

AN ABSTRACT OF THE DISSERTATION OF

Henry Gillow-Wiles for the degree of Doctor of Philosophy in Mathematics Education presented on November 7, 2011.

Title: Engagement in a Community of Learners as a Mediating Agent Toward the Construction of Technological Pedagogical Content Knowledge (TPACK) in an Online Master's Program.

Abstract approved: _____
Larry Enochs

This study investigates how teachers develop and extend their understanding and knowledge of teaching and learning with digital technologies in a primarily online Master of Science program.

The investigation focuses on exploring the relationship between developing an online community of learners and the construction of technological pedagogical and content knowledge (TPACK) during the online Master's program in mathematics education and science education. The purpose of this study was to explore rural elementary and middle school in-service teacher's perceptions of the relationship between their development of and participation in an online community of learners and the construction and extension of their TPACK. With a focus on engagement in an online community of learners, this study used a social-constructivist perspective transitioned to an online context as a framework for supporting the research. To shed light on the relationship in question, a general question was posed: How do teachers develop and extend their understanding and knowledge of teaching and learning with digital technologies (TPACK) in an online education experience? Three questions were used to guide this research:

- What is the mediating effect of engaging in an online community of practice during the program on the participants' perspectives of teaching and learning with integrating digital technologies?
- How do the instructional strategies used in the program mediate the development and support of an online community of learners?

- What are the participants' perspectives of the development of their understanding of teaching and learning with digital technologies as a result of their participation in the online educational experience?

Through a case-study analysis of interviews, classroom observation narratives, and online course artifacts, this study identified two primary mediating effects resulting from engagement in an online community of learners. The first effect was in providing the participants with tools and support for developing personal relationships where they were able to feel part of a meaningful community of learners. This learning community proved to be an essential environment and structure in which the participants shared aspects of themselves in ways that helped others connect with them as people, more than text on a screen.

The second effect was to provide an avenue for extended sense making discourse resulting in participants' individually building their TPACK. The online community of learners provided an environment and structure in which the participants were able to share ideas and understandings of the content and concepts presented in the online courses. These academically focused interactions were a necessary component in facilitating individual TPACK building.

An essential underlying element in both these effects was the importance of instructor monitoring and mediating of participant engagement in facilitating the formation and continued development of the online community of learners. Having the instructor act as a "vision keeper" throughout the entire program, where they monitored participant engagement and mediated these interactions to maintain an appropriate focus, was an essential component in initiating and continuing both socially and academically focused engagement behaviors. The findings identify the critical nature of developing and engaging in an online community of learners, facilitated through continued support by instructors, in developing TPACK in an inline educational experience.

Engagement in a Community of Learners as a Mediating Agent Toward the Construction of
Technological Pedagogical Content Knowledge (TPACK) in an Online Master's Program

by

Henry Gillow-Wiles

A DISSERTATION

submitted to

Oregon State University

in partial fulfillment of

the requirements for the

degree of

Doctor of Philosophy

Presented November 7, 2011

Commencement June 2012

Doctor of Philosophy dissertation of Henry Gillow-Wiles presented on November 7, 2011.

APPROVED

Major Professor, representing Mathematics Education

Chair of the Department of Science and Mathematics Education Department

Dean of the Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

Henry Gillow-Wiles, Author

ACKNOWLEDGEMENTS

The author wishes to thank his committee, in particular Dr. Larry Enochs, who served as committee chair, for his ability to ask just the right question at just the right time.

Additionally, the author wishes to thank Dr. Margaret Niess for her unflagging editing work and for not telling me how to do things, no matter how hard I begged.

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Finally, the author wishes to thank Kate Gillow-Wiles, without whom I would not be the person I am today. Her continued support, comfort and nourishment in every sense of the word made it possible for me to fulfill my loftiest goals.

In closing, this is for my parents, who always wanted to say “My son, the Doctor.”

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Chapter I

Introduction

This study investigates how teachers develop and extend their understanding and knowledge of teaching and learning with digital technologies in a primarily online Master of Science program. The investigation focuses on exploring the relationship between developing an online community of learners and the construction of technological pedagogical and content knowledge (TPACK) during the online Master's program in mathematics education and science education. The purpose of this study was to explore rural elementary and middle school in-service teacher's perceptions of the relationship between their development of and participation in an online community of learners and the construction and extension of their TPACK. The results of this research provides insights into how the structure of online learning experiences that include online communities frames the development of conceptual knowledge, in this case learning to teach mathematics and/or science with technology.

This research employed a multi-case study methodology to examine and illustrate how the perceptions of the participating teachers of their TPACK development are related to their perceptions of the development of an online community of learners. Six participants for this study were chosen from a group of nine teachers enrolled in the master's program focused on integrating technology with teaching mathematics and/or science. The criteria for choosing the study sample focused on grade level taught, single-subject or self-contained classroom, and the self-identified science or mathematics focus of the participants to achieve sufficient diversity and ensure a representative sample.

This chapter begins with an overview of the background framing this study. Following this introduction is the problem statement, the statement of purpose of the study and the specific research questions. Additionally, in this chapter a discussion of the research approach, the

perspectives of the researcher and the assumptions made by the researcher. This chapter concludes with a discussion of the proposed rationale and significance of the research and a thorough exposition of any terms or concepts used.

Background and Context

As the world develops greater dependence on digital communications technologies, these technologies assume more importance in the educational experiences of today's students (American Association for the Advancement of Science (AAAS), 2009; National Educational Technology Standards for Students (NETS-S), 2007). To be able to help usher students into 21st century citizenship, teachers need opportunities to learn and grow as educators (National Council for Teachers of Mathematics (NCTM), 2000; National Educational Technology Standards for Teachers (NETS-T), 2008). Along with students, teachers have to learn how to use digital technology to interpret and understand the world in which they live (NETS-S, 2007; NETS-T, 2008). However, teachers have roles in the educational experience of their students that require technological knowledge different from and beyond that of their students (Dede, Ketelhut, Whitehouse, Breit, & McCloskey, 2008; NETS-T, 2008).

Teaching with and about technology requires not only knowledge of different technologies, but more importantly, how to meaningfully integrate these technologies appropriately into educational experiences such that students are able to more fully develop their understanding and knowledge. This technological pedagogical and content knowledge (TPACK)¹(Mishra & Koehler, 2006; Niess, 2005) is at the center of the teaching and learning

¹ A more thorough description of TPACK is provided later in this document. For now it suffices to characterize TPACK as the intersection of technologically specific knowledge, content knowledge and the pedagogical knowledge needed to use the technology as a learning tool for the content.

with technology that must occur if students are to become full and contributing members of the modern digital community.

The importance of developing TPACK means that continuing education programs need to include training in TPACK for teachers to transcend their digital immigrant status and become members of the new, digitally integrated community of learners (Prensky, 2001). While teachers may not be able to obtain digital native status due to being prepared for teaching in a pre-technology world (Prensky, 2001; Stapleton, Wen, Starrett, & Kilburn, 2007), through carefully constructed professional development and continued learning experiences, they can learn to integrate technology into the educational experiences of their students as learning tools (Niess et al., 2009). To use technology as a learning tool as opposed to a teaching tool requires teachers to not only learn to use technology in the classroom, but in most cases, fundamentally change the way they teach (Mishra & Koehler, 2006; Niess, 2005).

To effectively use technology as a learning tool in the classroom depends on being able to put the technology in the hands of the students and let them explore their world (Lawson et al., 2003). A student-centered², inquiry-based pedagogy provides the necessary framework for structuring experiences where students have meaningful opportunities to guide the direction of and take responsibility for their own learning through using technology (Lester, 2007). Inquiry-based pedagogy may be characterized as an educational environment where decisions about topics are made mutually by teachers and students, and where tasks, texts, and tests are structured by strategies such as the 5Es: Engage, Explore, Explain, Extend, and Evaluate (van Zee, 2006). The extent to which teachers employ inquiry-based instructional strategies falls on a continuum illustrated in Table 1.

² A teacher or student-centered classroom refers to who has the primary locus of control concerning the direction of the learning process. Who is guiding discussions is an example of where the locus of control resides (Schaefer & Zygmunt, 2003).

Table 1. Continuum of learning environments.

Direct Instruction	Inquiry Approaches to Teaching and Learning	Learning during Everyday Life
Teacher decides:	Teacher and learner decide:	Learner decides;
Topics	Topics	Topics
Tasks	5Es; Engage, Explore	Tasks
Texts	Explain, Expand	Resources
Tests	Evaluate	Self-assessments

ranging from totally teacher-centered direct instruction, where the teacher makes all educational decisions, to totally learner-centered everyday learning, where the learner has complete control of direction and scope of learning. Effective educational inquiry practices fall somewhere in between, with the teacher acting as the “vision keeper”, guiding students in their inquiry processes.

Since teachers primarily teach as they have been taught (Stipek, Givvin, Salmon, & Macgyvers, 2001), unless teachers are already teaching with a student inquiry focused pedagogy, continuing education programs centered on TPACK development must also include training and support directed towards helping teachers move to a more inquiry-based, student-centered understanding of how to structure their teaching. The importance that developing teachers’ TPACK has on how students learn to become 21st century literate members in the communities of tomorrow means that all teachers, urban and rural alike, need access to opportunities for continuing education with a TPACK component (Lester, 2007; NETS-S, 2007; NETS-T, 2008).

For urban teachers, access to continuing educational opportunities provides less of a challenge than for teachers in more rural environments. Proximity to universities makes it possible for teachers to participate in graduate programs that provide opportunities for them to extend and develop their personal and professional knowledge (Lyons, 2008). While urban centers provide continuing education opportunities not available to teachers in rural districts, rural school environments provide several advantages for teachers and students alike. The small class

sizes that come with a reduced population density allow students to have more interaction with both their classmates and with the teacher (Annetta & Shymansky, 2008). Additionally, the strong sense of community and the role that the school plays as a central part of community activity inherent in rural environments provide for a greater community involvement in the education process (Lyons, 2008).

Although these benefits are important, they come at a price. The remoteness that is at the heart of the benefits of rural educational environments is a double-edged sword. While distance from urban environments can certainly provide a buffer for the problems of population density and a lack of a sense of community, distance also plays a critical role in access to opportunities for continuing education that are often located in urban centers. The extended travel time and scheduling issues that come with taking onsite university classes adds to the difficulty rural teachers have in finding time to participate in the continuing education programs they need to stay abreast of the changes in the world for which they are preparing their students (Levine, 2010).

Distance from urban centers is not the only way a rural district is characterized. Separation from other communities is also a factor (Cady & Rearden, 2009). While the small town may be a three hour drive from a metropolitan area, it may also be a two hour drive away from another community of similar size. This remoteness from both urban centers and from other communities contributes to the isolation and lack of collegial interactions often experienced by teachers in rural districts (Lyons, 2008). The small student populations in rural districts that often produce the small class size result in small teacher populations as well. Thus, often a single mathematics or science teacher works in the building. With possibly only one teacher in a content area, little, if any, opportunity exists for a rural teacher to engage in the kind of interactions that provide opportunities for sharing of ideas and knowledge that are so important to becoming better teachers (Chalmers & Keown, 2006). Additionally, these small teacher populations inhibit

opportunities for teachers to form supportive relationships that are instrumental in teacher retention (Malloy & Allen, 2007).

The importance of access to continuing educational opportunities and the support provided through interactions with colleagues has provided motivation for research into new and imaginative ways to bring teachers together to form communities of learners (Annetta & Shymansky, 2008; Cady & Rearden, 2009). An emerging paradigm for providing access to continuing education that supports teachers in building and maintaining communities of learners takes advantage of the development of information communications technologies (ICT) to transcend the limiting effects of a rural environment by removing the constraints of location and time (Hebert, 2007; McGraw, Lynch, Koc, Budak, & Brown, 2007).

Beyond providing meaningful avenues for students to share in their explorations of mathematics and science concepts and ideas, ICT have revitalized and revolutionized the idea of distance learning (Johnson, 2001). With the advent of modern digital communications and the World Wide Web, information can be shared with the speed of light and the limitations of time and space are left in the past. These new technologies provide teachers with opportunities for professional growth that would not have been possible 15 years ago (Hebert, 2007).

Clearly, the advent of the Internet, the World Wide Web, and ICT has provided students with access to a wealth of educational possibilities. Along with this wealth for students comes the need for teachers to develop an understanding of how to help students integrate these technologies into their lives in ways that further learning (NCTM, 2000; NETS-T, 2007; NETS-S, 2008). Ironically, the technology that fostered the need for new continuing education also provides an avenue for providing teachers in rural environments with opportunities for these continuing education experiences.

This new technology is not without its limitations, principally potential feelings of isolation and reduced levels of student discourse due to the sparseness of the communications medium (Dyer & Roberts, 2005). Established learning theory with a focus on communities of learners³ provides a structure and framework for constructing learning experiences that address these limitations of an online learning experience (Cady & Rearden, 2009).

Problem Statement

With the constraints of their location, rural teachers are limited in their opportunities for continuing education involving TPACK. Online programs are an important and often times the only avenue this demographic group has to further their professional education. Online education, due to constraints inherent in the online context, can be limiting in how deep, conceptual understanding is developed. Research indicates that using an online community of learners model in framing online educational experiences moderates the limitations of the learning environment in constructing meaningful, conceptual knowledge (Baran & Cagiltay, 2010; Correia & Davis, 2008; Hebert, 2007). However, little information exists concerning the relationship between online communities of learners and the construction and extension of TPACK in online continuing education programs.

Purpose of Study and Research Questions

This study was designed to investigate how teachers develop and extend their understanding and knowledge of teaching and learning with digital technologies through a primarily online master's program. This investigation focused on exploring the relationship between developing an online community of practice and the construction of technological pedagogical content knowledge (TPACK) during an online Master of Science in science

³ The phrase "community of learners" is used to characterize a group of like-minded people engaging in a common activity for a common purpose. This construct is more fully examined later.

education or mathematics education program. The purpose of this study was to explore with a group of rural elementary and middle school in-service teachers, their perceptions of the relationship between their development of and participation in an online community of practice and the construction and extension of their technological pedagogical content knowledge during their participation in a program focusing on the integration of technology for teaching mathematics and science. The results of this research provided insights into how the structures of online learning experiences through communities of practice frame the development of conceptual knowledge, in this case learning to teach mathematics and/or science with technology.

To shed light on the relationship in question, a general question was posed: How do teachers develop and extend their understanding and knowledge of teaching and learning with digital technologies (TPACK) in an online education experience? More specific research questions focused on the participants' experiences in the online education experience included:

- What is the mediating affect of engaging in an online community of practice during the program on the participants' perspectives of teaching and learning with integrating digital technologies?
- How do the instructional strategies used in the program impact the development and support of an online community of learners?
- What are the participants' perspectives of the development of their understanding of teaching and learning with digital technologies as a result of their participation in the online educational experience?

Research Approach

With the approval of the university's Institutional Review Board (IRB), the researcher studied the experiences and perceptions of a six member representative sub-set of nine participants of a three-year online Master of Science program. The primary methods of qualitative data collection included in-depth interviews and classroom observations. An interview focusing

on the teachers' TPACK, along with classroom observations was collected in the context of another research project with different research goals. For the purpose of this study, a separate interview, focusing on teachers' perceptions of their experiences with engaging in the online community of learners associated with the online Master's program was conducted. Through a comprehensive review of relevant literature, coding categories were developed and refined in an ongoing basis, guided by the study's conceptual framework. To further the confidence and trustworthiness of the study, various strategies were employed, including the search for discrepant evidence, fidelity in the coding process, the use of a researcher's journal, and review by the research group at important stages as the study progresses.

Assumptions

Based on the researcher's experiences with facilitating online courses, two primary assumptions were made regarding this study. First, people who enroll in online courses are motivated to choose an online context by a limited variety of factors, primarily either time- or distance-related. This assumption was based on the notion that given the opportunity, most people would rather participate in a course given in a traditional setting. The second assumption was that the people enrolled in the program in the study are strongly motivated to obtain the Master's degree. This assumption was premised on the notion that as in-service teachers, these people would not make the investment in time and money to enroll in an online graduate degree program unless they had a strong desire to complete the program and achieve the goal of obtaining a degree.

The Researcher

At the time of the study, the researcher was employed as a graduate research assistant, working as a data analyst on the research project for which some of the data were collected. Having served in this capacity for three years, the researcher had an intimate knowledge of the

data collected and was able to tease out the nuances that allowed for a complete picture of the study participants' perceptions.

While the experience of the researcher provided for knowledge of the data, there was also the potential for bias in analysis due to preconceived notions and opinions resulting from analytical work for the pre-existing research project. These potential biases were addressed through the use of a researcher's journal, where thoughts and ideas occurring during data collection and analysis were recorded. These thoughts and ideas were then challenged for evidence of bias and triangulated with the research group review as well as data triangulation activities focusing on the fidelity of analysis and interpretation of data, to reveal any biases or patterns of interpretation that result from biases on the part of the researcher.

Rationale and Significance

The rationale for this study emanated from the researcher's desire to uncover ways to structure and facilitate online educational experiences that result in student learning that is more meaningful, in-depth and conceptually rich. These experiences may be for teachers continuing their professional education, students preparing to become teachers, or rural students with geographical limitations who desire post-secondary educational opportunities.

Given the increased importance of online education programs to the mission of degree granting institutions in general and to teacher education programs in particular (Guilar & Loring, 2008), a better understanding of designing and facilitating online continuing education programs to provide meaningful opportunities for teachers to extend their TPACK understanding is critical. The results of this investigation are useful for designers of online teacher preparation and continuing education programs, particularly those with a significant technology component in the curriculum. Better understandings of how supportive online environments affect the development

of complex concepts like TPACK are relevant to both teacher educators and to designers of online courses in general.

Concepts and Constructs

Two main constructs were used in this study. The first construct is an *online community of learners* and the second is *technological pedagogical and content knowledge (TPACK)*. A thorough description of the development and characteristics of each construct is presented in the following sections.

Online communities of learners construct development. Initially, online course structure mimicked onsite courses, with content presented as written versions of lectures (Zhang, 2009). However, research around this kind of course structure uncovered several shortcomings. Research in online learning reveals that without a well-structured experience, students often feel isolated and disconnected from other students and the teacher (Dyer & Roberts, 2005). Additionally, research indicated the sparseness of communications resulting from the mediation effects of an online environment created difficulties for students in developing the social presence that naturally develops in an onsite learning environment (Rourke, Anderson, Garrison, & Archer, 1999). These shortcomings make it problematic to foster and support the development of deep, meaningful understanding and learning in an online learning environment (Johnston & Killion, 2005). One possible framework for structuring online experiences fostering and supporting this kind of learning is provided by a community of learners model of learning (Conrad, 2008).

The framework of a community of learners has developed from the idea that learning is always contextual or situated. Greeno (1998) presented the idea that learning takes place, not only in individual behavior and cognition, but also in a larger context, where interaction between “behaving cognitive agents” and the context frame knowledge and understanding (Greeno, 1998, p. 13). Furthering this idea, Lave and Wenger (1991), in their seminal work, described how

learning takes place through participating in the practice of a working group or community. These communities were characterized by shared knowledge, shared repertoire, and joint enterprise as well as critical informal relationships shaping group membership legitimization. This legitimization is a process where a person moves from a peripheral position to full membership by developing relationships with other group members based on mutual trust and respect. They characterized this legitimization process as “legitimate peripheral participation” (Lave & Wenger, 1991, p. 63).

In subsequent research, Lave and Wenger (2002) described a critical aspect of the social relationship that characterized learning in a community of learners in terms of relationships. The primary relationships affecting learning are not between teacher and student, but are the social relationships among students. As these social relationships within a community change through direct involvement in the activities of the community, the knowledge and understanding of the students change and develop (Lave & Wenger, 2002).

This characterization of learning as changes in relationships taking place in communities of learners led to the development of a set of defining characteristics of a community of learners providing a framework for developing how a community of learners structure would support learning in an online situation. The defining characteristics of a community of learners are the existence of: a domain, or a common interest that defines the group identity and separates members from other people; a community defined as a group that engages in common activities, learns from each other and shares information; and a practice, defined as the development of a shared repertoire of experiences, tools and ways of thinking, acting and being (Wenger, 2007).

The shift to an online community of learners does not alter these three defining characteristics so much as redefines the means of communication used in participating in the business of the community. Online communities of learners can be characterized as emerging

from online communities that use technology to communicate and collaborate in fulfilling an underlying task-based learning need (Johnson, 2001). These communities are described as groups of people interacting in cyberspace for their own common interests, relationship building, and transactions (Johnson, 2001). This characterization of online communities of learners retains the necessary characteristics of a community of learners (Koh, Kim, & Butler, 2007) as developed by Wenger.

Since participation and engagement in the activities of the community are at the heart of learning in a community of learners model, creating an environment where these behaviors are generated, fostered and supported lead to an increase in deep, conceptual learning. Three key components to creating just such an environment are in developing social, cognitive and teaching presences (Garrison, Archer, & Anderson, 1999) and are illustrated in Figure 1.

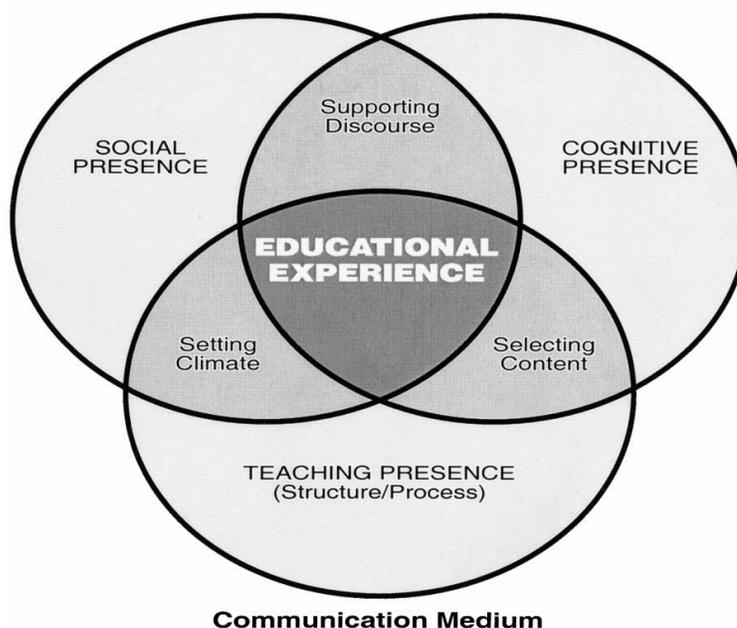


Figure 1. Community of learners model (Garrison, Anderson, & Archer, 1999, p. 88)

In the construct developed by Garrison, Anderson and Archer (2000), social presence is the degree to which participants in an online community feel affectively connected to one

another. Developing and supporting social presence leads to meaningful community member participation, the development and support of a community of learners, and educational experiences that result in meaningful learning (Garrison & Cleveland-Innes, 2005; Hill, Song, & West, 2009; Kinsel, Cleveland-Innes, & Garrison, 2005; Swan & Shih, 2005).

