13. I find it difficult to get digital technology to do what I want them to.

strongly disagree 1 2 3 4 5 6 strongly agree

14. At times I find working with digital technology very confusing.

strongly disagree 1 2 3 4 5 6 strongly agree

15. I would rather that we did not have to learn how to use digital technology.

strongly disagree 1 2 3 4 5 6 strongly agree

16. I usually find it easy to learn how to use a new software or online application.

strongly disagree 1 2 3 4 5 6 strongly agree

17. I seem to waste a lot of time struggling with digital technology.

strongly disagree 1 2 3 4 5 6 strongly agree

18. Using digital technology makes learning more interesting.

strongly disagree 1 2 3 4 5 6 strongly agree

19. I always seem to have problems when trying to use digital technology.

strongly disagree 1 2 3 4 5 6 strongly agree

20. Some digital technology definitely make learning easier.

strongly disagree 1 2 3 4 5 6 strongly agree

21. Digital technology jargon baffles me.

strongly disagree 1 2 3 4 5 6 strongly agree

22. Digital technology is far too complicated for me.

strongly disagree 1 2 3 4 5 6 strongly agree

23. Using digital technology is something I rarely enjoy.

strongly disagree 1 2 3 4 5 6 strongly agree

24. Digital technology is a good aid to learning.

strongly disagree 1 2 3 4 5 6 strongly agree

25. Sometimes, when using digital technology, things seem to happen and I don't know why.

strongly disagree 1 2 3 4 5 6 strongly agree

26. As far as digital technology goes, I don't consider myself to be very competent.

strongly disagree 1 2 3 4 5 6 strongly agree

27. Digital technology helps me to save a lot of time.

strongly disagree 1 2 3 4 5 6 strongly agree

28. I find working with digital technology very frustrating.

strongly disagree 1 2 3 4 5 6 strongly agree

29. I consider myself to be a skilled digital technology user.

strongly disagree 1 2 3 4 5 6 strongly agree

30. When using digital technology I worry that I might press the wrong button and damage it.

strongly disagree 1 2 3 4 5 6 strongly agree

Thank you for your time

Scoring the Computer User Self-Efficacy Scale

Part 1

Experience with computers—This question is scored using a standard Likert format where "none" is scored as 1 and "extensive" is scored as 5.

Number of computer packages used—Here the respondent is scored 1 for each package used and these are summed to give a total score.

Part 2

Items 1 to 30 are all scored on a 6-point Likert scale.
Items **1, 2, 6, 8, 9, 11, 12, 16, 18, 20, 24, 27,** and **29** are **positively worded** and the respondent's response is recorded as the actual scale score for these items, e. g. , a response of 4 to item 1 will be scored as 4, i. e.

Strongly *Disagree* 1 2 3 4 5 6 Strongly *Agree*

Items **3, 4, 5, 7, 10, 13, 14, 15, 17, 19, 21, 22, 23, 25, 26, 28,** and **30** are **negatively worded** and are scored in reverse, i. e.

Strongly *Agree* 1 2 3 4 5 6 Strongly *Disagree*

A scale score for these items is obtained by subtracting the respondent's response from 7, e. g. , a response of 4 to item 3 will be scored as 3.

Summing the scores for all 30 items gives the total self-efficacy score. Using this scoring method, a high total scale score indicates more positive computer self-efficacy beliefs.

Appendix H: Pre-Interview Protocol

Philosophy of Teaching

1. Describe a typical lesson in your class.
2. Describe your role as a teacher.
3. Describe an ideal student.

Technology Attitudes

4. What role do you think that technology should play in schools?
5. Are there situations when technology use is more or less appropriate? If so, when?
6. How comfortable do you feel using technology?

Technology Use

7. What types of technology do you use in your classroom?
    a. When did you start using (technology mentioned above)?
    b. Describe how you use that technology in your class.
    c. Why did you start using that technology?
    d. What was your teaching like before using it?
    e. How did it change?
8. Describe how technology is used at (school name).
9. How does that affect your technology use?

Appendix I: Post-Interview Protocol

Philosophy of Teaching

1. Describe a typical lesson in your class.
2. Describe your role as a teacher.
3. Describe an ideal student.
4. Do you feel that this has changed due to the lesson study professional development? If so, how?

Technology Attitudes

5. What role do you think that technology should play in schools?
6. Are there situations when technology use is more or less appropriate? If so, when?
7. How comfortable do you feel using technology?
8. Has this changed as a result of the lesson study professional development? If so, how?

Technology Use

9. What types of technology do you use in your classroom?
    f. When did you start using (technology mentioned above)?
    g. Describe how you use that technology in your class.
    h. Why did you start using that technology?
    i. What was your teaching like before using it?
    j. How did it change?
10. Describe how technology is used at (school name).
11. How does that affect your technology use?
12. At the close of the lesson study, what are your intentions for using technology in the future?

Lesson Study Group

13. Describe a typical group meeting.
    a. Things discussed
    b. Unanimity of the group
    c. How you dealt you disagreement among the members
14. Do you feel that you changed as a result of the lesson study professional development? If so, how?
15. Do you feel that (group member name) has changed as a result of participating in this lesson study group? (repeated for each group member)
16. In the future, what changes would you make to the lesson study process?

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