Cognitive presence is described as the extent to which participants are able to construct meaning through sustained communications. Developing and supporting cognitive presence, in conjunction with developing social presence, is what elevates interactions in a community to a higher level, beyond social and low-level cognitive exchanges, to a level where students are “cognitively engaged in an educational manner” (Garrison & Cleveland-Innes, 2005, p. 135).

Teaching presence consists of two activities which may be performed by any member of the community; the design and the facilitation of the educational experience. Designing the educational experience includes developing the structure, organization, and presentation of course content, activities, and assessments. Facilitation of the educational experience focuses on supporting students in their engagement with the online community of learners. It is teaching presence that supports and facilitates the development of social and cognitive presence, leading to the fulfillment of educational goals and outcomes (Garrison, Anderson, & Archer, 2001; Garrison & Cleveland-Innes, 2005).

It is through the support of communities of learners that students are able to engage in the activities that lead to meaningful learning (Lave, 1996). The successful development of an online community of learners hinges on meaningful member participation in the activities of the community in ways that develop shared knowledge, reinforce community and member identity, and contribute to the shared repertoire of being, thinking and acting as a community member. It is through group interaction that this participation is developed (Gee, 2003; Gunawardena, 1995).

Technological pedagogical and content knowledge (TPACK) construct development.

The advent of the World Wide Web and the ubiquity of modern computing technology created a new class of communications technology with applications for education that are quite different from previously existing technologies such as typewriters and overhead projectors. This new class of technology brought with it a new set of required pedagogy and content knowledge (Mishra & Koehler, 2006; Niess, 2005). The relationship between technological pedagogical and content knowledge (TPACK) is complex and dynamic. Technology in general and digital technology in particular both constrain and afford myriad representations, examples, analogies, demonstrations and explanations that facilitate more in-depth access to the subject matter (Groth, Spickler, Bergner, & Bardzell, 2009).

From this dynamic, interactive system, a characterization of TPACK emerges. This characterization portrays TPACK as the amalgam of all three knowledge constructs: technology, pedagogy and content. The interactions between technological pedagogical and content knowledge is illustrated in Figure 2.

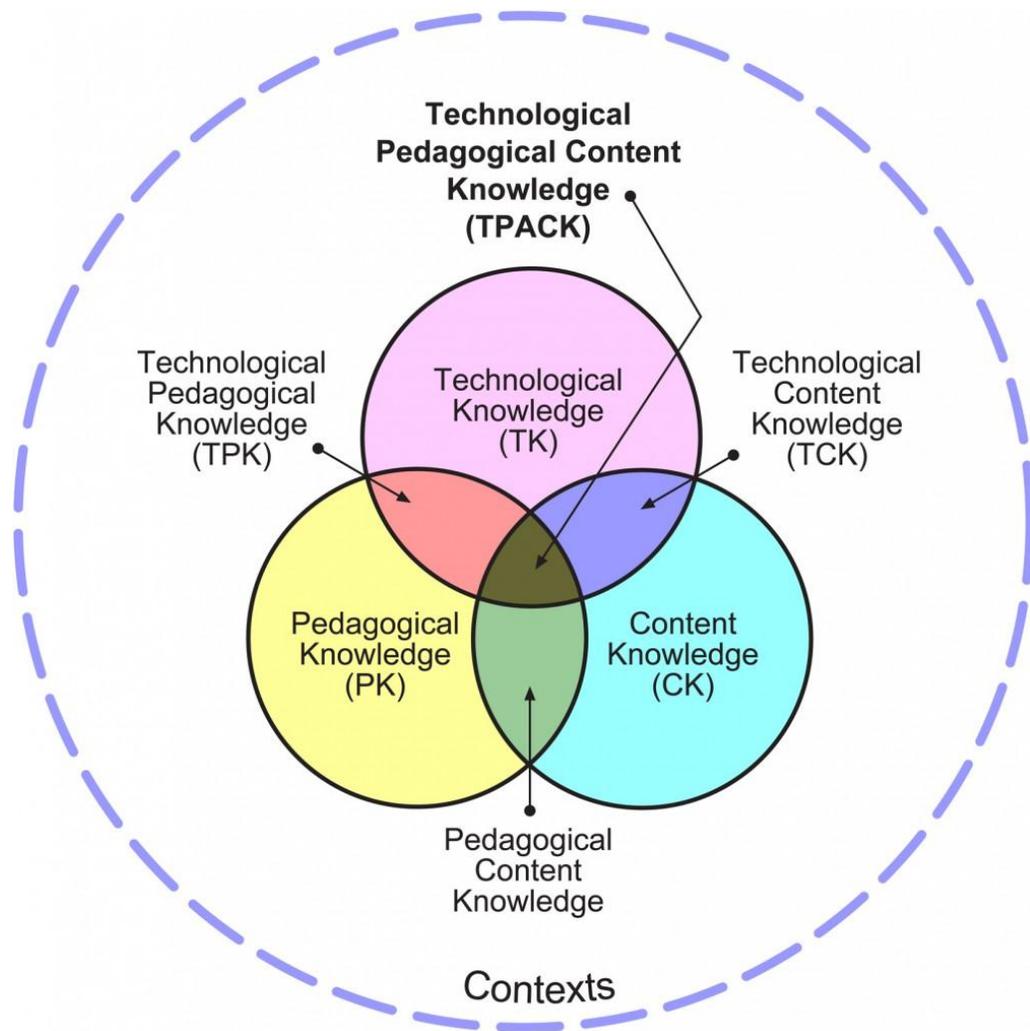


Figure 2. TPACK as the intersection of technological pedagogical and content knowledge. (<http://tpack.org/>)

This amalgam requires knowledge of the subtleties of the complex relationships between technology, pedagogy and content (Mishra & Koehler, 2006; Niess, 2005). The foundational concepts of TPACK had their roots in Shulman’s (1986) seminal work on pedagogical content knowledge (PCK) in which he described a dynamic relationship between pedagogical and content knowledge where content knowledge includes “the ways of representing and formatting the subject that make it comprehensible to others” (p.9). The introduction of technology into education revealed similar difficulties in how to meaningfully utilize technology as a teaching

and learning tool. Building on Shulman's work, Niess (2005) and others (Mishra & Koehler, 2006) presented a conceptualization of the intersection of technology, pedagogy, and content knowledge, where the knowledge of how to use technology and the knowledge of how to teach with technology are critical in using technology as a teaching and learning tool. The intersection of pedagogical and content knowledge was expanded to include technological, pedagogical, and content knowledge, creating a teaching and learning space where technology is used to as a tool to support student learning resulting in education experiences that are unattainable without the integration of technology (Mishra & Koehler, 2006; NETS-S, 2007; NETS-T, 2008; Niess, 2005; Niess et al., 2009). Quality teaching utilizes this knowledge to develop appropriate, context-specific teaching strategies and ways of presenting content through the meaningful integration of appropriate technologies (Niess, 2008).

Chapter II

Literature Review and Theoretical Framework

This study seeks to explore the relationship between developing an online community of learners and the construction of technology, pedagogy and content knowledge (TPACK)⁴ during an online Master of Science MS program with majors in Mathematics Education or Science Education.

This study was designed to investigate how teachers develop and extend their understanding and knowledge of teaching and learning with digital technologies through a primarily online master's program. This investigation focused on exploring the relationship between developing an online community of practice and the construction of technological pedagogical content knowledge (TPACK) during an online Master of Science in science education or mathematics education program. The purpose of this study was to explore with a group of rural elementary and middle school in-service teachers, their perceptions of the relationship between their development of and participation in an online community of practice and the construction and extension of their technological pedagogical content knowledge during their participation in a program focusing on the integration of technology for teaching mathematics and science. The results of this research provided insights into how the structures of online learning experiences through communities of practice framed the development of conceptual knowledge, in this case learning to teach mathematics and/or science with technology.

To shed light on the relationship in question, a general question was posed: How do teachers develop and extend their understanding and knowledge of teaching and learning with digital technologies (TPACK) in an online education experience? The process for this research

⁴ Sometimes referred to as technological pedagogical content knowledge or TPCK

included an initial, yet critical review of relevant literature for the theoretical framework. This critical review of literature explored the relationship between the experiences of the participants in developing an online community of learners and their perceptions of the development of their TPACK in the online environment. In light of this focus, three major areas of literature were reviewed: the relationship between online communities of learners and student learning in an online environment, the relationship between instructor activities and fostering online communities of learners, and the impact of situating continuing education for teachers in an online environment. A review of online communities of learners literature provided an understanding of the structure, interactions, and constructs of an online learning environment. A review of instructional strategies and course structure aspects of an online community of learners provided an understanding of the underlying foundations of how an online community is fostered and facilitated. A review of online continuing education literature provided an understanding of the development of teachers' perceptions of teaching and learning with technology in an online environment. To conduct this literature review, the researcher used multiple resources, including, but not limited to, books, professional journals, Internet resources, dissertations, and periodicals. These sources were assessed through ERIC, Google Scholar, ProQuest, and Digital Dissertations. Although no time limit was established for the conduct of this literature, when possible, resources later than 2006 were preferred. Because the field of online education is a new area of research when compared to educational research conducted in more traditional, face to face contexts, the focus on the more recent literature was chosen in order to develop a framework that reflected current understandings of the structure, affordances, and constraints of online educational environment.

Online Communities of Learners

The development of information communication technologies (ICT) opened a new field of research in how the opportunities provided by these new avenues of communication might be

utilized in educational contexts. A significant amount of work has been completed toward an understanding of how these technologies re-conceptualize teaching and learning drawing from a variety of learning perspectives (Chyung, 2007; Gabriel, 2004; Garrison, Anderson, & Archer, 2001; Guilar & Loring, 2008; Preece, Maloney-Krichmar, & Abras, 2003; Riverin & Stacey, 2008; eUniversities Worldwide, 2002). Garrison, Anderson, and Archer (2000) introduced a framework conceptualizing an online learning environment as a dynamic relationship of three presences: teaching, social, and cognitive⁵. See Figure 1 in Chapter I.

The three presences described here by Garrison et al. characterize necessary components of a functional online community of inquiry⁶. These fundamental components combine to form supporting elements of an online educational experience where the community of learners facilitates knowledge building and sense making. The sub-set identified as “setting climate”, at the intersection of teaching and social presence, describes how instructor actions and activities mediate the creation of a sense of place where students feel safe to share in ways that help others see them as real people. These activities and actions on the part of the instructor include implementing instructional strategies and course structure elements that facilitate student interaction. Creating a shared space where students are free to interact is a key element of a community of learners (Wenger, 2007). The sub-set identified as “selecting content”, at the intersection of teaching and cognitive presence, describes how instructor choices of content impact the ability of students to meaningfully access the concepts and ideas presented in the course. The affordances and constraints of an online environment play a pivotal role in guiding the instructor in making these content decisions (Garrison & Cleveland-Innes, 2005). The sub-set identified as “supporting discourse”, at the intersection of social and cognitive presence,

⁵ These three presences are more fully described in Chapter I.

⁶ In this context, a community of inquiry is analogous to a community of learners. (Wenger, McDermott, & Snyder, 2002)

describes how a community is able to meaningfully engage with content to create shared understanding and knowledge. This setting provides the foundational elements for discourse as the result of actions and activities on the part of the instructor: learners situated in a well defined shared space, participants who are seen as real people by other participants, and content that is accessible, (Garrison, Anderson, & Archer, 1999).

Kinsel, Cleveland-Innes, and Garrison (2005) used a content analysis methodology to characterize learning through the development of an online community of learners model where the social relationships necessary for meaningful interactions that led to critical discourse that was facilitated and supported through targeted actions on the part of the teacher. Their characterization of learning in the context of an online community of learners placed student engagement and interaction at the center of critical discourse.

Taking a different perspective, Miller, O'Brien, Kelly and Blackler (2010), used a framework of "Graduate Attributes [sic], the qualities, skills, knowledge and abilities that need to be developed by students during their studies" (p. 663) to investigate the abilities a student most needs to be successful in an online learning environment. Their work determined that the critical attribute for student success was effective communication, where students were able to meaningfully interact and communicate with others to exchange key concepts and relevant ideas. In this study, Miller et al. investigated the impacts of using ICT in a conference setting to interact with conference resources. Their findings suggested that in an asynchronous online environment, meaningful participant interactions were dependant on finding a "comfort zone" where there was a feeling of community. This community development, in an asynchronous online context, depended heavily on the involvement and interactions of the moderator or facilitator. Confirming the importance of facilitator actions, Vesely, Bloom and Sherlock (2007) used an exploratory content analysis methodology to compare perceptions of students and instructors in building online communities. They found an agreement between the students and instructors as being of

critical importance in building a community structure in online courses. However, the students perceived the importance of instructor modeling as being foremost in developing the community, while the perception of the instructor was that interaction and dialogue were the most important factors in the development of an online community.

With a focus on the impacts of reflection and conversation in building online communities, Lucey, O'Malley and Janssen (2009) analyzed threaded discussion board exchanges to reveal that reflection activities and postings helped create a safe, comfortable environment where students were more likely to engage in meaningful conversation. In the group studied, these reflection and conversation activities led to the development of online communities. Supporting the work of Garrison et al. (2005), their results presented student interaction and engagement as critical features for the development of online communities. Additionally, their work continued to reinforce the need for a comfort zone, where students felt safe and supported by a community while engaging in conversations around constructing knowledge.

The development and support of meaningful, robust communities of learners that foster student learning is a process that takes time. Students come into online courses with disparate preconceived ideas and perspectives that must be integrated into a set of community negotiated and accepted behavior norms (Muilenburg & Berge, 2005). In a study utilizing a factor analysis methodology, Garrison, Cleveland-Innes and Fung (2004) validated an instrument to assess the extent that students are able to re-define their roles as students, from an onsite characterization to an online characterization. Garrison et al. found that the more successful students were those who had a longer experience with online courses. These more experienced students were better able to renegotiate the expectations and demands, or social norms⁷, of being an online student in relation

⁷ This idea of negotiated social norms is similar to the concept of negotiated socio-mathematical norms presented by Yackel and Cobb (1996). In the Garrison et al. perspective, the focus is on developing ways of

to their understanding of being an onsite student. This social norm negotiation process, facilitated by the instructor, is essential for the development of a community of learners with shared purpose, knowledge, and practices and takes place over the entirety of the learning experience.

Instructional Strategies and Course Structure

In an online educational setting, the establishment and continuing support of an online community of learners relies on the involvement of the instructor, both before the course begins and as the course unfolds (Garrison & Cleveland-Innes, 2005). Targeted instructional strategies and purposeful course design create an environment that supports engagement rising to the level of critical discourse, where “if students are to reach a high level of critical thinking and knowledge construction, the interaction or discourse must be structured and cohesive” (Garrison & Cleveland-Innes, 2005, p. 136). It is through the actions of the instructor that students develop an understanding of what is important in the course, “That what is assessed is what is valued...” (Swan, Shen, & Hiltz, 2006, p. 45). This claim implies that to establish patterns of engagement in an online community of learners, assessed activities are needed where the students are interacting in ways analogous to the behaviors that establish communities of learners in face to face learning experiences (Collins, 2010; Swan et al., 2006).

Instructional strategies and course structures that stimulate, reinforce and support the establishment of an online community of learners come in many forms. Taking a best-practices perspective, Grant and Thornton (2007) used survey, interview and focus group data to characterize three critical aspects of online course structure and design that led to student achievement of educational goals. These best practices were described toward encouraging student-staff interaction, cooperation among students, and active learning. These best-practice

talking about the content in an online environment where there the rules and patterns of engagement are unfamiliar.

elements reflected and reinforced the findings of other researchers by revealing the importance of the activities of the facilitator or instructor, the need for student engagement with other students, and the impact of students taking an active role in their learning.

The development of social presence is directly tied to how technology mediates social interaction (Slagter van Tryon & Bishop, 2009). Since humans tend to interact with technology in much the same way as they interact with people and places, activities in online courses that develop familiarization with technology in ways that are similar to how people develop familiarity with other people help facilitate entry into an online learning environment (Carmody & Berge, 2008). Familiarization with Internet communications is the beginning of meeting the challenges of developing communities of learners in online courses.

While the characteristics of a typical online learner have shifted to become a student who is responsive to rapid technological innovations and new learning paradigms, there is still a need for familiarization with the particular ICT being used (Dabbagh, 2007). Since most online education interaction is text-based (i.e. forums postings, e-mail, instant messaging) (Ho & Swan, 2007), the level of comfort in navigating the ICT environment affects both initial student perceptions and long term satisfaction levels (Sargeant, Curran, & Allen, 2006). Helping students become familiar with ICT as used in the course is a task to which the instructor needs to attend. By facilitating student familiarity with relevant ICT through the use of videos, screen captures and clearly written directions, the instructor begins to help develop community participation (Swan & Shih, 2005).

Once students are able to navigate the oft-times labyrinth-like ICT environment and have begun to share with their fellow students, the instructor's tasks move to developing social interaction norms, the development of a group identity and the development of individual student identities (Moule, 2007). As has been detailed previously, the successful development of an

online community of learners hinges on meaningful member participation in the activities of the community in ways that develop shared knowledge, reinforce community and member identity and contribute to the shared repertoire of being, thinking and acting as a community member. This participation is developed through group interaction (Gunawardena, 1995) where the development of these aspects is facilitated through posting behaviors and collaborative activities (Handley, 2006; Hrastinski, 2009).

The role and activities of the instructor are critical in developing a community where students are comfortable with participating meaningfully in group activities (Sargeant et al., 2006). The instructor sets the stage and provides initial models for social interaction norms. The influence of an online environment brings an additional element of unfamiliarity (Sargeant et al., 2006). What to post, in terms of personal information, is one area where instructor activity models introductory postings that include relevant personal information and present a welcoming first impression to provide examples for students in support of the reduction of discomfort. The goal of this type of posting is to help present an appearance of a real person, fostering the development of personal identity (Lowenthal, 2010).

To develop meaningful posting behavior as a social interaction norm, direct assessment of posting contribution and frequency is an effective construct to establish desired social communications norms. Work by Ho and Swan (2007) described post contribution as a combination of quantity, where the post provides sufficient information and stays on point; quality, where the post is reflective and supported by evidence where necessary; relevance, where the post naturally follows the conversation; and manner, where the post is logically and clearly presented. With this characterization of a “good” post and the incentive of assessment on posting behavior, students quickly see the value of participating through appropriate posting behavior.

In onsite environments, common activities and interactions among and between students and teachers naturally foster participation and engagement that result in a sense of belonging and community (Adler, 1998). In an online environment, this interaction must be designed and supported by the instructor to a much greater degree. Collaborative group activities (Appendices C through E) that help develop shared knowledge and repertoire as well as negotiate and reinforce social norms of interaction and participation must be part of the student experience (Hrastinski, 2009). Activities on the part of the instructor that foster member interaction and help develop a sense of belonging to a community increase social presence and participation and are another necessary part of the structure of an online experience that fosters and supports meaningful learning (Swan & Shih, 2005).

Just as in assessing posting behavior, appropriate assessment of online collaborative activity is instrumental in both encouraging the activity and shaping the content (Swan et al., 2006). Assessment assigns value to and provides focus on activities, knowledge and behaviors. Through assessment, instructors indicate what skills, concepts and understandings are most important. Students also use assessment to guide their learning, concentrating on those areas of the course where assessment is a part (Swan et al., 2006).

In each of these contexts, fostering contributing posting behavior and collaborative group activities, the instructor either creates or facilitates experiences and activities promoting student interactions that develop the characteristics of a community of learners: domain, community and practice⁸. In other words, the structure of an online experience is guided by this three-part framework to help develop a sense of common interest, common activity and common identity.

In reviewing research literature for the development of the theoretical framework that was used as a guide for this research, student interaction and engagement, as well as the critical

⁸ Refer to Chapter I for details.

element of instructor involvement in creating an environment where students are able to converse and collaborate in creating online communities, were found to be important to learning in an online context. Both instructors and students realize the role that creating an online community plays in supporting learning and both groups see interaction and engagement as an essential component of online community development and learning.

Online Continuing Education

As learning in an online educational environment has become better understood, research into situating professional development or continuing education programs in an online learning situation has grown (Annetta & Shymansky, 2008; Baran & Cagiltay, 2010; Chalmers & Keown, 2006; Dede, Ketelhut, Whitehouse, Breit, & Mccloskey, 2009; Hebert, 2007; Hur & Brush, n d; Lyons, 2008; Ratcheva, Stefanova, & Nikolova, n d; Riverin & Stacey, 2008; Vavasseur & MacGregor, 2008; Wilson & Stacey, 2007). The ability to transcend distance and time has made online education a viable resource to provide continuing professional education to rural teachers who are hindered by distance and the demands of their professional responsibilities (Riverin & Stacey, 2008).

Using a case study methodology, Riverin and Stacey (2008) looked at a group of educators who were engaged in continuing education activities using ICT. They found that a critical element in forming and sustaining online communities of learners in a continuing education context was the “the tone of the environment” or all the community building practices needed for a functioning community (p. 55). This result is in alignment with the findings of Archer, Garrison, Anderson and Rourke (1999), centering on the social presence construct, and extends ideas that increased social presence, evidenced by increased engagement and participation in online continuing education experiences, results in increased engagement in discourse and a stronger sense of community.

Building on the idea that the development of a community of learners in online education supports learning, additional research investigated the impact of using a framework based on the work of Wenger, McDermott, and Snyder (2002) in designing communities of learners to structure online continuing education opportunities. In a review of literature, Hebert (2007) detailed the results of research into using a community of learners' model to structure online continuing education experiences. Her findings indicated the development of a community of learners provided necessary support for in-service teachers to interact in ways that helped them develop their understandings of the ideas presented in the continuing education experience. Additionally, her research revealed the important effect facilitator interaction had on how a community of learners in an online context functions. These findings extended the work of Garrison and Cleveland-Innes (2005) in extending the teacher presence construct to a continuing education context. Their research indicated that facilitator behavior acts as a critical factor in helping students take on a "deep approach to learning" (Garrison & Cleveland-Innes, 2005, p. 140) and that student to student interaction alone does not produce this shift in learning approach employed by the student.

In research that focused on the mediation effects of ICT on online continuing education opportunities, Chalmers and Keown (2006) used a case study methodology to report that technology alone was not enough to provide for successful continuing education events. The building of communities of learners, where teachers and facilitators form meaningful relationships, was necessary for effecting changes in teaching knowledge as actualized through changes in their classroom pedagogies. These communities of learners positively impacted teacher professional knowledge and have significantly impacted lifelong learning models.

Just as developing a community of learners takes time, so does developing teachers' TPACK. Meaningful development of an understanding of the complex relationships within technological pedagogical content knowledge requires more than a single professional

development event or a single course in a graduate degree program. In developing an instrument to assess TPACK development levels, Chai, Hwee, Koh, and Tsai (2010) found that maximum learning occurred when teachers had multiple opportunities to revisit, refine and reflect on ideas and projects used in the continuing education courses.

Not only do reflection and refinement opportunities over time increase and reinforce TPACK, extended collaboration and discourse has been shown to produce higher levels of TPACK development. In presenting the impacts of a new curriculum that include collaborative and reflective pedagogies, Hu and Fyfe (2010) used a self-reporting style survey in a formative assessment methodology. They concluded that a primary factor in developing pre-service teachers' TPACK was continued engagement throughout the pre-service program in activities where the prospective teachers collaborated on projects and engaged in discourse around ideas.

Having the support of a community and time to develop understanding affects perception of the online learning experience. In a mixed-methods study that investigated the effects of an online community on teachers' self-efficacy in teaching with technology, Vavasseur and MacGregor (2008) found that engagement in an online community of learners increased teachers' self-efficacy in teaching with technology. While there was an increase in technological content knowledge, the primary change exhibited by the participants of the study was in pedagogy that included teaching with technology and an increase in communication between teachers in different districts, sharing ideas. This result was reflected in a study by Cady and Rearden (2009) who, when investigating the effects of delivering mathematics continuing education in an online format, found that while participation in an online community of learners based continuing educational program did not significantly increase teacher mathematics content knowledge, the teachers did increase their mathematical pedagogical knowledge. The teachers attributed this increase to their engagement with other teachers. The result was in alignment with work by Kereluik et al. (2011) where they contended that to support teachers extending their TPACK

through a community of learners framework in an online graduate program, a continuing focus of interaction and engagement in collaborative activities must be facilitated and encouraged.

The primary theme emerging from this review of literature on online continuing education programs was the critical relationship between the development and support of online communities of learners and the creation of deep, meaningful conceptual understanding of ideas such as TPACK. To extend their understanding of conceptually-rich ideas, such as TPACK, teachers need extended opportunities for meaningful engagement with other teachers where their thoughts are expressed and ideas are developed. Teachers' perceptions are affected by opportunities to reflect and collaborate with other teachers.

Summary

This critical literature review has provided a perspective of how a community of learners' framework informs the design and structure of online learning experiences. In particular, the creation of comfort zones supporting meaningful student interaction by instructors is identified as a critical component of fostering and supporting the development of an online community of learners. These comfort zones are where students interact with the instructor and each other, engaging in conceptual knowledge construction and meaning making.

In an online continuing education context, these communities of learners are an important part of the process of learning. Teachers engaged in extending their understanding of teaching with technology have a greater perception of meaning and value when they are supported by a community (Garrison, 2007). Additionally, the process of extending their learning to changes in their classroom pedagogy and curriculum is made more effective through engagement over the long term with a cadre of like-minded teachers who share a common purpose and context.

Developing a meaningful understanding of the complexities of TPACK in an online educational environment, where teachers are then able to translate their knowledge into changes

in their instructional strategies depends on interplay between essential aspects of the online environment as well as interplay between essential aspects of teaching and learning with technology. Just as Garrison and others (Garrison, Anderson, and Archer, 1999; Garrison, & Cleveland-Innes, 2005) contend online educational experiences are at the intersection of teaching, social and cognitive presence, Niess and others (Mishra, and Koehler, 2006: Niess, 2005) contend TPACK is at the intersection of technology, pedagogy, and content knowledge. This review of literature implies the development of TPACK as an online educational experience can be found in overlaying the TPACK model onto the online presence model, to find the common intersection of both. It is only when all aspects of an online educational experience are utilized in developing all components of TPACK that teachers are able to develop and extend their TPACK such that this knowledge becomes an important component in their teaching philosophy and actualized as instructional strategies.

Chapter III

Methodology

This study was designed to investigate how teachers develop and extend their understanding and knowledge of teaching and learning with digital technologies through a primarily online master's program. This investigation focused on exploring the relationship between developing an online community of practice and the construction of technological pedagogical content knowledge (TPACK) during an online Master of Science in science education or mathematics education program. The purpose of this study was to explore with a group of rural elementary and middle school in-service teachers, their perceptions of the relationship between their development of and participation in an online community of practice and the construction and extension of their technological pedagogical content knowledge during their participation in a program focusing on the integration of technology for teaching mathematics and science. The results of this research provided insights into how the structures of online learning experiences through communities of practice frame the development of conceptual knowledge, in this case learning to teach mathematics and/or science with technology.

To shed light on the relationship in question, a general question was posed: How do teachers develop and extend their understanding and knowledge of teaching and learning with digital technologies (TPACK) in an online education experience? More specific research questions focused on the participants' experiences in the online education experience included:

- What is the mediating affect of engaging in an online community of practice during the program on the participants' perspectives of teaching and learning with integrating digital technologies?
- How do the instructional strategies used in the program impact the development and support of an online community of learners?

- What are the participants' perspectives of the development of their understanding of teaching and learning with digital technologies as a result of their participation in the online educational experience?

This chapter describes the study's research methodology through presenting discussions around the following areas: rationale for research approach; description of the research study population; summary of information needed; overview of research design; methods of data collection; analysis and synthesis of data; limitations of the study. The chapter concludes with a brief summary.

Research Approach

The qualitative research used in this study was informed by a phenomenological research paradigm concerned with developing an understanding of the common perceptions and interpretations of experiences (Creswell, Shope, Clark, & Green, 2006). The phenomenological research paradigm provided a framework for developing an understanding of the underlying essences of a shared, common experience (Husserl, 1970). These experiences were unique in both content and context, in that they happened in a particular situation and at a particular time. Given the focus of this study was to reveal and understand the perceptions of a group of teachers participating in the common experience of an online master's program, this phenomenological paradigm was most appropriate for guiding the design of the research.

The goal of this qualitative investigation was to examine and reveal the engagement of group of participants with each other, and with the environment, with the goal of developing an understanding that was holistic rather than reductionist. This understanding was focused on perceptions of meaning inherent in an experience and was, in part, the result of the interactions of the beliefs and knowledge of the researcher with the analytical process through which the understanding was developed (Adler, Ball, Krainer, Lin, & Novotna, 2005; Merriam, 1998). The

qualitative features of the research investigated how teachers developed and extended their TPACK in a primarily online master's program included: understanding the process by which the events and actions took place, developing contextual understanding, and facilitating interactivity between participants and the researcher. (Feilzer, 2010; Onwuegbuzie et al., 2009; Salehi & Golafshani, 2010).

For the purpose of the research, a multi-case study methodology was most appropriate in identifying the interrelationships among the participants, the knowledge they were developing, and the context within which they were interacting (Onwuegbuzie et al., 2009). The choice for using a multi-case study design was based on the need for an intensive description and analysis of how the participants interacted as members of an online community of learners while engaged in an online continuing educational experience (Merriam, 1998). Not only did a multi-case study methodology provide for understanding of participant perceptions but, through a cross-case analysis of specific diverse cases, quantifiable objective changes in perceptions were revealed and described. The result of using this multi-case study methodology was to provide access to knowledge of the participants' perceptions and how their educational environment framed their perceptions (Creswell et al., 2006; Onwuegbuzie et al., 2009).

Research Sample

A criterion-based sampling of convenience procedure was used for this study where a study participant group was chosen from the entire group of participants in the online masters program. The original population contained nine individuals from four school districts with varying degrees of "ruralness"⁹ as described by location, student population, and teacher

⁹ The term "ruralness" is used to indicate a combination of factors that result in a school being labeled a rural environment. These factors include: distance to major population centers, student population, and teacher population (Lyons, 2008).

population (Lyons, 2008; Malloy & Allen, 2007). All the participants in the program were currently teaching K-8 grade with tenure varying from 3 to over 20 years. The distribution of the nine program participants is presented in Table 1.

To maximize the information about the phenomena being investigated, a selection of six participants from the original population of nine participants in the online master's program was made. The criteria for this selection process maximized the diversity of the sample set while maintaining fidelity to the original study population. The choice of whom to include in the set of six study participants focused on: grade level taught, single-subject or self-contained classroom, and the self-identified science or mathematics focus of the participants. Additionally, an attempt was made to choose participants from different schools and districts. These criteria were used to achieve sufficient diversity and ensure an appropriate representative sampling (Onwuegbuzie et al., 2009).

Data Collection Methods

The use of a multi-case study methodology required multiple data collection strategies for the study in order to obtain an in-depth understanding of the phenomena being studied. Additionally, through the use of multiple data sources, triangulation of data analysis was possible, allowing for enhanced rigor, breadth, and depth as well as providing corroborative evidence for the analysis conclusions (Creswell et al., 2006). With these benefits in mind, this study employed multiple interviews in addition to classroom observations as data sources.

Phase I: Selection of a set of participants. In order to more thoroughly and completely develop an understanding of the relationship between fostering a community of practice and TPACK development in the online master's program, it was necessary to reduce the sample population to a manageable number. To accomplish this task and maintain the representative quality of the sample, a selection process for choosing the study sample used criteria focused on

grade level taught, single-subject or self-contained classroom, and the self-identified science or mathematics focus of the participants. This selection process addressed the need for a manageable sample size as well as maintained a diverse population that represented the larger, initial sample population (Onwuegbuzie et al., 2009). A comparison of the demographic diversity between the original population of nine participants and of the set of six study participants is presented in Table 2. As can be seen from the information in the table, the set of six study participants had diversity in the categories mentioned similar to program population. By addressing the demographic and professional diversity of the original population of nine participants and using that diversity as a guide, the researcher was able to select a representative sample consisting of six participants whose perceptions and experiences portrayed those of the larger group (Sandelowski, 2000).

Table 2. Comparison of original population and study participant demographic information

Category	Number of Participants ¹		%	
	Original Population	Study Population	Original Population	Study Population
Grade Level				
Primary	2	1	22	17
Elementary	4	3	44	50
Middle School	3	2	33	33
Content Identification				
Mathematics	2	2	22	33
Science	7	4	77	67
District				
District 1	3	3	33	50
District 2	2	1	22	17
District 3	2	1	22	17
District 4	2	1	22	17
School				
School 1	2	1	22	17
School 2	2	1	22	17
School 3	1	1	11	17
School 4	1	1	11	17
School 5	1	1	11	17
School 6	1	0	11	0
School 7	1	1	11	17

1. Nine participants in the original population and six in the study population.

Phase II: Selection of existing data. Having selected the sub-set of participants, qualitative data consisting of narrative classroom observation reports and interview transcripts were collected. These data sources provided fundamental sources for investigating both the participants' perceptions of online courses and their perceptions of online continuing teacher education programs (Ho & Swan, 2007; Sargeant, Curran, & Allen, 2006; Swan, Shen, & Hiltz, 2006; Heather R Thornton, 2007; Anderson, Rourke, Garrison, & Archer, 2001; Garrison & Cleveland-Innes, 2005; Rourke, Anderson, Garrison, & Archer, 2001b; Dede, Breit, Ketelhut, McCloskey, & Whitehouse, 2006; Hebert, 2007; McGraw, Lynch, Koc, Budak, & Brown, 2007; Vavasseur & MacGregor, 2008).

In this initial phase, existing data from the afore-mentioned research project was surveyed and relevant data were selected for an extensive analysis. The criterion for the selection of data was the relationship between the focus of the data collected and the purpose of this research study. The selected qualitative data sources were:

1. Narrative classroom observation report data associated with the RTOP¹⁰ based classroom observations focusing on technology integration and TPACK development.
2. Interview data collected over a two year period addressing participants' perceptions of teaching with technology.
3. Selected student artifacts from program course work.

Phase III: Data collection. Since the data were collected in the context of an existing research project, the differences between the purpose of that study and this study resulted in the need for further data collection beyond the context of the initial research project. With the assistance of the research group, an interview protocol based on the existing set of questions was developed to more explicitly investigate participants' perceptions of the relationship between engagement in an online community of practice and the development of TPACK in an online continuing education program. Basing this new interview protocol on the protocol for previously-used sets of interview questions provided a measure of continuity in questioning and analysis. The interview data were collected at the conclusion of the three year online master's program and addressed participants' perceptions of the following: their professional development experiences in relation to the three year online master's program; their engagement in the online community of practice associated with the three year online master's program; their perceptions of the role various instructional strategies and course structures had in the development and support of an

¹⁰ Reformed Teaching Observation Protocol, (Turley et al., 2000)

online community of practice; and their perceptions of the relationship between their engagement in an online community of practice and their development of TPACK.

Methods of Data Analysis

The qualitative data were analyzed using a coding process detailed by Saldana (2009) and began with a complete reading of the transcripts of each interview separately, the interviews focusing on community of learner engagement first, then the interviews focusing on perceptions of TPACK development, and finally the classroom observation narratives. This complete reading was done to familiarize the researcher with the tone and flow of the narrative responses of the interviews.

After the set of interview transcripts was read in total, each data set was read for analysis. This analysis began with a coding process where the researcher assigned codes to portions or snippets of transcripts providing the researcher with insight into what a participant was thinking and how that participant was interpreting his/her experiences. This coding process focused on identifying occurrences where the participants were talking about their experiences in the masters program that impacted their engagement in the online community of learners or that impacted the development of their TPACK.

After the interviews were coded, a second pass at each interview and observation narrative was made to ensure that the coding was consistent within each data source and across the three data sources. Having determined that the coding was complete and reflected the participants' responses, the codes were analyzed with the goal of revealing common categories to which the codes might be assigned. Codes were then assigned to appropriate categories and these categories were then reflectively compared to the interview transcripts as a check of how well the categories reflected the experiences of the participants. It was at this point a search for discrepant data was made.

Having been satisfied that the categories reflected the codes and the interview responses, the researcher analyzed the categories for emerging themes and concepts. These themes and concepts were then reflectively compared to the data in order to ensure the themes truly and accurately reflected the participant perceptions of their experiences in the online masters program.

Data Analysis and Synthesis

For the research questions posed, three aspects needed attention. The first aspect focused on developing an understanding of the participants' perceptions of a community of practice and their engagement in the online community of practice in the context of the three year online master's program. For a framework to develop this understanding, the researcher turned to the work of Garrison et al., (2000) where, in developing a conceptualization of social presence, a description of engagement behaviors that lead to the development of social presence were presented. The analysis of the interview focusing on participants' engagement in the online community of learners used this description to develop a set of codes that characterized the participants' perceptions of how they engaged in the online community of practice and the impact that engagement had on their experiences in the online master's program.

The second aspect addressed was towards developing an understanding of the participants' perceptions of how and why the online community of practice developed and what events or activities contributed to the continuing support of that community. The analysis of the interview focusing on this part of the participants' experiences in the online master's program used, as a basis for developing codes, research literature describing the following; the impacts of collaborative activities in an online course on the development of an online community of learners (Peters, Shmerling, & Karren, 2011); how assessed posting effected engagement behaviors in the online community of learners (Roblyer & Wiencke, 2004), and how online

conversation and reflective activities affected the way the online community of learners developed and how the participants engaged in that community (Lucey, O'Malley, & Jansem, 2009). From this review of relevant literature, a framework for understanding the perceptions of the participants about how and why the online community of practice came into being was developed and used in the analysis of the interview transcripts.

The third aspect addressed was the perception of the development of TPACK on the part of the study participants. To make this assessment, the researcher turned to the work of Niess et al. (2009) for a framework that described a progressive development of TPACK understanding. Following the development of the TPACK framework, Niess (2009) proposed a set of technology content standards as a basis for a framework to inform classroom practices that include the use of technology as a supporting element for teaching and learning. Beginning with Grossman's (1990,1989) four components of pedagogical content knowledge, Niess initially developed four components of TPACK that encompassed the essential elements of thinking needed to design and implement a curriculum that integrated technology into teaching and learning. These components were framed as:

1. An overarching conception about the purposes for incorporating technology in teaching subject matter topics.
2. Knowledge of students' understandings, thinking, and learning in subject matter topics with appropriate technologies.
3. Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics.
4. Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies. (Niess, 2005)

In determining the perceptions of TPACK development of the members of the sample, an analysis of interview transcripts and classroom observation reports was performed using a coding process as described previously. Through that iterative coding process, indicator phrases and terms, framed by the four components of TPACK, reflecting how the teachers used their engagement in the community of practice in extending their TPACK were developed. Once these indicators were characterized, they were used as codes to assess the mediating effect of the development of, and engagement in, a community of practice has on the development of TPACK of the sample

Using a process described by Eisenhardt (1989) dealing the development of a case study, both a within-case analysis, where each case was investigated individually, developing an understanding of each participant, and a cross-case analysis, where the cases were investigated as a whole, looking for emerging themes, was performed. The goal of these analyses was to gain familiarity with the data and to look beyond initial impressions, seeing evidence through multiple lenses.

Data Management Strategy

The volume of data produced through the coding of multiple interviews and observation narratives required an organizational structure through which the data could be arranged and re-arranged, looking for emerging patterns and themes. After an initial foray into the use of commercial qualitative data analysis software, a decision was made to use Microsoft Access as a data management tool. Entering information into a data base provided the ability to quickly sort, search, and test relationships between categories or themes, while still providing the hands-on feel of mucking around in the data.

Following guidelines presented by Auerbach, (2003) during the initial coding process, relevant text sections representing the chosen coding categories were entered into the database.

These sections of text were then used as sources for further coding activities. Subsequent coding focused on aligning the text sections with the coding schemes derived from the theoretical framework presented in an earlier section. Finally, having a completely coded data set, database queries were made with the goal of revealing categories and themes. A major benefit of using a researcher-created database as opposed to a commercial data analysis application was in how the relationships were discovered. Commercial applications resort in excellent in pattern recognition, but this feature, in the mind of the researcher, removes the kinds of immersion in the data necessary for uncovering the essence of the experiences of the participants and is at the heart of qualitative social science research.

Limitations of the Study

The limitations of this study stemmed from the use of a qualitative methodology in general and from the specifics of the research design in particular. From the choice of a qualitative method study, the possibility of researcher bias and subjectivity was introduced, primarily when interpreting the results of the data analysis (Malterud, 2001). A key component of possible bias and subjectivity of the researcher was familiarity with the existing data. Due to past activities, the researcher was very familiar with the data gathered during the previously described research project. This familiarity had the possibility of creating preconceived ideas of meaning and interpretation from the data. To combat this problem, the researcher used a combination of reflection through the use of a researcher's journal and consultation with members of the research group, as well as reflection with study participants, to ensure that issues of possible biases in analysis and synthesis of data are recognized and appropriately addressed.

Issues of trustworthiness. To ensure that the results of this study accurately represent the perceptions of the participants, truly reflect the current literature, and are as free of bias as possible, issues of trustworthiness for qualitative data collection and analysis were addressed.

Ideas about credibility, dependability and confirmability better described qualities of qualitative data collection, analysis and synthesis (Merriam, 1998). Regardless of terminology used, ongoing attention was given to recognizing and addressing issues of potential bias that appeared in the design, implementation, and analysis of the study.

Credibility. In this study, credibility referred to the accuracy of the findings from the standpoint of the researcher, the participants and the reader. The criterion for credibility was an important aspect in this qualitative research design (Malterud, 2001; Marshall & Rossman, 2006; Morgan & Smircich, 1980). In addressing both methodological and interpretation validity, the researcher used a variety of data sources as well as a variety of data collection methods. This variety in both source and collection methods provided ample opportunities for triangulation, where the biases inherent in any single data source or collection method were revealed by comparison with other data sources or collection methods. Additionally, the use of a researcher's journal provided reflection opportunities to review intentions and procedures, helping reveal biases and preconceptions.

Dependability. Using a qualitative methodology with this small of a sample size precluded claims of reliability in the sense that reliability is thought of for quantitative research. For this study, reliability was a question of whether the findings were consistent and dependable with the data collected (Marshall & Rossman, 2006). To address issues of dependability, the researcher used a researcher's journal documentation procedure to insure that the coding schemes and categories developed for each data source were used consistently. Additionally, a process of peer review by the research group of procedures and coding processes were employed to address issues of interpretation bias and consistency.

Confirmability. In this study, confirmability corresponded to the notion of objectivity in collecting and analyzing data as well as in interpreting and reporting the results. By its very nature, this qualitative research design meaningfully incorporated the interpretations and

knowledge of the researcher (Marshall & Rossman, 2006). To address the issues around confirmability, the researcher made every attempt to be transparent in making decisions about design, data collection, analysis, and interpretation. Additionally, the researcher journal was used for reflection and consultation with research group members to ensure an awareness of biases and issues of subjectivity.

Summary

In summary, this chapter provides a detailed description of this study's research methodology. A qualitative method multi-case design was employed to investigate and reveal the relationship between teachers' perceptions of an online continuing education program and their perceptions of learning to teach mathematics and/or science with technology through developing their TPACK. The initial sample population was made up of nine participants in a three-year online master's program with this number being reduced to a sub-set of six participants, using demographic data to produce a diverse representative sample. To fully capture the underlying perceptions of the teachers, a number of qualitative data sources were collected. The data were reviewed against literature as well as emerging themes. Issues of credibility and dependability were addressed through source and interpretation triangulation as well as through the use of a researcher's journal and consultation with research group members. This study was intentionally directed toward a contribution to the existing knowledge concerning online education and the development of TPACK. This extension of knowledge was proposed as useful for those teacher educators who design and implement online continuing education programs.

Chapter IV

Findings

This study was designed to investigate how teachers developed and extended their understanding and knowledge of teaching and learning with digital technologies through a primarily online master's program. This investigation focused on exploring the relationship between developing an online community of learners and the construction of technological pedagogical content knowledge (TPACK) during an online Master of Science in science education or mathematics education program. The purpose of this study was to explore with a group of rural elementary and middle school in-service teachers, their perceptions of the relationship between their development of and participation in an online community of learners and the construction and extension of their technological pedagogical content knowledge during their participation in a program focusing on the integration of technology for teaching mathematics and science. The results of this research provided insights into how the structures of online learning experiences through communities of learners frame the development of conceptual knowledge, in this case learning to teach mathematics and/or science with technology.

To shed light on the relationship in question, a general question was posed: How do teachers develop and extend their understanding and knowledge of teaching and learning with digital technologies (TPACK) in an online education experience? More specific research questions focused on the participants' experiences in the online education experience included:

- What is the mediating effect of engaging in an online community of practice during the program on the participants' perspectives of teaching and learning with integrating digital technologies?
- How do the instructional strategies used in the program mediate the development and support of an online community of learners?

- What are the participants' perspectives of the development of their understanding of teaching and learning with digital technologies as a result of their participation in the online educational experience?

This chapter presents findings in the form of case studies organized by participant. A response to each research questions follows the case studies. A summary is provided at the end of each case study. This chapter closes with a summary of the findings of the research.

Case Studies

A case study data analysis method was used to gather and organize the findings in order to develop an understanding of the participants' perceptions of their experiences in the online masters program. These case studies drew from extensive interviews, classroom observations, and artifacts from online courses as part of the master's program to describe the participants, the world in which they teach, and how they saw the online master's program affecting their TPACK. The case studies will first present demographic information describing the context in which each participant teaches. The next section of each case study will describe the participant's perceptions of their engagement in the online learning community. Each case study closes with a description of shifts in both their instructional strategies and how they perceived the role of technology in their teaching and the learning of their students.

Bob. Bob was 29 years old and in his sixth year of teaching elementary grades when he entered the master's program. Bob taught in a school district located in the middle of his state. This district was middle sized for the area, but like most rural districts, had a small population relative to geographic area. Bob's district had a significant proportion of students on a free or reduced lunch program.

Bob's district was successful in its search for technology-based grants, with all teachers having a SMART Board and projector in the classroom as well as access to laptop carts. Bob had

enough laptops available for groups of two students per laptop. When Bob received his SMART Board, he was able to participate in vendor-provided SMART Board training. In addition to that training, his district continued to provide occasional professional development opportunities focusing on SMART Board features and techniques for the classroom. These trainings included a requirement that the teachers create and deliver a lesson where the SMART Board played a pivotal role. Additionally, the building administration conducted observations and evaluations of these lessons.

Besides participating in district SMART Board professional development events, during his time in the master's program, Bob participated in several district-wide professional development events focusing on student engagement. These professional development events provided training in the use of instructional strategies geared towards increasing student engagement in reading and mathematics. These professional development events also included ongoing observations and evaluations of Bob's classroom implementation of the prescribed teaching strategies. Bob felt that his development of these instructional strategies was a good addition to his work in the master's program in helping him learn to teach in a more engaging, student-centered manner, "They gave us different professional developments that help us learn how to engage students better, different strategies to use that way. Total student engagement in reading and math, eventually in all subject areas."

As with all teachers, Bob's school day was consistently filled, leaving little time for informal interactions with his peers. His building had weekly team meetings, but the agenda for those meetings was set by his administration, making the time unusable for other learning community engagement. To help offset these limited opportunities for collaboration, Bob's building principal encouraged teachers to take time to observe other teachers at least once per each quarter throughout the school year.

Bob's interactions with the teachers in his building aligned with his perceptions of a community of learners as developed through his experiences in the online masters program. Bob characterized a community of learners as, "a group of people that get together and can share ideas, ask questions of each other, and work on a goal." In an interview, he described his thinking of the purpose of a community of learners as, "...to become something we couldn't on our own, to work together to improve, to help us with what we are learning, to help each other learn and create something we couldn't on our own."

Bob was able to successfully transition this view of a community of learners to an online environment through the use of different digital technologies such as text-based discussion forums, Google Apps, and Skype instant messaging. He saw how being able to function in the digital, online environment was essential in developing relationships, "for just knowing that there was a close connection to our classmates, we could contact each other any day, using the tech we were given." He described how the community of learners in the online master's program helped address issues of isolation stemming from the online environment, "we're not sitting in a classroom with our fellow classmates, so the community of learners is trying to substitute for that as the next best thing, in collaboration with each other. I think not having a classroom setting motivated us to develop a community of learners."

In the online master's program, Bob felt that his TPACK learning experiences were enhanced and strengthened through the online discussions in which he participated. He thought the, "community was vital for the encouragement we gave each other." Sharing his ideas with other participants was an essential part of his knowledge building.

Teachers used the tech for different things and that was shared through the community of learners. Lesson plans, ideas on how to use it, experiences were shared, through the community of learners, learning to use the tech as a teaching and learning tool. The things that were shared

helped shape how I used the tech in my own teaching. If I was just learning how to use it on my own, I wouldn't have all those other experiences.

The initiation and development of the online community of learners, in Bob's perceptions, would not have been successful if not for the actions of the instructors. He felt that, "in the beginning, people were not as open with each other and were slowly starting to get used to the idea of interacting with each other online." Beginning each course with an initial introduction where the participants shared information about themselves to help the others develop a more rounded, complete perception helped this interaction develop. Bob particularly thought these introductions were instrumental in helping people get to know each other on a more personal level. He described his perceptions as:

You began with an introduction even if you already knew each other. At first you say the superficial things, but as you go along, you add more personal things. The introductions, over time, those developed into more than just, "...hello, my name is so and so and I'm from here."

The instructor actions, in Bob's view, were critical in helping the participants begin engaging in the kinds of discussions where they could develop their TPACK. Bob thought the most important instructional strategy employed to develop and support an online community of learners in the online courses was having assessed interactions. Describing his views about the effect of assessed online community engagement, Bob said, "in all the online courses, there were discussions that were required, there were introductions where we learned about the course and our classmates. That was good because it gave us a beginning perspective on it." He went on to describe how he thought this effected the development of the online community of learners by saying, "we were assigned partners to complete different projects and we had to collaborate on that and we had to evaluate each other's work, by doing all those things, it really did create a collaborative atmosphere."

Besides having assessed engagements, Bob thought that the extended time the online community of learners had to develop was important to its functionality. Bob felt that having the instructors continue to monitor and mediate an online community of learners across the entire online master's program was a critical component in how close the participants became. He thought that by, "having a longer time period with the community of learners, you can develop those relationships and really help each other out in your learning." In comparing his experiences in the online masters program to other, shorter professional development experiences where participant interaction was a part, he commented that, "I don't remember a lot of interaction because it was just one course, it was real quick and you didn't develop deep connections like we did over the three years of the master's program."

This extended opportunity for the participants allowed them, in Bob's perception, to transition from engaging in the online community of learners as an assignment, to engaging in the online community of learners for more personal benefit. He thought that:

I think it started with interacting with each other, it was like an assignment. As it went along, it was still part of the assignments, but at that point, we were interacting with each other because we wanted to help each other. We were a functioning community of learners without having someone telling us to do it or hold our hand. We got to the point where we were communicating all on our own.

When Bob entered the master's program, the instructional strategies he used were primarily teacher-centered, with the students having little influence in how they approached the content, saying that, "Traditionally, I felt more comfortable with direct instruction." The interactions between Bob and his students created a classroom climate characterized as teacher-centered and directed. While Bob made some attempt at engaging students through questioning, his questions were primarily the type where students were expected to respond with facts rather

than being asked to make hypotheses or draw conclusions. During the initial observation of Bob and his class of third graders, Bob appeared to be uncomfortable with unstructured activities. His classroom was organized in rows, with students facing the SMART Board or front of the class, where Bob stood. The behavioral expectations seemed to be for the students to sit quietly in their seats, copying information from the SMART Board on to worksheets.

At the onset of the master's program, Bob had a minimal awareness of how to use technology in the support of teaching and learning. His use of his SMART Board was an extension of how he used his overhead, primarily as a tool to display information. At that time, Bob's class had access to a computer lab with enough desktop computers for each student to have their own, but his use of that resource was sporadic and unstructured.

The instructional strategies and classroom climate observed in use in Bob's classroom at the end of the master's program illustrated a complete revision and was a clear example of reform-based teaching with technology. He expressed this change as resulting from his experiences in an online course centered on inquiry-based instructional strategies when he commented, "Through this experience, I have learned that group inquiry is a very effective strategy to incorporate in teaching science with technology." Instead of rows, his students sat in groups of mostly two and an occasional group of three. One observed activity had a goal of exploring motion while learning about the capabilities and characteristics of motion detector technology. Each group used a motion detector and a laptop with data collection software. Rather than carefully controlling student activities, Bob gave a brief introduction and let the students explore in their own way.

Although no large group discussion happened, the students interacted with those in other groups to compare actions, discoveries, and results. These conversations were guided by Bob when necessary, but for the most part, the students were engaged in self-directed exploration and

knowledge building. In his own words, Bob tried to “be more of a facilitator than an instructor” and this desire was evident in how he approached the different groups. His interactions with the group members focused on asking questions about what they discovered and equally as important, how they came upon their discoveries. He almost never gave direct answers, but rather provided suggestions for how the students might find their own answers. From applying what he had learned in the online courses, Bob said that he thought his students, “learned the concepts much quicker and understood the information at a deeper level than they would have with direct instruction. They were scientists themselves, working in groups, collaborating, experimenting, and working with technology as a tool in their scientific inquiry.”

Bob’s use of technology as a learning tool for his students at the end of the master’s program also exhibited a similar turn-about. Bob’s overarching conceptions for the purposes of incorporating technology in to his teaching practices made a dramatic shift from technology as a display tool to take on a role he described as, “learning tools in science and mathematics classes to use them as tools to teach or perform the science or mathematics.” Rather than using technology as a teaching tool to display information, primarily in the hands of the teacher, Bob put the technology in the hands of his students. From his experiences in an online dynamic spreadsheets course, Bob thought that as a result of, “teachers integrating spreadsheets more and more into science and mathematics curriculum, students will become more accustomed to using them as learning tools in these content areas.”

Bob’s use of instructional strategies where students controlled the technology in the course of self-directed inquiry illustrated a critical component how his knowledge of student understanding, thinking, and leaning with technology changed during his experiences in the online portion of the master’s program. Additionally, combining his knowledge of inquiry-based instructional strategies with his developing understanding of how students learn with technology was a critical component of the development of his understanding of meaningful TPACK.

In summary, from his experiences in the online courses in the master's program, Bob made significant shifts in both the instructional strategies he used and his understanding of integrating technology into the learning of his students. From his activities in the instructional strategies and the dynamic spreadsheets online courses, Bob incorporated his experiences centering on the how's and why's of using technology to developing his understanding of curriculum where technology was integrated to support inquiry-based learning into his classroom activities. He summed up his experiences in the online master's program by saying:

The online discussions, article reviews, and discourse with colleagues throughout these courses helped me incorporate these instructional strategies into my teaching. Placing students in collaborative inquiry-based science groups, implementing different question strategies, and incorporating the role of facilitator in my teaching are a few of the instructional strategies that I have learned throughout this course. I feel as an educator, I have grown in my teaching instruction and my students have grown with me in their learning.

These changes in his understanding and teaching, combined with the development of his ability to articulate his knowledge in supporting teaching and learning mathematics and science through the integration of technology, have helped Bob create an identity in his district of a teacher leader, qualified to design and implement professional development events to support teachers in developing their TPACK.

Alice. Alice was 28 years old when entering the program and relatively new to teaching, having taught first grade for only three years prior to entering the masters program. Alice taught in a small district located in the middle of her state. Like most rural districts, her district covered a large geographic area, but had a small population relative to area. Additionally, like other rural districts, Alice's district had a significant proportion of students on a free or reduced lunch program.

Although the district where Alice taught was struggling for funding, the teachers were successful in their search for technology-based grants. The year before Alice entered the masters program, as a result of being awarded a grant, the third and fourth grade teachers in her building received SMART Boards. Unfortunately, Alice did not receive a SMART Board during the initial purchase, but did get one between the first and second year of her master's program. In addition to her classroom SMART Board, Alice also has access to a computer lab with enough desktop computers to give access to each student.

Because she was in the second round of SMART Board allocations, Alice was unable to participate in the vendor-provided SMART Board training given to the teachers who received their SMART Boards in the initial purchase. This lack of training and Alice's personal comfort with technology in general led her to initiate her own learning to use the SMART Board effectively. Perhaps because of her being younger than her building colleagues, where she was comfortable with newer digital technologies, or because of her self-directed learning style to use various computer-based technologies in support of her teaching, Alice became an informal resource for technological training for her building as well as leading technology focused professional developments for her district.

Another potential reason for the growth of her identity as a go-to person for technology questions from her colleagues was Alice's belief in the importance of collaboration with her peers. The design of her building and the location of her classroom facilitated Alice interacting with the other K-2 teachers informally on a daily basis. Although possibly due in part to Alice's outgoing nature, this interaction appeared as an important element in the development of a supportive community with Alice as a contributing member.

Besides her self-directed investigations into the uses of various educational technologies, during her master's program, Alice participated in several district-wide in-service or professional

development events focusing on literacy and reading skills. These professional development events centered in developing instructional strategies where teachers helped students become active learners in the context of increasing reading scores. Alice felt that these instructional strategies were applicable in teaching mathematics and science and tried to bring these ideas into teaching those content areas. She felt her district led professional development activities meshed well with the knowledge of teaching mathematics and science through the integration of technology she was developing in the master's program. Additionally, she was confident the skills she was honing in creating professional development experiences through the master's program would have a significant impact on her leadership of professional development events in her district. She described this confidence coming from the fact that, "a large part of my district professional development correlated with the master's program, because I started taking what I was learning in the master's program and leading professional developments for my staff."

Alice's perception of a community of learners was framed through her experiences interacting with her teaching colleagues as well as through her experiences in the online master's program. In discussing how a community developed around using technology in teaching amongst her colleagues in her building, Alice commented that, "I think that we are so used to each other and comfortable with each other that it was more like, I've been the tech guru because of my age and growing up with computers. I kind of took it upon myself of helping them learn and continuing to help them learn." She described her perceptions of a community of learners in terms shared activities, "...it seems that a community makes up a group of people. I think of a group of people who live, work, play, and eat in close proximity."

She described similarities between how the community of learners developed in her building and the online community of learners developed in the online master's program in saying, "You were building a community, but it was in a much different form because it wasn't where you would reach out and talk to these people in a face to face environment." She described her

perception of the mediating effects of an online context as adding an extra component to community development, “I would take that same analogy and put it over that these are the same people that you learn with, and so the online community adds a whole other piece to that. Your place in the community felt more awkward, you were this name in a computer screen and there was no association to you.”

Alice recognized the important role time plays in how a community of learners develops. In reference to the community or learners in her building, she said, “At my school, my first year, I didn't feel part of the community, but as time went on and people started to know you, you found your place in the community.” She felt that time played an important role in developing the online community of learners, as well, “As time went on and you got to meet people and people had certain expectations of you because they know who you were and what your thinking was, then the community kind of evolved itself.” In her view, her engagement in the online community of learners developed into something she valued beyond the academic interactions. Alice described this transition by saying:

It definitely progresses over time and it turned into a habit. I'd come home and get online to check what's going on and it wasn't anymore because it was Tuesday. I'd get on just to see what people were saying. It became part of my daily routine just to see what people were doing and to check it out. It became part of my daily routine just to see what people were doing and to check it out.

Instructor interactions through monitoring and mediating interactions were, in Alice's perception, a critical component in developing the online community of learners. In describing how having assessed engagements effected her interaction, she said that, “it was a score, something I had to do initially then it kind of developed into, I know these people, what is an idea they might have, what are they thinking about?” Alice felt these assessed interactions compelled

her and the other participants to begin the process of developing an online community. She expressed her thoughts by saying:

I think people shared a lot of good ideas because it was an assignment, more than that; you had to respond to someone else. If people had just posted things and there was no requirement to read them, I wonder if there would have been people going on and reading them. I know that convinced me that I needed to get online and read some of these things.

When Alice entered the master's program, her classroom culture was a result of teacher-directed instructional strategies where students had little impact in either the direction or content of their learning. All interaction between students was framed by questions or directions coming from Alice. Her typical teaching strategy arc began with a teacher-directed exploration of content material. This exploration was followed by questions or directions like "What did you notice happening?" or "Look for patterns." Directions like "Tell someone next to you about what you see" were her attempts to include student discourse in her teaching. Even though Alice seemed to be aware of the importance of student discourse in how students created knowledge and understanding, her teaching strategies did not provide students with many opportunities for sense making conversations.

At the beginning of Alice's master's degree program, she had an awareness of educational technology (i.e. using online virtual manipulatives), but her use of technology in the classroom centered on rewards for behavior/performance or simple, worksheet reinforcement activities. During an observed activity, her class went to a computer lab and accessed an online virtual manipulative website. Her students used this time as mostly playtime, with no group conversation about what was happening on the screen or how the students' activities related to their learning.

These initial characterizations of Alice's teaching strategies and her perceptions of technology integration were in contrast to how her knowledge of instructional strategies and representations for teaching and learning with technology and overarching conceptions about the purposes of incorporating technology into teaching were actualized when observed near the completion of her graduate degree. Alice felt that, "through the use of the Smart Board, students were able to participate together as a group while interacting with a technological component that enhanced their learning." At the end of the master's program, the culture of her classroom portrayed a clear feeling of a learning community. Instead of beginning with a series of questions where students were expected to respond with facts rather than being asked to make hypotheses or draw conclusions in the observed activity, Alice began with a whole group discussion about temperature and sharing research ideas. Alice commented on how, as a result of her experiences in the online courses, she had come to understand the importance of, "providing opportunities for discourse and sharing in a supported environment where students are responsible for their learning and are expected to participate in activities that reinforce the concept while working collaboratively with their peers."

Alice's use of technology as a learning tool at the end of her master's program experience was also in contrast to her initial uses. In the observed activity, her growing understanding of curriculum that integrated technology in learning was illustrated in how her students used temperature probes with data collection software on a computer, as a means to an end rather than an end in itself. In the experiments conducted by her students, the technology was used to gather data and make sense of the event, as opposed to a toy used by learners. By meaningfully integrating technology into her teaching and her students' learning, Alice developed her overarching conception about the purposes for incorporating technology through demonstrating an understanding of the difference between technology as a teaching tool and technology as a learning tool. Alice's knowledge of students' understanding, thinking, and learning when using

technology in the classroom was affected by her experiences in the online master's program. Speaking about how her understanding changed as a result of her experiences in an online Instructional Strategies course, Alice said that she thinks that, "I feel that student discourse and sharing of ideas provides an educationally rich environment because it allows students the opportunity to share and build upon prior knowledge, explain and justify their thinking and reasoning with their peers, and provide clarification or an alternative strategy for students who may need additional help with the concept or skill."

In summary, as a result of her experiences in the online master's program, Alice made significant shifts in both her teaching strategies and her use of technology in the classroom. Alice combined learning from her professional development and continuing education experiences with knowledge and skills she developed on her own resulting in a noticeable change in her TPACK. These changes in her TPACK helped her feel confident enough to set some ambitious professional goals she described as:

I want to continue to encourage students to take a risk, to guess, to offer insight. I want to encourage a community of learners that support each other's participation, thought and strategies. As educational trends continue to incorporate more technology and research defines meaningful classroom instructional strategies, I would like to continue to modify my teaching and instructional practices to provide the best educational environment for my students that I can.

Dawn. Dawn began her master's program when she was 48 years old and in her tenth year of teaching fourth or fifth grade. She taught in a district located in the central portion of her state and served the fifth largest metropolitan area in the state. Although this district was large in comparison to the other districts represented in this study, it also had a significant proportion of students on a free or reduced lunch program.

Dawn's district was successful in their search for technology grants, but the availability of technology for teachers was uneven, with the inequities seemingly building related. Dawn had a SMART Board in her classroom and access to a laptop cart sufficiently supplied to allow each student to have the use of an individual laptop, while teachers in other buildings were still using whiteboards and overhead projectors. When Dawn got her SMART Board, she participated in a few short after-school, vendor or district provided training events focused on the features and capabilities of SMART Board. She was left to her own initiative in developing her SMART Board technological pedagogical knowledge.

During Dawn's master's program experience, she was part of a mathematics textbook adoption team. As part of her role, Dawn focused on investigating and making suggestions about what kind of mathematics curriculum her district might best utilize. This experience coincided with Dawn taking a course on curriculum development in her master's program. She felt the course provided her with the knowledge and vocabulary to speak as an expert when expressing her views and opinions about perspective textbook choices.

With the design of the building where Dawn taught arranged in wings of classrooms, grade level groupings were more natural. In spite of the physical proximity to other fourth or fifth grade teachers, Dawn purposefully did not interact extensively with her peer teachers. She characterized her staff lunch room as where, "...nobody talks about students or teaching..."

In spite of her colleagues having minimal community engagement, Dawn developed a thorough understanding of the role of a community of learners. She described her perceptions as:

I think of a community of learners as my classroom, as meeting with a fellow teacher, as a staff meeting focused on a particular topic. They are all good for sharing ideas and putting effort into something. When people are willing to share their ideas and question

each other and be willing to respond, having a lot of discussion, it needs to be moving forward on a particular topic. You have to participate and you can't just sit there.

Dawn was comfortable with transitioning her community engagement to an online environment. She felt the online environment provided some challenges, but could support meaningful community engagement. "From my perspective, that when people had a question, it gave them power to turn to someone other than the instructors. I think they were more comfortable asking questions, it gave them somewhere to go, it gave them less isolation."

From Dawn's perspective, the intentional actions on the part of the instructors, where they monitored and mediated online engagement, were the critical elements in creating an online community of learners. She commented, "I think that really clear expectations from the instructors were what motivated and drove the learning community, you were really clear that it couldn't be just 'I agree'. What happened was that it became a requirement."

Dawn also recognized how instrumental these assessed interactions were in helping the community participants develop an understanding of how their engagement might help them develop their knowledge, "I think it naturally developed as we were forced to do, as we were going, "oh gosh, I'm glad I read that, it was so helpful in me processing my thoughts. It felt like a discussion, it felt like everyone got heard. You couldn't interrupt a person so they got their thoughts out."

The important role time played in developing a community of learners was something Dawn understood, commenting, "I think there was a lot more participation and buy-in as we went along. It felt like there was a group, much more of a group. It felt like a discussion with people sharing ideas and it gave me ideas that I wouldn't have had on my own." Engaging with the same group over an extended period of time provided Dawn with the opportunity to find value in different perspectives, "After a while, I knew exactly who to read, who to listen to. I knew who

was putting in the work and would be thoughtful.” She also attributed extended time in the community of learners with developing personal relationships, “I think that time helped with familiarity and trust. It built around familiarity and trust.”

However, as much as Dawn found her community of learner engagement essential for developing her TPACK, she was not interested in making a transition from academically focused engagement to engagement with a more social focus, “I only did as much as required. I really stuck to what was required of me. I had no time for the social stuff.” Her reluctance to extend her engagement was, in her perspective, due in part to a lack of available time, “the only reason for this was strictly time management. I had no time to do more.” Additionally, while she saw the benefits of her engagement, her personal preferences guided her engagement patterns, “everyone has to do what they need to do. I didn't like going on the discussion boards, but it was useful.”

The instructional strategies Dawn employed at the outset of her master's program were dominated by teacher-directed, teacher-centered actions and activities with her students having no input in the direction or content of their learning. The interactions between Dawn and her students created a classroom climate where the teacher controlled every aspect of the school day. Dawn did make some attempt at engaging students in discourse through questioning, but the questions primarily originated from Dawn and were of a type where students were expected to respond with facts rather than to illustrate their thinking. During the initial observation, Dawn transitioned through five mathematics activities, each one focusing on a different mathematical concept. No connections were made to larger concepts nor were connections made between activities. From conversations during a post-observation interview, Dawn appeared uncomfortable with sharing control of the classroom and the learning with her students.

At the beginning of her involvement in the masters program, Dawn had little understanding of the importance of integrating technology into her teaching. In the initial

observation, her use of an overhead to display information was the extent of her technology utilization. A post-observation interview revealed Dawn's discomfort with technology in her own life and how that lack of knowledge translated to her not using technology in her teaching.

When Dawn completed her master's degree, classroom observations revealed a significant shift in both the instructional strategies she employed and how she integrated technology into her teaching. During an online instructional strategies course reflection, Dawn recognized the shortcomings of how she used to teach, writing that, "Traditionally, teachers ask a question, students respond and the teacher takes back control of the discussion. Basically, there is not much room for discussion; the teacher is doing all the talking."

The observed classroom climate she created exemplified a learning community where the teacher and students were engaged in sense making and knowledge construction together. Her views were reflected in her perceptions of instructional strategies and representations for teaching with technology as she described, "The idea of giving students more responsibility for judging what is being said, giving praise for contributions, accepting all answers neutrally, and encouraging, even praising those who challenge the teacher's ideas all create a classroom environment open to student discourse." Even though Dawn was personally reluctant to participate in the online community of practice associated with the online master's program, she understood the essential nature of supporting her students in developing a classroom community of learners.

During her time in the master's program, Dawn rearranged her classroom so that students sat in groups of four or five and they had the freedom to move about as the situation demanded. In the observed activity, Dawn and her students were using spreadsheets and the SMART Board to make sense of the result of adding even and/or odd numbers. Dawn's role in this event was that of a facilitator or "vision keeper" in that she facilitated small group/whole group discussion by

asking leading questions. Her most frequent questions were “Why did that happen?” and “What do you think will happen?” These shifts in her teaching represented how Dawn re-structured her overarching conception about the purposes for incorporating technology into teaching and learning. From her experiences in the online courses, Dawn revised her perception of her role as an educator, characterizing her new view by saying that, “As educators, we can encourage student engagement by giving the responsibility for thinking back to the entire class. We can accomplish this by relaxing our need for authority and allowing our students to ask questions and clarify their own meaning.”

In the activity observed near the completion of her master’s degree program, Dawn’s students’ use of technology as a learning tool for supporting the development of their ideas illustrated how her knowledge of students’ understandings, thinking, and leaning with technology had shifted as a result of her experiences in the online master’s program. How her overarching conception about the purposes for incorporating technology changed as a result of her experiences in an online Dynamic Spreadsheet course was enacted in how her students used technology in their learning. In the observed activity, her students were using spreadsheets on their laptops in much the same way as a student would use paper and pencil 10 years ago.

The spreadsheet technology used by the students replaced paper and pencil to the point where it was simply a tool to relieve some of the drudgery involved with repetitive calculations. This action allowed the conversation about mathematical concepts to flow much more naturally than if there had to be breaks where results were manually calculated for each hypothesis. Dawn was able to use her developing knowledge of students’ understandings, thinking, and learning with technology as well as the instructional strategies she developed in online instructional strategies course to create a classroom culture where technology was freely accessible and where it’s use was expected and supported.

In summary, as a result of her experiences in the online master's program, Dawn made significant shifts in how she conceptualized her role as a teacher. She was more comfortable relinquishing some measure of control of the classroom and the learning process to her students. For example, in a post-observation conversation, she mentioned that she had not been sure where the observed lesson about properties of adding even and odd integers was going, but was pleased in how it ended. In the observed activity, Dawn played much more of a supporting role where she acted as the facilitator, keeping focus on developing understanding, and let her students guide their learning through making and testing hypotheses. Her understanding of the purposes technology can play in teaching and learning changed as well where she demonstrated knowledge of the importance of integrating technology as a supportive tool.

However, a few conflicts did exist in Dawn's teaching. Dawn embraced spreadsheets as a meaningful tool, but resisted the integration of other technologies, saying that if she is not comfortable using the technology, she is not going to use it in her classroom. Additionally, although she was unable to justify her decision, Dawn insisted on drilling and time-testing her students on multiplication facts. Going as far as to say, "I don't think it helps them learn math", she made this activity a priority in her classroom. These views might be an artifact of her age, stemming from her digital immigrant status, and suggesting Dawn's perceptions of inquiry-based teaching with technology were still developing.

Charlene. At 26 years old when she began her master's degree, Charlene was the youngest teacher in the sample population. When she started the program, Charlene had taught middle school mathematics at the same central state district for five years. Her district was one of the more rural of those represented in the study and was the smallest in terms of population. Additionally, like other rural districts, Charlene's district had a significant proportion of students on a free or reduced lunch program.

The ruralness¹¹ of Charlene's district may have been a contributing factor in their being awarded a significant grant in partnership with Google Corporation, receiving laptops for every student in the district. In connection with bringing laptops to the students, Google provided extensive professional development in the use of Google's suite of collaborative software as tools for teaching and learning. Along with these laptops, Charlene had a document camera and a projector in her classroom.

Maybe because of her exposure to and connection with Google and the Google Apps platform, Charlene had taken developing her knowledge of online collaborative software as a major focus of her professional growth. During her master's program, her activities in this arena included participation in several district wide training events where she held a leadership role. Additionally, Charlene attended state and national level conferences focusing on technology in the classroom. She felt that the combination of her work in the master's program, specifically developing her knowledge of instructional strategies for integrating technology into learning mathematics and science, with her work using collaborative applications as tools for teaching and learning, resulted in a well rounded knowledge base for teaching and learning with technology. She characterized the different contributions of each experience as, "The master's program provided theory and foundation while the conferences provided more hands-on tech use."

Charlene was outgoing and confident in her knowledge and skills of teaching with technology, freely sharing ideas for activities and lessons with her colleagues. The administration in her building recognized the importance of interaction by providing time for teaching groups to gather. Her administration suggested conversation topics, but did not create a mandatory agenda. These group meetings provided an avenue for Charlene and her peers to discuss anything they found to be important and pertinent. Through these meetings, Charlene was able to interact with

¹¹ The term is used in the same sense as in Chapter III, Methodology.

the teachers in her building, sharing teaching tips and ideas. Charlene felt that these opportunities helped her to, "...start communicating with more teachers, showing them things and become engaged in that community of learners."

From her work with Google, her conference experiences, and her work with her building staff, Charlene had a well developed sense of what a community of learner was all about. She described her conception of a community of learners as, "consisting of a group of people having a conversation and sharing and learning from each other. A learning community helps people learn in a collaborative process, everyone is equal and people learn from each other."

Transitioning a learning community to an online environment resulted in differences and challenges described by Charlene when she commented that:

I think they both serve the same purpose. The main difference is the mode of communications where in the first one (online), it is written and the second; it is more oral (face to face). With writing, sometimes if someone is trying to express something that's hard to communicate, like sarcasm isn't easily interpreted.

In Charlene's perspective, situating community of learner interactions brought other challenges besides having to rely on written communication. These challenges stemmed from having to rely on digital technology for communicating. She described how:

It's a different experience. It takes people time to be comfortable with the tech. It takes awhile to get used to it. You have to get over the hurdle of people being comfortable with it.

Even though she thought there was an initial hurdle to engaging in an online community of learners, Charlene recognized the importance of engaging in an online community of learners

in developing her TPACK. She felt that sharing her ideas with her colleagues provided her with a broader perspective of the concepts and ideas:

It provided an outlet to ask questions, collaborate, bounce ideas off of, increased the amount of resources we had. It gave me a different perspective and how different people were viewing the assignment. That was helpful.

Charlene was clear in her descriptions of the driving forces in developing and supporting the online community of learners in saying, “A group was brought together and you interacted with individuals. That forced people to start communicating.” In her opinion, it was moderation and mediation on the part of the instructors that initiated and facilitated engagement in the online community of learners. She expressed these thoughts by saying:

Part of it was forced. There were clearly presented expectations and loss of points. This motivated individuals in participating.

Through extended time in engagement in the online community of learners, Charlene was able to develop relationships with the other participants which not only provided her with academic support, but had a social aspect as well. She found, “the more comfortable I got with an individual, the more willing I was to ask questions or be real with the individuals. More comfort, changed from just a professional development experience.” She found a connection between her engagement and her perceived value:

I defiantly found the value the more I put in it. It developed over time, with working with people more, the more successful it became. There were definitely people I would listen to and put their suggestions into my assignment.

Finding value in her engagement increased Charlene’s engagement, “I posted regularly and checked back frequently. I was frequently online throughout the week.”

When Charlene entered the master's program, the classroom climate she created was the traditional, teacher-centered, teacher-directed typology. She characterized her teaching at that stage of her career as "talking to the students, not a lot of student engagement." Her primary instruction strategies revolved around question and answer patterns where the questions with students responding with facts, rather than describing their thinking. In her initial classroom observation, Charlene used worksheets and problems presented with the document camera as primary activities for her students. Her students worked individually with no large group discussion beyond the previously mentioned questioning strategy. Reflecting her teacher-centered perspective, when first observed, the desks in her room were arranged in rows, facing the whiteboard and projector screen, where Charlene sat or stood. It appeared that her behavioral expectations were also aligned with a teacher-centered perspective in that the students were directed to stay in their seats and work quietly on their tasks.

Technology use, as seen in the initial observation, was limited to Charlene's use of a document camera to present information. At no time in the observation did either Charlene or any of her students use the document camera to display work illustrating or describing thinking needed to solve a problem. It was unknown whether Charlene had access to a computer lab, but there was no indication during the observation or subsequent conversations that computer technology was a part of the students' educational experiences.

This characterization of Charlene's classroom as being dominated by teacher-directed activities and devoid of learning with the support of technology was in contrast to what was observed near the completion of her master's degree. In actualizing how her conceptions about the purposes for incorporating technology in teaching, she was having her students use laptops with Google Apps to design surveys to collect data for later analysis. These surveys were to be delivered school wide through the Google Apps platform with the use of the previously mentioned laptops. While the students developed their own surveys, Charlene encouraged them to

talk freely with each other about their development process and progress. This shift to a student-centered instructional strategy based on student driven discourse illustrated how Charlene utilized her developing knowledge of instructional strategies and students' understanding, thinking, and learning in creating a classroom curriculum where students were able to create individual knowledge. Although the activity was primarily individually focused, a climate of collaboration resulted in students seeing their fellow students as local resources. In the observed classroom, Charlene's actions were in the role of a facilitator, helping students with procedural questions and aiding in the design of the surveys. In a reflection from an online instructional strategies course, she characterized how she values and facilitates classroom discourse:

As a class, we developed discourse in the area of mathematics by having lots of conversations about what we were doing in mathematics, how we were doing it, what we thought about the concepts, and questions that came up. By creating an open environment for communication, it allowed students to gain a better understanding of the concepts and ideas. The more talking about math that we did, the more students understood and the more opportunities they had to clarify misconceptions and ask questions.

An even stronger contrast between the initial and final observations was evident in the differences in how Charlene integrated technology into her classroom curriculum as a supporting tool for learning mathematics. In the initial observation, the only technology in use was a document camera with Charlene as the sole user. In the final observation, shifts in Charlene's overarching conceptions about the purposes for integrating technology were actualized through how individual student laptops were the primary technology in use, with the students having their own to use as they desired. In this case, the technology was clearly in the hands of and under complete control of the learner, rather than that of the teacher.

Charlene's extended knowledge of student understanding, thinking, and learning with technology as well as her developing knowledge of instructional strategies supported putting the technology in the hands of the students. In a reflection about an activity involving motion detectors, Charlene described her role as shifting away from controlling the learning process to:

...straight giving my students little direction and letting them be in charge of their learning. Generally speaking, I tend to give my students a little guidance when sending them on a learning mission. In this instance, I explained how to work the motion detector, turning them on and off, and how to access the program (LoggerLite). Besides that basic information, students were given free rein to explore and experiment with the motion detectors. It was after they had done the exploring and experimenting that I gave the students a challenge and a direction to move their investigations in.

In summary, as a result of the experiences Charlene had, both as part of her master's program and outside of that program, major shifts occurred in her knowledge of curriculum and instructional strategies for teaching and learning with technology, as well as in her perspectives of the role of technology in the classroom. Using her extending knowledge of students' understanding, thinking, and learning with technology, Charlene was able to incorporate her knowledge of collaborative software gained from her experiences with the Google Corporation into her teaching. Additionally, her experiences in the master's program influenced how she structured her classroom climate and the ways her students engaged with the content through the integration of technology. The online master's program experiences helped Charlene create an identity as a leader in her district for providing support in integrating technology into teaching and learning.

Betty. Betty was 33 years old and in her seventh year teaching seventh and eighth grade mathematics when she entered the master's program. She taught in a district located in the central

portion of her state and served the fifth largest metropolitan area in the state. Although this district was large in comparison to the other districts represented in this study, a significant proportion of students were on a free or reduced lunch program.

Betty's district was successful in their search for technology grants, but the availability of technology for teachers was uneven, with the inequities seemingly building related. In some buildings all teachers had SMART Board, while in other buildings, some teachers were limited to projectors and document cameras. Betty had access to laptops sufficient to allow pairs of students to use a laptop. Although Betty did not have a SMART Board, she did have a projector and a document camera.

During her time in the master's program, Betty participated in several other short and long term professional development programs. In addition to these district level professional development experiences, she was part of a mathematics textbook adoption team. As part of that team, she was provided with extensive training from the publisher in the use of the adopted text and attending curriculum. This training was provided through the publisher and focused on using the text and surrounding resource materials. Another professional development experience in which Betty participated had student mathematics learning through student discourse as the primary goal. In this professional development program, teachers investigated instructional strategies where justification of knowledge, or how to assess student conceptual understanding, was of primary concern. In yet another professional development program, Betty was part of a grant focused on helping students represent their thinking through the use of technology. Betty felt these experiences were meaningful in augmenting her training in the online master's program centering on using technology in teaching mathematics to provide her with a well-rounded professional development experience and expressed her views about how her professional development activities resulted in, "Making me focus more on what I do and why I do it and what

I am getting out of it. It helped me look at the lesson goals for my lessons and really dig into the math goals.”

The design of the building where Betty taught utilized open common spaces surrounded with classrooms. These spaces were used for large group activities with potential for including students from several classes. However, Betty was the only mathematics teacher in her class grouping, resulting in her feeling isolated from the other mathematics teachers. She commented on this feeling by saying, “I feel isolated. I’m not close enough to other math teachers to make contact during the passing periods.” With her two-thirds time teaching schedule, she did not have that common prep that the other mathematics teachers shared. However, she did utilize e-mail as a method for engaging other mathematics teachers. Additionally, she met with other grade-level teachers during lunch a couple of times a week.

Experiences in the many professional development programs she has been involved with helped Betty develop a well thought out perception of a community of learners. She described her understanding by saying, “A learning community would be a group of people that get together for a common goal and a common vision. The purpose is to keep growing, to collaborate with people to keep growing and learning and developing.” She continued with a comment on how she thought a community of learner structure supported collaboration, “So you are not working in isolation, so you can pool your resources.”

In comparing online learning communities to face to face learning communities, Betty thought there were similarities, “They were so different but equally influential. The purpose of them is the same, just the mode of communication is different.” However her personal feelings towards online learning framed her perceptions of engaging in an online community of learners, “Online can be so difficult. The online portion can definitely be more challenging than being in a classroom together.”

Even though Betty was not entirely comfortable engaging in a community of learners in an online environment, she did realize the importance of that engagement, commenting that, “It was creating ways for us to work together even though we weren’t in the same space. It was a way to meet together as a class where we could talk to one another.” In her perspective, engaging in the online community of learners enhanced Betty’s TPACK development:

This gave us a way to put questions out there. It could be clarifying an assignment or helping develop an idea. It made my work a lot richer because I learned from the other people in the class.

In Betty’s view, it was the purposeful actions of the instructors in monitoring and mediating community interactions that were the driving force in initiating and supporting the online community of learners. Betty felt the initial requirement of beginning introductions was essential, “You were very intentional in developing the community in having people post their pictures and write something about themselves and responding to people's introductions. It helped us find common ground with one another, and helped us get to know one another so that we would be comfortable working together through the course.” The actions of the instructors, in Betty’s view, were critical in helping participants overcome initial reluctance resulting from a move to an online environment and start interacting:

You were very intentional in using teaching strategies. It got people engaged. It was a way to get people communicating that were not in front of each other. It was creating a classroom atmosphere. It was creating ways for us to work together even though we weren’t in the same space. I don't think the community would have just happened. It wouldn't have developed to the depth that it did without the instructional strategies. It got people talking. It got people started. If it was optional, there were quiet people that would not have engaged.

Betty was convinced that her experiences in the online community of learners would not have been as rich and meaningful had she not had time to find her place in that community. She thought that over time, “People's introductions changed and people became more comfortable in what and how they shared about themselves.” It was this developing comfort that allowed her to share her thoughts and ideas in a safe environment, “That is where the online community comes from, that takes time to develop in a course. We got to work with the same people for three years.” Building relationships with the other participants supported Betty in extending her TPACK through using the other people as resources, “I just remember learning a lot from people later on. Earlier, I tried to look toward myself as a resource rather than the rest of the cohort.” It took her some time to overcome her reluctance with the digital communications technologies as well. “I understood how to use it from the beginning, but wasn't using it like a way to have a classroom discussion from the beginning. Later, I used it much more as a resource that I did early on.”

When Betty began her master's program, her classroom had the appearance of valuing discourse and inquiry through posters and signs, but the behaviors of her students and her teaching did not reflect those values. While Betty was outgoing and sought to create a welcoming classroom climate, her classroom was teacher-centered and directed. Her teaching was dominated by a “teach, re-teach, guided practice” model where her questions were primarily where students were expected to respond with facts with little opportunity for students to discuss their thinking. Her students seemed particularly uncomfortable with questions that demanded explanations of their methods or processes and Betty was clearly using these strategies specifically for the observation. A student comment to the researcher implied that Betty had changed her teaching practices for the observation and that he liked being told how to do mathematics.

At the onset of Betty's master's program, her use of educational technology was minimal. At the time of the first observation, Betty had an overhead projector and a white board in her

classroom. Her use of this technology was primarily to display information, although during the observation, she did have two students present work. However, no meaningful follow-up discussion happened.

The instructional strategies and classroom climate observed at the end of Betty's master's program provided evidence of a shift in Betty's perceptions of student-centered, inquiry-based teaching and learning. With her developing knowledge of students' understandings, thinking, and leaning with technology, Betty worked hard at engaging students as members of a learning community. Even though the class was a mathematics support class for students struggling with content, Betty tried hard to move the locus of control to the students by helping them see each other as primary resources. In a reflection from an online course, she expressed how important she felt student interaction was by saying, "Students need to turn and talk and listen to one another and then share their ideas with the class." Her efforts were hampered by the students' reluctance to take responsibility for their own learning.

Her work in online courses in the master's program displayed a developing knowledge of instructional strategies and representations for teaching and learning with technology, but Betty was not confident in her skills in creating an environment where students were sufficiently engaged to make the shift to a more student-centered classroom structure. However, she did recognize the effects her experiences in the online master's program, expressing her perceived shifts in understanding as:

I know that my knowledge has been expanded as a result of the work we have done in the program. There are times where we all are in our infancy with something. That is where I was at the beginning of the program.

Betty's use of technology seemed to make a greater shift than did the instructional strategies she used in the classroom, probably due to her having greater access to different, newer

equipment. In the final observation, while Betty still did not have a SMART Board, she had a projector, an iPad, and a classroom set of laptops. In the observed lesson, she first used the iPad and the projector to have students order various whole numbers, fractions and percents on a number line, with a student controlling the iPad. In a second activity, her classroom used laptops and a spreadsheet to calculate median from a data set they created.

As with her knowledge of instructional strategies and representations for teaching and learning with technology, evidence from online courses indicated Betty's overarching conception about the purposes for incorporating technology in teaching was developing. This knowledge was evident in her reflections from an online spreadsheets course where she characterized her thoughts about student using spreadsheets. "If we give them the spreadsheet or show them without allowing them to work and struggle a bit, they see a cool tool that they will not know how to utilize themselves. I don't care how cool something is if students don't learn how to use it or are unable to transfer knowledge to other situations." Despite evidence of her knowledge about teaching with technology, she continued struggling with how that should be done. Her perceived difficulties in accomplishing this integration might have been related to her understanding of the role of technology in the classroom. This view was illustrated by a comment made during an interview where she said, "I think technology is better used for reinforcing fundamental concepts in math than developing them." She continued, saying that, "I think I am still at the fundamental belief where kids have to have an understanding of math concepts before they use tech and I don't think that's true, it's just where my current understanding is." Her developing understanding was evidenced in a reflection written during an online instructional strategy, where she said, "Sometimes a concept can be introduced with technology while others, like linear relationships are better suited to work with technology after students have a foundation."

In summary, as a result of her participation in the online master's program, Betty experienced shifts in her knowledge of inquiry-based instructional strategies and representations

that integrated technology in learning and teaching as well as in her conceptions about the purposes for incorporating technology in teaching. Betty demonstrated a developing knowledge and understanding of why using technology to support student-directed learning results in greater student engagement and knowledge development. Where Betty was limited in her developing TPACK was in her ability to operationalize her knowledge through actions in her classroom. Betty had yet to develop her understanding of how to accomplish this process of using her knowledge as a framework to re-contextualize her classroom strategies and structures as fully as some other participants. Her experiences in many different professional development programs during the past three years may have limited her attentions and thinking for focusing on a single, targeted pedagogy, resulting in her difficulties in the implementation of any pedagogy.

Adam. Adam was 44 years old and in his 22nd year of teaching fourth or fifth grade when he entered the master's program. He taught in a district located in the central portion of his state and served the fifth largest metropolitan area in the state. Although this district was large in comparison to the other districts represented in this study, it also had a significant proportion of students on a free or reduced lunch program.

Adam's district was successful in its search for technology grants, but the availability of technology for teachers was uneven, with the inequities seemingly building-related. In some buildings all teachers had SMART Boards, while in other buildings, some teachers were limited to projectors and document cameras. Adam had access to a sufficient number of laptops to allow pairs of student to use a laptop for activities. Although Adam did not have a SMART Board, he did have a projector and a document camera.

During his time in the master's program Adam participated in few professional development events outside of those provided by the program. One such event was the result of his district engaging in a mathematics textbook adoption with teachers being provided with

district-lead monthly trainings in the use of the new curriculum. Additionally, his district had a focus on reading skills and provided occasional in-service trainings geared to influencing instructional strategies to develop reading skills. While Adam found these district-lead professional developments useful, he thought they were not as focused and comprehensive as the master's program, commenting that, "the district stuff feels more like somebody's idea of how we should do something, where the master's program was very focused and it was very directional in the activities."

Adam's interactions with the other teachers in his building reflected his perception of a community of learners. He described the primary factor influencing his day-to-day teaching as his engagement in his grade level professional learning community (PLC), "The influences that colleagues have on me that are the most impacting the way I run things in my classroom would be our PLC." Besides these interactions, Adam engaged with the other grade-level teachers more informally. "I'll often pop into their classrooms or they'll stop by mine and we'll talk about the different things we are doing. Somebody will say, "That's a good idea", and I might see how I can adapt that to fit into my classroom."

These interactions, both formally in the grade-level PLC and informally in chatting with his fellow teachers, framed Adam's perceptions of a community of learners. He characterized his view as, "My understanding of the PLC concept is that it would be a team of teachers that do things together. The role of a community of learners is to insure that students are being successful at the level we want them to be successful." In comparison to how he viewed the online community of learners in the master's program, his view of the role of a community of learners in his building was more student achievement focused than the role of the online community of learners, where the focus was more on supporting each other in learning. He described his perceptions of the differences as, "In the PLC in the school, the end goal was test scores; in the

master's program it was more of a support for each other. It adds in a very positive way to the PLC, that social aspect beyond the academic aspect.”

Adam was able to transition his perceptions of a community of learners to an online context by seeing how he could use the digital communications technologies in facilitating the kinds of conversations he had in face-to-face environments. He felt that, “the online forum made me more prolific because it was easy, accessible and could be done on my own time.” Additionally, Adam felt that he was able to have meaningful discussions through digital communications. “The online interactions with my fellow students were of a discussing thoughts nature, talking about our take on this or that, just hashing out what we were learning about.”

Through Adam's engagement in the community of learners, he came to value the relationships he developed with the other participants. These relationships helped him develop his TPACK through sharing his thoughts and ideas, “as far as reviewing each other's papers, it gave us insight, it allowed us to see inside to each other's thinking, who we were, and give our input in those things.” In Adam's view, these interactions had an extending and reinforcing effect on his TPACK development. He described these effects as, “... (impacting teaching with tech) it did in a minor way, in just sharing ideas. The profound ideas I got about teaching with tech didn't come from those online discussions, but was enhanced through those discussions.”

In Adam's perception, the actions of the instructors in moderating and mediating engagement was the primary component in initiating and supporting the development of the online community of learners. In his opinion, the most effective instructional strategy used by the instructors was assessing engagement, Adam described the community development, saying, “...it developed because of the instructors pulling the strings, the puppeteers. You just made it mandatory for our grade that we posted x many times in a given week.” He felt that:

At first, there was very little interaction online. People were very busy and overwhelmed. It felt a little contrived and there were times where it was, but after doing it, people started realizing there was some real value in that. At first I didn't want to do it because I was too busy doing other stuff; then I did it because I had to. My attitude changed just by virtue of doing it.

Adam also saw how extended time mediated participants' interactions with each other in the online community of learners. He recognized a need for prolonged engagement to develop relationships and find value in the engagement. He felt that as time went on, these relationships became more personal, with social as well as academic aspects. He described his experiences in this way:

I think that it started carrying itself and some of that was that social feel. In a strange way, it had some of that social network feel to it a little bit. I found value that I didn't expect that I started picking up. I started seeing the value in it to the point where I was getting on to see what people had to say. I would even sneak it during my work day, what are people saying, what are people talking about right now? As I got to know people better, I became more comfortable and less formal. In any relationship, there is a certain warmth to it, a social aspect to it that enhances that interaction. It is enhanced by that social piece, that human piece. It made me feel more invested in the program, more part of a team, more part of a cohort.

Adam's instructional strategies and classroom climate at the start of his master's program were primarily teacher-centered, with his students having little influence in the direction of their learning. While Adam made attempts in initiating classroom discussions, he often spent more time with classroom management than discourse. In an observation early in Adam's program, he began with questions that drew on students' pre-knowledge of units of measure, but subsequent questioning strategies became less inquiry-based and changed to questions where students

responded with facts, rather than ideas or descriptions of their thinking. While Adam's room was laden with physics gadgets, musical instruments, a giant pendulum and other stuff, at the beginning of his involvement in the master's program, no digital technology tools were present. At that time, Adam had a projector and a document camera, but used it himself, primarily to display information. It is unknown if Adam had access to a computer lab as there was no mention of using computers in any context of his lessons or activities.

An observation near the completion of Adam's master's program displayed a dramatic shift in both the instructional strategies he employed and the classroom climate he fostered. While Adam still used a classroom management technique where students learned to manage their own behavior, he was much more explicit in facilitating the negotiation of socio-educational behavior norms¹². Having his students all take a part in developing the behavioral expectations resulted in a greater buy-in level and reduced the time and effort needed for Adam to manage his students' behavior. In the observed activity, Adam demonstrated his knowledge of students' understanding, thinking, and learning with technology in how he structured the activity. The students were investigating motion detectors with the goal of discovering how they might be used. Adam began the activity by asking who had experience with the technology and then made sure that each group contained an experienced student. This introduction was followed by a short, verbally delivered outline of the goal of the activity after which the students were then set to the task. After about 40 minutes, Adam gathered the students together as a large group, helping them consolidate their findings and make sense of what they had discovered. Adam changed his teaching methods to focus on helping students make sense of their experiences rather than

¹² This term is used to describe a set of behavioral norms negotiated in a classroom context where the social aspect of the environment carries importance, but the overarching purposes are educational. This concept is similar to the idea of socio-mathematical norm negotiation proposed by Yackel and Cobb (Yackel & Cobb, 1996).

provide answers. “Their reaction has been extremely positive, which makes me more interested in doing more of it.” Adam attributed these shifts in the instructional strategies and representations for teaching and learning with technologies to his experiences in the online master’s program when he said that he had:

typically been reluctant to use much cooperative learning as I have never felt that I was particularly good at organizing it in such a way as to make it really effective. However, in light of what I have learned in this class, I decided to challenge myself to structure a unit in which every lesson involved cooperative groups. Of course there were other variables involved, such as the inquiry and the hands-on aspect of the lesson, so it was difficult to determine whether it was the cooperative nature of the activities or one of these other aspects that lead to the high level of on-task behavior and student interest. It is my sense that it was a combination of all three.

Prior to his beginning the master’s program, Adam spent little time thinking about how to use technology in teaching science and mathematics. At the completion of his master’s program, Adam clearly understood the importance of integrating technology into teaching science and mathematics, “...it’s made me think about it more than I ever did. I didn’t give it a thought previously.” Adam demonstrated his knowledge of students’ understandings, thinking, and learning through providing exposure to probeware for his students in a way they could build their own knowledge about the technology and its capabilities.

Additionally, while he still did not have a SMART Board in his classroom, his use of the projector now included students with their laptops, sharing their findings and describing their thinking. In both situations, student use of probeware and student use of computers/projector, Adam’s knowledge of instructional strategies and representations for teaching with technology led him to put the technology in the hands of the student, giving them opportunities for

constructing their own knowledge using technology. He expressed his thoughts about helping students learn with technology in a reflection during an online course, “The effective teacher can help students gain skills and understanding about using technology as learning tools by finding and/or developing activities that highlight the usefulness of the tool.”

In summary, Adam made a significant shift in both his knowledge of instructional strategies and representations for teaching with technology as well as his knowledge of students’ understanding, thinking, and learning with technology. Adam refined his classroom management program to more effectively facilitate a community of learners’ classroom climate. This more functional community structure, combined with Adam actualization of his knowledge of the overarching conceptions for incorporating technology in teaching and learning, provided a learning environment where his students had significant influence in the direction and content of their learning. The freedom and support Adam gave his students in their use of technology provided them with the tools necessary to take advantage of the opportunities a supportive, open learning environment provided in helping them influence their learning and creating personally meaningful knowledge.

Analysis of Case Studies

The case studies presented above served as evidence for the identification and development of emerging thematic perceptions common to the participants. In each case study, views how instructor actions mediate participant community of learner engagement, participant perceptions of their online community of learner engagement and the impacts of the online master’s program on developing participants’ TPACK was described in detail. Through a cross-case analysis, these rich descriptions provided researcher access to how the participants perceived their experiences in the online master’s program. It is these emergent, common across

participants, perceptions that supply the framework and support for building an understanding of how these participants developed and extended their TPACK in an online educational experience.

Through a cross-case analysis of the detailed case studies, the foundational elements of the purpose of this research were built, with the specific research questions framing this construction. The cross-case analysis is presented in response to the specific research questions, with a summary at the end of each response. This chapter will close with a summary of findings and results.

Research question one. Research question one was: What is the mediating effect of engaging in an online community of practice during the program on the participants' perspectives of teaching and learning with integrating digital technologies? From the case studies, the mediating affect of engaging in the online community of learners associated with the online master's program on the participants perspectives of teaching and learning with integrating digital technologies centered on developing personal relationships where the participants felt comfortable to engage in meaningful conversations centered on building individual knowledge of the concepts and ideas presented in the courses.

All six participants recognized the value of developing relationships with the other participants in the master's program. Several participants felt that online education was inherently challenging in getting to know people. These difficulties, in the perceptions of the participants, resulted in feeling isolated and alone. However, through the development of an online community of learners, the participants felt much more connected with each other and, as can be seen in the case studies, expressed how their engagement in the online learning community helped them develop a community identity. Alice said it best in her case-study, "...as time went on and people started to know you, you found your place in the community."

The emerging theme of valuing relationships where participants saw each other as more than text on a screen was common across all participants and each expressed this idea as a critical element in their ability to share their thoughts and ideas. In the online community model developed by Garrison, et al. (2000), this social presence component is an essential element in supporting discourse. However, in his discussion of social presence, Garrison focused on participant interactions leading to the development of a more personal perspective of each other, where emotional content of interactions played an important role. Evidence presented in the case studies indicated that a more important element than the type of interaction in developing these personal relationships was the length of time the community had to develop. In describing how they thought the online community of learners helped them feel part of a group, all six participants attributed the extended time frame for community development provided by having consistent engagement expectations throughout the entire three-year master's program as being a critical element in the functionality of the online community. As can be seen in the case studies, each participant, in some fashion, discussed the effect of this continuity of community engagement development. Betty focused on how important she felt the reoccurring interactions were in helping her develop how she pictured each person. Alice, as reported in her case study, thought that the passing of time helped other people learn who she was and how she thought.

Garrison et al. (2000), in developing a model of how social presence facilitated discourse, presented social presence as having three categories: emotional expression, open communication, and group cohesion. These categories imply the need for some level of social interaction or social relationship beyond engagement for academic purposes. An important finding from analyzing the case studies was that a social relationship, while certainly important in addressing feelings of isolation, was not necessary for a participant to be able to meaningfully interact with the other participants. From her case study, Dawn, due to either her loner personality or to her perceived lack of available time, chose to not develop engage online socially with the other

participants. However, this choice of focusing on academic engagement did not reduce Dawn's perceptions of value in her interactions with the other participants. As shown in her case study, she came to understand the personalities of each participant and decided whose work might be of interest to her for any particular assignment. In the case studies of the other participants, no evidence was presented of them not including Dawn as a contributing member of the online learning community due to her not participating in socially focused engagements.

Regardless of the level of social interactions, all six participants recognized the value in sharing their thoughts and ideas with each other. From her case study, Dawn described how she thought her engagement with the community felt like a discussion where people shared ideas and helped her see concepts from new perspectives. This perception was a common theme across the case studies, where in each case study the participants described how the community supported collaboration. As presented in her case study, Betty felt her participation in the online community of learners helped her develop and extend her TPACK through being able get help in developing an idea or pool resources.

In summary, as seen in the case studies, all participants expressed their opinion that it took more than a single course, or a single term for that matter, to develop these relationships. The participants, those who mentioned a time frame in the course of being interviewed, talked in terms of academic years and most said it was not until the second year of being with the same people and the same engagement expectations they felt a part of a community of learners. Additionally, comfort with sharing opinions was a result of interacting with the same group of people over an extended period of time, rather than developing a social relationship where personal information was shared. Even though Dawn did not develop the same level of social relationships, she found value in her interactions with the community and got the support she needed to extend her TPACK.

In alignment with the framework for an online learning experience presented by Garrison, et al., (2000), the participants felt being able to share ideas and discuss concepts was at the heart of cognitive presence. From the case studies, all six participants realized the importance of this ability to share and structured their engagement in the online community of learners to take advantage of the relationships they developed with the other participants. From the case studies, Betty was not comfortable with an online environment, but put her apprehension aside in order to engage with the community of learners. Dawn, a loner by nature, did not like text-based forums as a communications medium, and never developed much in the way of social relationships, felt that her engagement in the community to be valuable enough in developing her TPACK to overcome her reluctance and meaningfully participate.

Research question two. Research question two was: How do the instructional strategies used in the program impact the development and support of an online community of learners? From the case studies, the instructional strategies used in the program mediated the development and support of an online community of learners through instructor monitoring and mediating interactions in the online community of learners. This monitoring and mediating on the part of the instructors initiated interaction behaviors where the participants were compelled through a desire for a grade to engage in online discussions. These engagement behaviors were supported and reinforced through consistent use of instructional strategies and course structures consisting of collaborative activities, peer review activities, and intentional grouping. These instructional strategies and course structures, including assessed engagement, continued through the entire three-year online master's program.

In alignment with the work of Swan, Shen, and Hilts (2006), across all the case studies, the opinion of the participants identified assessed engagement as the single most important strategy used in initiating and facilitating a successful online community of learners. However, while their work demonstrated the necessity for assessing collaborative activities to encourage

engagement, they did not consider the influence of time, nor did their work address mediating effects of various collaborative structures.

As presented in the case studies, all six participants attributed their initial participation in the online community of learners to their engagement being assessed. In comparison to the online master's program, most of the participants thought that the lack of engagement in a community of learners in other professional development events was a result of no accountability for participation. In his case study, Adam likened the actions of the instructors to puppeteers, pulling the strings. However, he recognized the need for direct intervention by the instructors and later commented that his attitude towards engaging in the online community of learners changed by virtue of his participation. The other participants, as seen in the case studies, universally expressed their perception that the online community of learners would not have developed as successfully if it had not been for the continued actions on the part of the instructors in requiring a certain level of engagement for a grade.

While the participants felt assessed engagement was the primary initiating agent in developing the online community of learners, the case studies showed they thought the design of the activities in all of the program coursework was instrumental in providing them with opportunities for the kind of interactions and sharing of ideas described in the previous section, where their engagement in these activities helped develop the online community of learners. The case studies demonstrated that all the participants felt at least one of the strategies or structures was effective in generating and supporting discussions and most of them thought all the strategies and structures had that effect. In her case study, Charlene expressed how she thought the expectation of collaboration, actualized through assessed engagement, provided additional motivation for meaningful community interaction.

These instructional strategies and course structures would not have been as effective in developing and supporting a community of learners without the continued moderation and mediation on the part of the instructors. The research by Garrison and Cleveland-Innes (2005), who found that conceptual learning in an online educational environment necessarily included meaningful interaction between instructors and students, reflected this finding. However, their work did not address online community of learners' development in connection with continued instructor activities.

In the case studies, the participants described how the continued actions of the instructors in providing clear expectations (Appendix F) was what motivated and drove the continued development of the online learning community. As presented in his case study, in his description of the effects of the instructional strategies and course structures used in the program coursework, Bob felt that by doing all these things (different collaborative activities), a collaborative environment was created.

An important effect of continued instructor monitoring and mediating of online community of learning interactions was a shift in motivation for engaging in the community. From the case studies, it was seen that most participants transitioned from participating in online discussions in response to an assignment to participating for more socially focused reasons. Several participants recognized this transition and expressed surprise at the possibility they could have these kinds of interactions in an online environment. Of those who experienced this transition, the continued assessment of their engagement in different activities during their coursework was identified as the primary driving force. As presented in her case study, Charlene commented on how extended time interacting with the other participants resulted in her feeling more comfortable asking questions. To her, an increased level of comfort shifted her interactions to have an element of personal connection, outside of just a professional development experience. This perception represented that of the group of participants.

In summary, the instructors' intentional, purposeful, and continual actions were the most influential actions in the initiation and facilitation of the online community of learners. Through assessed engagement in a variety of contexts, the participants were initially forced to interact with each other. These initial interactions, because of repetition, and instructor monitoring and mediation, developed into habits, where the participants began to see value in their engagement. This perception of value, combined with relationships developed over time, lead the participants to shift their motivation for online community of learner engagement from a desire for a grade to a desire to engage other participants in meaningful discussions. These discussions were supported through consistently employed instructional strategies and course structures, and though continued instructor monitoring and mediation, were an important sense-making and knowledge construction activity.

Research question three. Research question three was: What are the participants' perspectives of the development of their understanding of teaching and learning with digital technologies as a result of their participation in the online educational experience? Evidence provided in the case studies indicated the participants' perspectives of the development of their understanding of teaching and learning with digital technologies as a result of their participation in the online educational experience centered on their experiences in the various courses. In combination with their engagement in the online community of learners, the concepts and ideas presented in the program coursework were the driving force in developing their understanding of student-centered, inquiry-based instructional strategies as well as developing and extending the participants' TPACK.

As shown in the case studies, all six participants presented their understanding of how the changes in their instructional strategies resulted from the experiences they had in the various courses, combined with the opportunities they had for discussions with other participants where they were able to develop understanding. In her case study, Dawn characterized her perspective

of a traditional classroom where teachers take control of discussion and do all the talking. She discussed how, as a result of her experiences in the master's program, she thought relaxing the need for authority and allowing students to ask questions were essential for encouraging student engagement. Her focus on student engagement mirrored her perception of the important role of engagement in her own learning.

Other participants made connections between their experiences as students, engaging in collaborative learning activities, and their developing understanding of collaborative instructional strategies for use in their classrooms. From his case study, Bob discussed how his experiences in an instructional strategies course in the master's program helped him see the value of collaboration as a strategy when integrating technology. He commented that his understanding of the value of collaboration as an instructional strategy was connected with his experiences as a student engaging in collaborative activities in the online coursework.

Attributing these changes in the participants' perceptions of inquiry-based instructional strategies to their engagement emerged across all case studies, regardless of how they perceived their relationships with each other. Even those for whom the online environment was not their preference or for those who never developed social connections, the mediating effects of sharing their ideas in meaningful discussions was viewed as the primary learning structure in developing their individual knowledge.

This learning community engagement had far reaching effects for all participants. As seen in the case studies, as a result of discussion and sharing of ideas, most of the participants experienced significant shifts not only in how they taught, but in how they conceptualized their teaching. From his case study, Adam described how his teaching moved from seldom employing a group work strategy to not only have all his activities be done in student groups, but how his thinking about collaborative learning had shifted as a result of his experiences in collaborative

activities in the online master's program. His teaching philosophy, as a result of his experiences, centered on inquiry and student direction as fundamental to the design of any curriculum or activity. Dawn, even though she did not form social relationships in the online community of learners, still felt that her experiences in the online courses were supported through her interactions with the other participants and resulted in a fundamental shift in her teaching philosophy, from a teacher-center view to where she actively tried to give the responsibility for thinking back to the entire class.

A reoccurring theme across the entire set of participants was their perceptions of how their relationships developed in the online community of learners supported the development and extension of their TPACK. Not only did they share ideas and thoughts about teaching with technology, but various instructional strategies supporting student-centered inquiry were often the topic of discussion. Through these online discussions in the context of their master's program coursework, the participants felt they were able to develop individual knowledge and understanding of TPACK. This individual development and extension of their TPACK was evidenced in their case studies through differences in how they internalized their experiences in the online master's program as well as how they put their TPACK into action in their classrooms. Dawn's case study presented evidence of her decision to limit her choice of technology she used in her classroom to spreadsheets. Dawn's comfort level with technology in general resulted in her being reluctant to try new technology if she was in anyway unsure of her abilities.

In contrast to Dawn, Betty was confident enough in her abilities to focus her TPACK investigations in her program course work on technology that was not part of the master's program. As a result of professional development activities outside of the master's program, Betty was exposed to different technologies. She felt supported enough through her online community of learner experiences to use these technologies in her classroom as well as in developing her TPACK. The rest of the participants used the technologies presented in the online

master's program in their classroom in different ways, some using pre-made activities and others creating their own. These differences in the technologies used, in addition to how the participants put their TPACK into action in their classrooms indicated an individual TPACK construction, while the emergence of common understandings of the underlying framework of teaching and learning while integrating mathematics, science, and technology, indicated a more global perspective of TPACK.

In summary, the participants felt their experiences in the online masters program were the combination of program coursework, their engagement in the online community of learners, and their opportunities for meaningful discussion. They felt the coursework provided them with the structure needed to develop and extend their TPACK and knowledge of student-centered instructional strategies. The role the online community of learners was in providing them with the tools for discussion through the development of relationships with other participants allowing them to share their ideas in a safe environment. In the view of the participants, the structure of the courses, combined with the safe, comfortable environment provided them with the opportunities for extended engagement with each other about the concepts and ideas fundamental to teaching and learning with technology.

Summary

From case study evidence presented in response to the three specific research questions, teachers developed and extended their understanding and knowledge of teaching and learning with digital technologies (TPACK) in an online education experience through a dynamic inter-relationship between; purposeful, continued monitoring and mediating actions on the part of the instructors; extended supportive, meaningful engagement in an online community of learners; and intentionally designed courses where instructional strategies and course structure supported and facilitated collaborative interactions.

The evidence presented in the case studies supported the underlying fundamental construct developed by Garrison, et al., (2000) as described in Chapter III, where an online educational experience resided at the intersection of social, teacher, and cognitive presence. Garrison's model put the actions of the instructor in the foundational position, without which social presence rarely developed. This perspective was confirmed through evidence from all six case studies, where the participants agreed on the importance of intentional actions on the part of the instructors. These instructor actions, from the perception of the participants, needed to begin with the initial contact in setting expectations and modeling behaviors, and continued through to the end of the program, in monitoring and mediating community of learner development through assessing engagement and structuring courses to facilitate collaboration.

Besides continuing to assess participant interactions through monitoring and mediating engagement in the online community of learners, the participants recognized how continued, intentional instructor decisions in choosing collaborative and peer-review instructional strategies provided access to the course content. The use of these interactive instructional strategies constructed a learning environment where, through the relationships built in the online community of learners, the participants were able to have extended discussions about the concepts and ideas presented in the online courses.

The evidence from the case studies both confirmed results of research in describing the importance of instructor interactions and extended these results in revealing the perceived importance of extended instructor monitoring and mediating of all aspects of the online educational experience. The participants, across all case studies, described their perceptions of the critical nature of instructor involvement. It was the participants' view that the community of learners would not have been as functional without continued instructor intervention in the form of assessed engagement, nor would the courses have been as valuable without purposeful

decisions on the part of the instructors to use collaborative instructional strategies and course structures in every course in the program.

The importance of the interdependency between the actions of the instructors, the actions of the participants, and the structure of the content in developing TPACK was portrayed through evidence in the case studies. Regardless of their perceptions of online learning or the kinds of relationships they formed, all six participants felt they had made significant shifts in their TPACK. These shifts went beyond just learning how to use technology in supporting teaching and learning mathematics and science, to be the cause of participants rethinking their teaching philosophies. In some manner, evidence from all six case studies revealed changes in the participants teaching philosophies that reflected their extended understanding of inquiry-based, student-centered instructional strategies as support for actualizing their TPACK in their classrooms. Through instructor actions in initiating and facilitating an online community of learners, where the participants were able to form relationships with each other, and instructor actions in designing courses where their monitoring and mediating of collaborative activities provided support for extended discussion, the participants thought they were able to engage in sense-making knowledge construction in ways that supported integrating the new knowledge with their existing knowledge, resulting in a restructuring of their teaching philosophies and identities.

Chapter V

Discussion and Implications

This chapter provides a discussion of the findings of the study in relation to the research questions and purpose of the study. Beginning with a summary of the study, the chapter continues with the presentation of a model representing the findings. This model frames further discussion of the implications of the results of this study, detailing where the findings are integrated into existing literature and how the findings extend and expand current knowledge. The chapter closes with a discussion of how the results of this study might frame further research.

Summary of the Study

The role technology plays in education is building with every new generation of digital device and Internet application. Today's students, born into a world rich with technology of all kinds, are entering an adulthood where their future depends on being comfortable working and learning with the support of technology. To fulfill the educational needs of these children of the 21st century, teachers must bridge the digital divide, bringing technology into their classrooms and into the educational lives of their students. But, because most teachers in the field today had pre-service experiences with a minimal technology component, they must first bring technology into their own professional teaching lives. This requires access to continuing education focusing on teaching and learning with the integration of technology.

As important as this professional development is in helping teachers learn to teach in a 21st century context, the world in which teachers work sometimes puts immediate concerns above professional development. The busy lives of in-service teachers make it difficult for those teachers most in need of the training they require. Besides being otherwise engaged with teaching during what are traditionally the times continuing education programs are offered, location plays a significant role in limiting access to graduate degree programs where teachers are able to

develop their technological pedagogical and content knowledge (TPACK). Teachers in rural locations often live too far from degree granting institutions for them to engage in learning how to teach mathematics and science with technology.

One venue for teachers to access the training they need in using technology is provided by one of the technologies driving this need for professional development. The development of Internet communications technologies assures that people in different places are able to meaningfully communicate and thus supports distance learning as a meaningful choice for those who are constrained through either location or time availability in pursuing their educational goals.

The significant penetration into peoples' lives of Internet technology has helped online education or distance learning become a viable alternative to face to face educational experiences. Having access to continuing educational opportunities is only one part of helping teachers develop their TPACK and bring technology into the lives of their students. Ironically, the very technology provides access that also introduces constraints to the learning process. These constraints originate from moving the learning environment from the personal, face to face world of the physical classroom to the impersonal, virtual world of the Internet. Due to the mediating effects of a limited, mostly text-based communications medium, students often feel isolated and removed from the instructors and their classroom comrades. These feelings of isolation significantly affect perceived quality of the educational experiences and impinge on the ability for students to form the important supporting group relationships they are used to in face to face educational experiences.

While the importance of these supporting group relationships or communities of learners in face to face contexts has been the focus of research for several decades (Lave, 1991), the effect of an online community of learners in creating a meaningful online educational experience is

much less well understood. Initially, effective online course design was thought to be a mirror of face to face course design. Research revealed this design to be lacking in several areas, resulting in educational experiences where students were dissatisfied and had reduced achievement. What was found to be missing was the interaction and engagement through which students, with guidance from instructors, are able to socially build individual knowledge and understand.

Further research around online community of learner development produced a proposed theoretical framework where the interaction and intersection of three presences: teacher, social and cognitive, create opportunities for meaningful educational experiences (Garrison, Archer, and Anderson, 2000). In this construct, the actions of the instructor in structuring and facilitating the educational environment through supporting student interactions and construction of online courses play the most critical role in developing the online relationships so important in providing opportunities for sense making and knowledge building.

The initial guiding framework central to this research study took the essence of socio-cultural learning theory combined with concepts from a community of learners construct and re-contextualized the primary ideas of socially constructed knowledge as the product of sustained discourse to include elements made necessary by a shift to an online environment (Garrison, et al., 2000). This re-contextualization necessitated a redefining of the engagement space from being physically oriented and where interaction is face to face to where the space is defined as a nexus of ideas and interactions, irrespective of time and place, and where these interactions are mediated through Information Communications Technologies (ICT) (Jones & Norris, 2005).

In addition to redefining the engagement space, to bring the idea of a meaningful educational experience into an online environment required a redefining of the roles and identities of both the students and the instructors (Kinsel, Cleveland-Innes, & Garrison, 2005). Students had to learn to interact not as traditional students, but as students in an online world. Instructors

needed to become aware of how online learning communities form and what specialized knowledge they needed to foster these communities in an online world. Both students and instructors, by virtue of their immersion in this new environment, were compelled to become familiar with ICT in ways they might not have otherwise. This familiarity with digital communications technologies was operationalized both in how the participants interacted in the online world to develop shared knowledge and in how they contextualized their knowledge in their classrooms. Their technology knowledge was evident in how they used technology in initiating and facilitating learning communities with their students. These ideas were presented as a framework for necessary components of an online educational experience presented in more detail in Chapter Two.

This study was designed to investigate how teachers develop and extend their understanding and knowledge of teaching and learning with digital technologies through a primarily online master's program. This investigation focused on exploring the relationship between developing an online community of practice and the construction of technological pedagogical content knowledge (TPACK) during an online Master of Science in science education or mathematics education program. The purpose of this study was to explore with a group of rural elementary and middle school in-service teachers, their perceptions of the relationship between their development of and participation in an online community of practice and the construction and extension of their technological pedagogical content knowledge during their participation in a program focusing on the integration of technology for teaching mathematics and science. The results of this research provided insights into how the structures of online learning experiences through communities of practice frame the development of conceptual knowledge, in this case learning to teach mathematics and/or science with technology.

To shed light on the relationship in question, a general question was posed: How do teachers develop and extend their understanding and knowledge of teaching and learning with

digital technologies (TPACK) in an online education experience? More specific research questions focused on the participants' experiences in the online education experience included:

- What is the mediating affect of engaging in an online community of practice during the program on the participants' perspectives of teaching and learning with integrating digital technologies?
- How do the instructional strategies used in the program impact the development and support of an online community of learners?
- What are the participants' perspectives of the development of their understanding of teaching and learning with digital technologies as a result of their participation in the online educational experience?

In order to understand the impact that instructor actions in monitoring and mediating student interaction as well as in targeted course design had on developing collaboration, the experiences of six participants in an online master's in science program were investigated. Course artifacts, interviews and observation narratives were collected and analyzed, using a coding process based on relevant education theory and research. The result of this analysis was presented using a case study methodology where the individual cases described a participant's teaching environment, their teaching community, their perceptions of their experiences in the online master's program, and how their instructional strategies and TPACK shifted during their time in the program. These cases were then subjected to a cross-case analysis where the underlying essential essence of their experiences was revealed.

These emerging themes provided a portal into the educational experiences of the participants through which the researcher was able to investigate the inter-relationships between the instructor and the participants in supporting the development of their TPACK. These dynamic inter-relationships took various forms and characteristics depending on the context and participants. In order to more fully understand this complex, interactive system of engagement

and relationships, the researcher used the research results in developing a visual representation where the roles played by teaching, social and cognitive presences are portrayed, as shown in Figure 3.

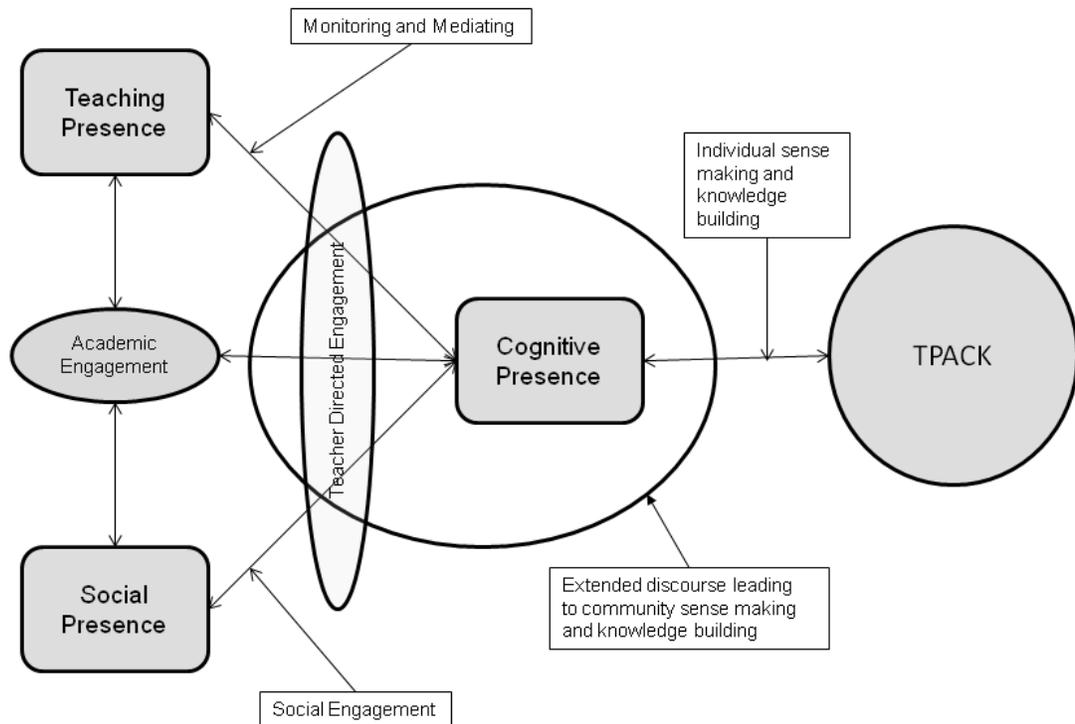


Figure 3. Relationships between teaching, social and cognitive presences in developing TPACK (Garrison, et al.,2000)

Presentation of Model

As can be seen in Figure 8, three primary constructs lead to the development of TPACK: teaching, social and cognitive presence. These constructs were described in detail in Chapters Two and Three. While these constructs all figure prominently in supporting meaningful educational experiences, Garrison, et al. (2000), in the initial development of their theory, placed

cognitive presence at the heart of success in higher education. However, as a conclusion of their initial work in this area, they indicated cognitive presence by itself was “not sufficient to sustain a critical community of learners” (p. 94). They felt that high levels of social presence were an essential component of developing conceptual understanding and collaborative relationships. Developing and extending social presence, “the ability of participants in a community to project themselves socially and emotionally” (Garrison, et al., 2000, p. 94), was seen as the vehicle through which cognitive presence was fostered and facilitated. It is social presence that frames engagement as a collaborative community of learners.

When discussing the role of teaching presence, where the teacher constructs and facilitates the educational environment, Garrison, et al., (2000) felt that teaching presence was the binding element in creating a community of learners focusing on educational experiences. They went so far as to credit the establishment of a critical community of learners is “dependant on a teacher” (p. 96). Moreover, Garrison, et al., (2000) identified the combination of social and teaching presence that led to the development of the cognitive presence, and thus leading to a meaningful educational experience.

In contrast with Garrison, et al., (2000), the findings of the study position teacher presence as the foundational element in supporting a meaningful online educational experience. All participants felt the actions of the instructors were essential in initiating and facilitating the development of a community of learners where they were able to build knowledge. Betty related how her engagement in course activities impacted her perceptions of community; she felt, “I don't think the community would have just happened. It wouldn't have developed to the depth that it did without the instructional strategies.” Given the importance the teaching presence had in the findings, the role of this construct is discussed first, followed by that of social presence, with these leading to a discussion of how the cognitive presence comes from the interplay between the teaching and social presence.

Teaching presence, from the findings, was the foundational element in beginning the development of a meaningful online educational experience. When comparing their experiences in the master's program to other professional development experiences, the participants felt the instructor actions in the master's program were what helped them form relationships with other participants. In these other professional development experiences, the participants described how they never really connected with the other participants and perceived this lack of connection to have negatively impacted the effect of these professional developments. Charlene felt that in another professional development program in which she had participated, there was "no required participation, so my engagement was pretty minimal," while having, "...weekly interactions [in the master's program] that you were required to do and respond and communicate required [my] participation," thus helping her "feel connected." In the perception of the participants, this feeling of connectedness was at the heart of creating the relationships necessary in facilitating the development of an online community of learners central to their success in the educational experience.

The choices made by the instructors in instructional strategies and course structures were found by the participants to be critical in initiating and facilitating the development of an online community of learners (Appendices C through E). This finding was reflected in research where in differentiating between interaction and "critical discourse", Garrison and Cleveland-Innes (2005) described how higher-order learning is a product of engagement in a community of learners. They characterize interaction as no guarantee that students are engaged in a cognitive manner. A high level of group interaction, while possibly indicating group cohesion, does not indicate cognitive presence. It is through the leadership role of the instructor, in the findings of Garrison and Cleveland-Innes (2005), meaningful discussions and conceptual knowledge construction are facilitated.

The findings of this study confirm the mediating effects of a strong teaching presence in developing an online community of learners described by Garrison and Cleveland-Innes (2005). The participants described how instructor actions helped facilitate interactions where they were able to engage in discussions focused on helping them build their knowledge. In the view of the participants, “the cooperative group one felt like each person had a goal and responsibility and to make it come together, everyone had to do their part.” It was in these activities they felt their, “...collaboration was to create something that you wouldn't be able to create on your own.” The views of the participants were summarized by this comment, “The quality of the community was entirely dependent on how involved each person was in whatever online collaborative it was.”

Social presence, describing how participants perceive each other, is directly related to teacher presence. Garrison, Cleveland, and Fung (2010) described the central role teaching presence plays in developing social presence. They point to structure and design as well as facilitation and leadership as crucial for “deep and meaningful approaches to learning” (p. 35). This perception was confirmed by the findings of the study. In the master’s program, several instructional strategies initiated and facilitated the development of an online community of learners. The common structure across all strategies was assessed engagement in some form. The concept of assessing interaction is supported by research, where literature on facilitating interaction in online educational environments indicates that through the actions of the instructor, students develop an understanding of what is important in the course. “What is assessed is what is valued...” (Swan, Shen, & Hiltz, 2006, p. 45). This claim implies to establish patterns of engagement in an online community of learners, assessed activities are needed where the students are interacting in ways analogous to the behaviors establishing communities of learners in face to face learning experiences (Collins, 2010; Swan et al., 2006).

Confirming research, the findings of this study indicate the participants found having their engagement behaviors assessed provided sufficient motivation for them to overcome their

initial reluctance and begin to interact with each other. Compelled through assessment to interact, they began to find value in their interactions. Alice indicated, “It was a score, something I had to do initially then it kind of developed into, I know these people, what is an idea they might have, what are they thinking about?” Commenting on how she felt grades mediated engagement, Charlene said, “Clearly presented expectations and loss of points motivated individuals in participating.” (Appendix F).

These interactions began as academic discussions but as time passed and the participants became more familiar with each other, the motivation for engagement transitioned to having a social component. This transition, while not represented in literature, described participant perceptions of their engagement in the online learning community as becoming more comfortable, with an increased level of trust. Through a consistently applied program of assessed engagement in the context of instructional strategies where the participants had opportunities for discussion, reflection, and a variety of interaction, the participants were able to develop comfort and trust. This increased level of comfort and trust allowed them to form relationships where interaction and engagement were motivated more by desire than for grades. The perceptions of Adam reflected those of the other participants:

At first I didn't want to do it because I was too busy doing other stuff, then I did it because I had to. Then I started seeing the value in it to the point where I was getting on to see what people had to say I would even sneak it during my work day, "what are people saying, what are people talking about right now?" As I got to know people better, I became more comfortable and less formal. I think that it started carrying itself and some of that was that social feel. In a strange way, it had some of that social network feel to it a little bit.

This shift in motivation for engagement reflected a transition from the participants feeling like they were alone in their efforts in the program to the participants feeling like they were part of a community of learners. Alice indicated, “It was a score, something I had to do initially then it kind of developed into, I know these people, what is an idea they might have, what are they thinking about?” The relationships formed through continued interactions supported the participants in freely discussing their ideas and understandings of the concepts presented in the courses. During these discussions, sometimes initiated by the instructors and other times by participants, the students felt they were learning the most. Again, Adam’s comments represented the perceptions of the group, “...the online interactions with my fellow students were of a discussing thoughts nature, talking about our take on this or that, just hashing out what we were learning about.”

In presenting their conceptualization of teacher presence Garrison, Anderson, and Archer (2000) described two components, making choices about instructional strategies and course structure, and facilitating student interaction and engagement. Their work did not describe in any detail what these strategies or structures would entail, nor did they provide guidance or direction for facilitating student interaction. The findings of the study provide evidence for utilizing instructional strategies and course structures centered on collaboration as well as suggested methods for facilitating student interaction through which the participants felt they were able to develop meaningful relationships with the other participants.

The mediating effect of teacher actions in the context of both course design and interaction facilitation helped the participants develop their social presence. While initially focused on developing social presence in the context of academic engagement, instructional and structure choices on the part the instructors facilitated and supported the participants in developing relationships based on comfort and trust, where social engagement became a significant component of their interactions. This social component provided the participants with

additional avenues for interaction where they were able to engage in unstructured discussions helping them in community sense making and knowledge building. Charlene, in describing her perceptions of how her social relationships supported her learning indicated these relationships, “Provided an outlet to ask questions, collaborate, bounce ideas off of, increased the amount of resources we had.” Betty’s perceptions reflected a similar impression, “It wasn't so much about what the assignment required or asked of us, but it was just talking with your classmates about the assignment and your ideas.”

In the view of the participants, their developing social presence was the driving force in forming a functioning online community of learners, where the focus was on developing their TPACK through extended discussions resulting in community sense making and knowledge building. Betty in describing how her views changed as results of her interactions with the other participants said, “I just remember learning a lot from people later on. Earlier, I tried to look toward myself as a resource rather than the rest of the cohort,” She went on to say that, “Later, I used it much more as a resource that I did early on.”

Their interactions, in their perspective, were either in response to direct actions on the part of the instructors and had an academic focus, or flowed out of their social relationships supported and facilitated by instructor actions. These interactions, regardless of the source, still lead them to engage in extended discussions where they developed and extended their understanding of TPACK. Again, Betty commenting on how her social interactions mediated her experience in the online community of learners felt “it helped us find common ground with one another, and helped us get to know one another so that we would be comfortable working together through the course.”

Whether directly monitoring and mediating student interactions through instructional strategies or supporting and facilitating student interactions through guided forum-based

discussions where the instructor role was more of a vision keeper, providing input only to stay on point, the participants felt the continued support by instructors enabled them to meaningfully engage in sense making discussions where they built knowledge and understanding. In reflecting on how instructor mediated unstructured discussions influenced his learning, Adam felt that "...just getting us to talk to each other about our ideas, I thought was valuable." He continued to describe how a more structured interaction, based on a particular instructional strategy choice, helped him develop a social presence when he commented, "as far as reviewing each other's papers, it gave us insight, it allowed us to see inside to each other's thinking, who we were, and give our input in those things."

Cognitive presence, characterized by Garrison, Anderson, and Archer (2000) as the ability for members of a community of learners to construct meaning through sustained communication (p. 89), is at the heart of a meaningful online educational experience. All the participants, regardless of how they perceived their experiences, felt their engagement in discussions with each other was the most important component in how they developed and extended their TPACK. Dawn indicated, "it felt like a discussion with people sharing ideas and it gave me ideas that I wouldn't have had on my own." It was through these interactions, in an environment where they felt safety, comfort and trust, they were able to build their understanding of TPACK as a shared body of knowledge. Here again, Dawn had a meaningful comment, "I think we were sensitive about each other's papers and as time went on, we were more willing to be helpful, not pick the papers apart, but be supporting and that trust allowed us to do that."

Literature supports the need for utilizing collaborative instructional strategies as tools to foster higher level thinking in online educational experiences (Garrison, et al., 2000; Levine, 2010; Stahl, 2005; Swan, et al., 2006). What is lacking in the literature reviewed is the impact of utilizing a combination of several collaborative instructional strategies with an overarching course structure of assessed engagement and purposful grouping. While an enlarging body of

research describes the theoretical frameworks for the interactions between teachers, students, and content, few studies are described where the impact of specific online instructional strategies. These instructional strategies (assessed engagement, collaborative activities, peer-review as an assignment component, intentional group design, and supported free-flowing discussions), are individually effective in helping to stimulate interaction. However, alone, none of these strategies or structures had the impact of implementing them together as a complete program, utilized from beginning to the end of the program.

In describing how they felt each instructional strategy impacted their educational experiences, the participants expressed their perceptions as “the cooperative group one felt like each person had a goal and responsibility and to make it come together, everyone had to do their part”, and “The online forum made me more prolific because it was easy, accessible and could be done on my own time”, and “You mixed people up so that you would work with different people. When you mix groupings, it forces you to interact with different people.” Finally, “I enjoyed the peer review process. It gave me a different perspective and how different people were viewing the assignment. That was helpful.” These comments indicate the participants’ realizations of how the different instructional strategies were mediating their learning experiences in different, but complimentary ways, resulting in a more complete understanding than if they were experiencing only one instructional strategy.

The findings of this study support the importance of participant engagement in a functioning online community of learners in developing and extending the shared TPACK of the community. This shared body of knowledge gave them the tools they needed to develop their own, individually TPACK. Evidence provided in the case studies indicated each participant operationalized their TPACK in different ways. The use of technology in developing understanding was two-fold, where digital technology provided the participants with the means to interact as well as with tools for developing inquiry in their classroom. While there were two

categories of technology in use (technology for communication and technology for learning in the classroom), there was a significant use of communications technology in use in the classroom used to initiate and facilitate learning communities. Dawn focused on using spreadsheets in supporting her students' mathematics inquiry. Bob centered his use of technology on probeware and pre-made curriculum in the context of science inquiry. Adam again used probeware, but more in the support of student directed, student constructed curriculum. Betty focused her technology integration activities on technology she discovered and that was not a part of the master's program.

Each participant took what they learned from their common experiences and created their own individual TPACK. Through their experiences in the master's program, they developed the knowledge and understanding necessary for them to be able to individualize their TPACK. Charlene described how her experiences helped her develop her knowledge, "The MS program provided theory and foundation...." Betty, in connecting her TPACK with teaching math indicated she thought "It's not tech and math as separate entities, but they are thing that can work together to create new information and to discover stuff and to explore stuff." In describing how her TPACK development influenced her teaching, Alice said, "My thoughts have changed because I am using these tools. I'm having these experiences with them and the kids are having these experiences with them and I'm noticing how much more engaged they are."

Implications

Online education is a growing component in the continuing education lives of teaching professionals. If these educational experiences are going to be meaningful in addressing 21st century educational needs, then an understanding of how people learn in this environment is a critical first step in creating effective online educational experiences. The results of this study provide strong evidence indicating the primary learning mechanism in an online environment is

extended interaction and engagement with both other learners and instructors where there are opportunities for discussion in a safe, open environment.

The findings of this research resulted in a model illustrating the impact instructor choices of instructional strategies and course structures had on how these teachers developed their TPACK in an online master's program. Extending knowledge of learning in an online context is an essential goal for educational research. To increase the usefulness of this proposed model further research, where these instructional strategies and course structures are utilized, would add needed depth to the findings while broadening their applicability.

In creating the sample population for this study, the researcher drew from a pool of people participating in an existing grant-supported research project. This pool of participants all taught in school districts considered by literature to be somewhat rural. An area where further research would significantly add to the usefulness of the proposed model would be to create a study where there was a greater geographical diversity. Having all the participants live and teach in rural environments might have contributed to their willingness to engage with others through the use of Internet communications technologies. Additionally, the study participants were all from the same central region of their state. This would imply the possibility of them having previous connections through participation in region or state wide in-service events. These possible previous connections might have influenced their willingness to interact in the online master's program. To strengthen the model presented in the study, additional research where the sample population represented different states, both urban and rural environments and a variety of regions within each state would meaningfully extend the applicability of the findings.

Besides geographical diversity, research extending the proposed model to populations with teaching level diversity would enhance the usefulness of these findings and strengthen the model. In the study presented here, the sample population represented teachers teaching first

through eighth grade. The characteristics and pedagogy of K-8 students and teaching is very different from those of high school students and teaching. For the proposed model to be extended to professional development experiences targeted towards high school teachers, research drawing from this larger demographic group is needed. Professional development and continuing education needs are not limited to K-12 teaching and learning. Research in post-secondary teaching indicates a need for professional development or continuing educational opportunities if these programs are support meaningful student achievement (Hickson & Wilson, 2009; Mrazek & Orr, 2009). For this model to be useful in this arena, research centered on the impacts of designing an online professional development educational experience focusing on the concerns particular to post-secondary teaching and learning framed by the findings of this study is a necessary next step.

Another area for further research to support and extend this proposed model is an investigation of the impact pre-existing content knowledge might have on the willingness of participants to interact in an online community of learners. The content knowledge level of the sample population was entirely appropriate for their grade levels. However, there was variety in the confidence level the participants had in their content knowledge, in both mathematics and science. This differential in confidence might have influenced how willing the participants were to interact with each other. Those who were a bit less confident might have sought support and comfort more quickly than those participants with a stronger confidence in their content knowledge. Research where the sample population has a greater level of diversity in content knowledge might provide insight in to the mediating effect of this variable and extend knowledge of TPACK development in an online program.

This study focused on developing an understanding of how in-service teachers develop their understanding of TPACK through engaging in an online continuing education experience. Literature focusing on socially constructed knowledge and communities of learners make little

mention of the content at the center of this knowledge construction. Furthermore, online learning constructs are increasingly being utilized as environment where direct content knowledge is the focus. These online programs, particularly in mathematics, are designed as self-paced, modular learning experiences where students have little if any interaction with the instructor or other students. Literature indicates these course designs have a negative impact on student achievement, where a cause for student success being significantly reduced is limited engagement with instructors and other students (Bliss, 2009; Li, Uvah, & Amin, 2009).

Research where the proposed model is used in framing online mathematics or science course design would meaningfully extend the findings to these important areas of online learning. The impact of meaningful student engagement in learning communities where developing mathematics or science content is the focus of discussion would significantly extend understanding of how to structure online learning experiences where students had opportunities for sense making interactions. Transitioning the proposed model from teacher professional development or continuing education to become a framework for designing online educational experiences focusing contexts other than teacher continuing education will require careful consideration of how these populations, teachers in case of continuing education and students in the case of mathematics or science content, differ in how they learn, their expectations, and their ability and experiences with Internet communications technologies, as well as other important variables. Even with the anticipated challenges, research extending the proposed model to this new area of education would potentially provide important insights for developing a deeper understanding of how to construct meaningful online educational experiences. This model has the potential for supporting online education providing learning opportunities for those who are challenged by distance or time, opening up new, important avenues for access to learning.

Internet communications technologies became the breakthrough distance education was waiting for in supporting a move to being more than the last resort in learning opportunities. The

opportunities for instantaneous communication, where information could be transported in real time, provided learners with educational experiences approaching those of a face to face experience. What was found missing, after the blush was off the rose, was that certain connection created when people are meaningfully discussing ideas and concepts of common interest. Initial attempts at designing online education experiences did not include provisions for intentionally facilitating these conversations, even though their importance was illustrated through extensive research. As realization of the importance of opportunities for discussion and reflection developed, online course design began to include provisions for these activities.

The findings of this study present not only an extension to current literature through the development of a model illustrating the inter-play between teachers, students, and socially constructing knowledge in an online context, but go further in detailing a set of best practices in choosing instructional strategies and course design structures through which a functioning community of learners might be initiated and facilitated. This proposed model of the underlying theoretical framework of online educational experiences, in conjunction with the proposed set of best online course design practices, provides a next step on the road to bringing online education into the 21st century, where online students have not only high achievement, but engage in learning communities in ways that will benefit them as life-long learners.

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Appendices

Appendix A is the interview protocol used during the existing research project. This interview protocol uses the four components of technological pedagogical and content knowledge (TPACK) as a frame the questioning prompts. The goal of this interview was to collect data describing the participant perceptions of these four aspects of TPACK and how these aspects of TPACK are represented in their teaching.

Appendix B is the interview protocol developed for this study. The goal of this interview was to collect data describing the participant perceptions of their experiences in the online community of learners associated with the online master's program. Additionally, the participant perception of how the online community developed and how their experiences in the online portion of the master's program mediated the development of their TPACK was investigated through this interview.

Appendices C through E are examples of assignments utilizing cooperative, collaborative, peer-review and grouping instructional strategies and course structures. Appendix F is an example an assessment rubric used in the masters program.

Appendix A

Understandings and Beliefs of Digital Technology and TPACK Components Interview Protocol

1. *An overarching conception about the purposes for incorporating technology in teaching subject matter topics.* This conception is what the teacher knows and believes about the nature of the subject and its selected topics, what is important for students to learn within that subject, and how technology supports that learning. This foundation serves as a basis for instructional decisions.

- Think about teaching and learning with digital technologies.
- What do you believe is the role of digital technologies in teaching and learning in classrooms today?
- Tell me about your beliefs and understandings of how integrating digital technologies influence teaching mathematics.
 - Think about topics in mathematics that are supported by digital technologies. Talk about how they support students in learning the topic.
 - You might think of specific digital technologies and how these technologies influence teaching mathematics.
- Tell me about your beliefs and understandings of how integrating digital technologies influence teaching science.
 - Think about science topics that are specifically supported by digital technologies. Talk about how they support students in learning the topic.

- You might think of specific digital technologies and how these technologies influence teaching science.
 - Tell me your view of how these (mathematics versus science focus with technologies) different and how they are the same.
 - Has your thinking about teaching and learning with digital technologies changed over the MS program? If so, how and why? If not, why not?
2. *Knowledge of students' understandings, thinking, and learning in subject matter topics with appropriate technologies.* In this component, teachers rely on and operate from their knowledge and beliefs about student' understandings, thinking, and learning with technologies in specific subject matter topics.
- Think about your understandings and beliefs about digital technologies for classrooms today
 - Tell me about three technologies potentially have the most influence on students' learning.
 - Why did you make these choices?
 - Why did you not choose other technologies?
 - Describe your understandings and beliefs about the impact these digital technologies have on student learning.
 - Tell me about your understanding and beliefs of students learning math with the integration of digital technology.
 - Tell me about your understanding and beliefs of students learning science with the integration of digital technology.
 - Do students come to the same kinds of understandings of math or science concepts when learning with digital technologies as they do without digital technologies? If so, why? If not, why not?
 - Describe your understandings and beliefs of how digital technologies influence assessment?

- Are there aspects of student understandings and thinking that become clearer to you as a teacher through the integration of digital technology? If so, what are they and why? If not, why not?
 - Has your thinking about students' understandings, thinking and learning shifted as you have considered digital technologies changed over the MS program? If so, how and why? If not, why not?
3. *Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics.* With respect to the curriculum, teachers discuss and implement various technologies for teaching specific topics and how subject matter concepts and processes within the context of a technology-enhanced environment are organized, structured, and assessed throughout the curriculum.
- Talk about some math/science ideas, concepts or processes that you consider to be essential for students to learn.
 - Would teaching and learning these concepts be enhanced through the integration of digital technologies? If so, why and how? If not, why not?
 - How are the influences of digital technology the same for teaching and learning math topics the same as those for teaching and learning science topics? Why?
 - How are they different? Why?
 - Describe your ideas of what kinds of curriculum or curricular materials are best suited for integrating digital technologies? Why did you choose these?
 - Think about the curriculum in use at your school. What aspects of that curriculum lend itself to a smooth integration of digital technology? Why?
 - What aspects of that curriculum make it difficult it integrate digital technology? Why?
 - Has your knowledge of curriculum and curricular materials that integrate technology changed over the MS program? If so, how? If not, why not?

4. *Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies.* Teachers adapt their instruction toward guiding students in learning about specific technologies as they are learning subject matter topics with those technologies. They employ content-specific representations with technologies to meet instructional goals and the needs of the learners in their classes.
- Think about teaching and learning math/science with digital technologies.
 - Tell me about the instructional strategies you might use to support student learning when you are involving digital technologies in any way.
 - Why did you choose those ideas?
 - Would you choose different strategies for integrating different digital technologies? Why or why not?
 - How are your choices for strategies for teaching/learning math with digital technologies the same as those for teaching/learning science?
 - How are they different? Why?
 - How are your strategy choices when integrating technologies different for different types of learners? Why?
 - How are your strategy choices when integrating technologies different for topics? Why?
 - Has your knowledge of instructional strategies and representations for teaching with technologies changed over the MS program? If so, how and why? If not, why not?
 - This interview has been about you helping me to understand your perceptions and understandings of digital technologies and teaching/learning with digital technologies. Is there any concept or idea that you find important to help me understand your perceptions that we have not talked about?

Appendix B

Participant Perceptions of Online Communities of Learners Interview Protocol

Section One: Teaching environment and the impact of participating in an online master's program

This section of questions provides an overall perspective of the educational environment and culture of the participant and seeks to identify the role of the online master's program in influencing that environment and culture.

Grand Tour Question:

1. Think about your teaching over the last three years. Tell me about the experiences you have had that were influential in framing your teaching.

Possible Situational Probes:

- Tell me about the professional development/continuing education experiences you have had in the last three years.
 - How have these experiences influenced your teaching and learning?
- Of the experiences that have had the greatest impact on your teaching and learning, why were they so influential?
- If more than one experience has been influential, how were those experiences the same? How were they different?
- Tell me about the professional development/continuing education experiences you have had in the last three years that have involved teaching and learning with technology (in any form).
 - How have these experiences impacted your teaching and learning?
- Of the experiences that have had the greatest impact on your teaching and learning, how and why were they so influential?

- If more than one experience has been influential, how were those experiences the same? How were they different?
- Think specifically about your experiences in the online portion of the master's program.
 - How have your experiences in the program impacted your teaching and learning?
- Describe the experiences you had in the online portion of the master's program that had the greatest impact on your teaching and learning.
- How and why were these experiences so influential?
- If more than one experience has been influential, how were those experiences the same? How were they different?
- Did you participate in any professional development/continuing education programs other than the online master's program in the past three years?
 - If so, briefly describe them, including what group provided them and the reasons you participated.
- Compare these other programs to your experiences in the master's program.
 - In comparison to the master's program, how do you think these experiences impacted your teaching and learning?
 - In relation to your experiences in the master's program, were these other programs more or less influential to your teaching and learning? If so, why? If not, why not?

Section Two: Engagement in an Online Community of Learners

This section of questions provides an understanding of the participants' perspectives of the role(s) of a community of learners, their participation in a community of learners, and the impact of engaging in a community of learners on their experiences in the online master's program.

Grand Tour Question:

Think about your experiences interacting with other teachers in the last three years. Tell me about your experiences with interacting with other teachers that have had an impact on your teaching and learning.

Possible Situational Probes:

- Think about how you interact with other teachers. Tell me about your experiences with engaging in learning communities (same thing as a community of learners).
 - How do you think of learning communities? From your perspective, what defines a community of learners?
 - What is the role(s) of a learning community?
 - How were these learning communities created/developed?
- Who formed or facilitated the development of the community?
 - Describe how you engaged in the(se) learning community(ies).
 - Thinking about the community of learners that developed in the online portion of the master's program
 - What were your perceptions of that learning community?
 - What were the roles(s) of that community?
 - Does moving to primarily an online environment change your perceptions and understandings of a community of learners? If so, why and how?
 - What is your perception of why the community of learners developed during the course of the program?
 - Did your perception of the community of learners change over the time were in the online portion of the master's program?

- Think about your experiences in the online portion of the master's program. Tell me about your experiences engaging in that community of learners.
 - How did you engage in that community of learners?
 - Did your engagement with the community of learners change over the time you were in the online master's program? If so, how and why? If not, why not?
 - Did your engagement in that community of learners have an impact on your experiences in the online master's program? If so, how and why? If not why not?
 - Did your engagement in that community of learners have an impact on your development of your understanding about teaching and learning with digital technologies? If so, how and why? If not why not?
- Think about the technologies used to interact with the community of learners.
 - Did the different types of internet communications technologies influence how you interacted with other community members? If so, how and why? If not, why not?
- Think about learning communities outside of the online portion of the master's program. Have you participated in a community of learners outside of the online portion of the master's program in the past three years?
- Compare your engagement in the community of learners in the context of the online portion of the master's program to your experiences with other educational professional learning communities
 - How were your experiences in the community of learners in the master's program the same as your experiences in other learning communities?
 - How were your experiences in the community of learners in the master's program different than your experiences in other learning communities?
 - If there were differences, why? If not, why not?

Section Three: The development and support of an online community of learners.

This section of questions provides an understanding of the participants' perspectives of how the online community of learners in the online master's program was developed and supported.

Grand Tour Question:

Think about your experiences in the online portion of the masters program. Tell me about how you interacted with the other students and instructors during your time in the program.

Possible Situational Probes:

- Think about how the community of learners in the online master's program developed.
 - What is your perception of how the online community of learners developed during the course of the program?
 - What do you think were some of the important activities or events that helped foster the development of an online community of learners in the master's program.
- Think about the various instructional strategies and course design elements used during the coursework in the online master's program (collaborative and cooperative activities, graded forum postings, clearly presented engagement norms, etc).
 - How did these strategies and elements impact the development of a community of learners?
 - Were there other factors that influenced the development of the online community of learners? If so, what were they and what was the influence?
 - How did these strategies and elements impact your engagement with the community of learners?
- Were there any other events or experiences that you had in that influenced how the community of learners developed?

- Is so, what were they and how did they influence your perceptions of how the community of learners developed?
- Think about the technology you used to engage in the community of learners.
 - Describe your perceptions of the different ways you communicated with other participants and the instructors.
 - How are the different communications technologies the same?
 - How are they different?
 - Did different communications technologies provide for different types of engagement? If so, how and why? If not, why not?
- This interview has been about you helping me to understand your perceptions and understandings of online communities of learners and how you engaged in an online community during your experiences in the masters program. Is there any concept or idea that you find important to help me understand your perceptions that we have not talked about?

Appendix C**SED 595 Assessment and Evaluation****Fall 2011****Week 3 Assignment****Key Questions:**

1. Why is reliability an important concept for educational assessment?
2. Why is validity such a significant concept for educational assessment?

Due Date:

Saturday, October 15, 2011

General Description of Expectations: Organize this assignment in sections in a single worddocument using **single spacing and a 12-point font:**

1. **Updating Unit Plan Description** The last two weeks you have been focused on items 1-4. This week your task is to continue with the general description of this plan. Based on the feedback, you have received, you should make revisions as you see necessary and add #5 to this unit description:
 - **Unit:** Identify a unit of science or mathematics instruction in a formal or informal educational setting.
 - **Educational situation:** Describe the educational situation for this unit (e.g., 7th grade pre-algebra; 10th grade chemistry; middle school museum display on the solar system where multiple rooms are designed to provide an educational experience with a broad understanding of the solar system) and the targeted group of students. Describe the learners in the situation considering their cognitive, physical, personal and social development.
 - **Rationale for the unit.** What is the principal reason for the study of this unit? What purpose will it serve the learner?

- **Goals, Objectives and Achievement Targets:** Link the objectives with the goals and describe their alignment with state/national/international standards.
- Describe the goals for this unit.
 - Provide specific learning objectives that students should be able to demonstrate at the end of the unit. Each objective should be aligned with a particular goal.
 - Clearly identify the Achievement Targets (or Learning Targets) for each objective. What do you want students to know and be able to do? Be sure to consider knowledge, reasoning, performance skills, products and dispositions (Stiggins, 2008, pg. 51). **At minimum, you must identify one objective aligned with each of the achievement targets.** Table 1 provides a sample of how you might demonstrate this information

Table 1: Method for displaying alignment of goals, objectives and achievement targets

Goals	Objectives	Achievement Target
Goal 1: Reference appropriate standard(s)	Objective 1.1: ...	
	Objective 1.2: ...	
	...	
	...	
	Objective x.x: ...	

Goal 2: Reference appropriate standard(s)	Objective 2.1: ...	
	Objective 2.2: ...	
	...	
	...	
	Objective x.x: ...	

2. **Unit Organization:** Identify **the main concepts and ideas and sub-concepts** that are important in this unit. Prepare a sequence of how you would plan to address your

goals/objectives/achievement targets in the unit. Describe and explain how this flow addresses:

- The goals, objectives, and achievement targets
- The integration of science, mathematics and technology;
- The needs of the learners; and
- How this flow will assist in the development of the unit within the overall curriculum in which students are engaged.

This prompt requires you to flesh out the table above with details that illustrate the concepts used to meet each goal. These concepts are just that, not teaching strategies or classroom instructional activities, but indications of the larger, and more encompassing ideas that guide the unit. Each goal is part of a single overarching unit plan and as such should be related to the other goals so that there is a logical flow from one goal to the next. The response we are anticipating here might be in the form of an essay that addresses the four bullet points, using the key questions as a lens where appropriate. It is your thinking of how you identify these concepts, why you chose these particular concepts and how these concepts support the four underlying issues in the bulleted points that is what is important. Be sure to support your choices with literature, your personal experiences and/or the experiences of your classmates.

On the other point of describing the unit organization, the focus is on developing enough of a description to be able to think from a more theoretical perspective about what issues underlie assessment and evaluation. To do this meta-analysis, there is no need for the details required in lesson plans. Teaching strategies, instructional activities, detailed descriptions of the content, and materials lists are not needed and would tend to divert focus from the larger, more conceptual ideas and analytical thinking that are the essential elements of the course. Thinking more theoretically will help you to understand what is expected.

3. **Final Statement on Validity and Reliability.** Validity and reliability are key constructs in educational assessment. Your task as an educator (regardless of whether formal schooling, home schooling, or in free-choice learning opportunities) is to assess what the students or participants have learned. Respond to the key questions for this week. Describe how the concepts of validity and reliability apply to your particular educational situation and to your Unit Assessment Plan. Should you be concerned with them? And if so, how? Link your statement to the work that you completed for the Appendix through your small group activities.

4. **Reflection on the Community of Learners:** This week you have been asked to engage in a cooperative group in framing responses to directed questions about validity and reliability. Complete a reflection that considers the following ideas:
 - What various ways did you interact with your assigned cooperative group in the development of the Appendix response?
 - How did your group get organized for completing this cooperative assignment?
 - How did the readings assist in your discussions and responses to the questions?

- What ideas did you get from your classmates in the discussion that helped you frame your ideas? Discuss how the discussions with your classmates helped you understand as you were framing your individual essay through responses to the key questions. Reference your classmates as you talk about how they assisted in your understanding.
 - What is your impression of how your understanding of the key concepts developed through the discussions?
 - How did the requirement to individually prepare a final response on validity and reliability extend your learning from the group work?
5. **Reference List:** Use APA style. Be sure to add appropriate reference citations (that are linked with this Reference List) in your work in this assignment. Keep in mind that if you reference ideas from your classmates, it would be in the reference list as a personal communication that includes the date and means of communication.
6. **Appendix:** The work in this section is in support of your statement for item #1 titled **Validity and Reliability**. You will be organized in small groups to respond to these questions as a **cooperative** group. Each member of the group should attach the group cooperative response to the questions as an Appendix to this Week 3 Assignment. You are provided with multiple chapters to support your discussions about these items. Be sure to defend your responses including appropriate references to the readings, etc. Be sure to include the names of the students who developed this response.

Question 1. Engage in a discussion to develop responses to each question;

- a. What is a valid assessment?
- b. What is a reliable assessment?
- c. Why is important that assessments be both valid and reliable?

Question 2. After completing the readings and your discussions with your classmates, describe each of these terms with respect to (1) standardized testing (like the state tests), (2) classroom tests, and (3) classroom alternatives to testing as a means of assessing student progress toward the goals and objectives of the instruction.

- a. Reliability
- b. Validity
- c. Consistency
- d. Internal consistency
- e. Standard error of measurement
- f. Content-related validity
- g. Criterion-related validity
- h. Construct-related validity

Question 3. Answer each question using your readings and discussions.

- a. Why do tests such as the state achievement tests and the National Assessments of Educational Progress (NAEP) absolutely require the assembly of valid and reliable evidence?
- b. What bias(es) might exist in these assessments and how might such bias(es) be eliminated or accounted for?
- c. What kinds of validity evidence should classroom teachers assemble regarding their classroom assessments?
- d. Can bias in assessments in your particular educational situation be totally eliminated? Why or why not?
- e. What is your opinion on this statement? Explain
Traditional assessments (using a combination of multiple choice/true-false/ responses along with short answer responses) have the most potential for being valid and reliable with the least evidence of bias.

Appendix D

SED 595 Assessment and Evaluation

Fall 2011

Week 4 Assignment

Key Questions:

1. What assessments are needed to gather data about students' progress with the goal and objectives in the interdisciplinary science, mathematics, and technology educational context?
2. What different types of assessments need to be scored using detailed scoring rubrics?
3. How should scoring guides be designed to address validity and reliability issues and capture science, mathematics and technology goals/objectives in an interdisciplinary unit?

Due Date:

Saturday, October 22, 2011

General Description of Expectations: Organize this assignment in sections in a single word document using **single spacing and a 12-point font:**

1. **Assessments for your unit plan.** The Appendix contains a table that you are to complete in your assigned collaborative group where you **Strengths and weaknesses of various assessment instruments.** You are to include the work of the group in the Appendix to this Week 4 Assignment and reference this Appendix as you **propose and defend** the use of potential assessments for your specific interdisciplinary unit.
2. **Scoring Guides.** Prepare a response to Key Questions #2 and #3 where you identify important features of scoring guides that address validity and reliability issues and capture science, mathematics and technology goals/objectives in an interdisciplinary unit. Propose specific methods for meeting the goals/objectives and achievement targets that you have identified for your specific interdisciplinary unit.
3. **Reflection on the Community of Learners:** This week you have been asked to engage in a collaborative group in completing the Appendix for this assignment. Complete a reflection that considers the following ideas:
 - How did your group organize itself for completing the task in the time available?
 - What ideas did you get from your classmates in the discussion that helped you frame your ideas? Discuss how the discussions with your classmates helped you understand as

you were framing your individual essay through responses to the key questions. Reference your classmates as you talk about how they assisted in your understanding.

- How did the readings and movie assist in your discussions and responses to the questions?
 - What is your impression of how your understanding of the various assessment types developed through this project?
 - How did the requirement to individually prepare a final response with respect to your own unit plan aid in your understanding of the usefulness of various assessments for your interdisciplinary unit?
4. **Reference List:** Use APA style. Be sure to add appropriate reference citations (that are linked with this Reference List) in your work in this assignment. Keep in mind that if you reference ideas from your classmates, it would be in the reference list as a personal communication that includes the date and means of communication.
5. **Appendix:** For this list of different types of assessment that might be used for **your** science/mathematics educational setting, describe potential Achievement Targets and the Cognitive Demand for the assessment along with strengths and limitations for the particular assessment. Identify the strengths and limitations for using the specific type of assessment. Example responses are provided for the True-False selected response items. **You are to add one addition assessment method for each member of your group.** Be sure to include any citations in your reference list for this assignment.

Appendix E

SED 595 Assessment and Evaluation

Fall 2011

Week 5 Assignment

Key Questions:

1. What are different types of performance assessments and how do they match with the achievement targets?
2. What are important features for developing performance items and tasks?
3. What are validity and reliability concerns to consider with performance assessments?
4. What are important features of scoring guides for performance assessments?

Due Date:

Saturday, Oct 29, 2011

General Description of Expectations: Organize this assignment in sections in a single word document using **single spacing and a 12-point font:**

1. **Performance Assessment Key Questions:** Prepare a response to each of the key questions for this week providing specific examples from your specific educational situation. Ultimately this discussion should lead directly to #2 where you describe the performance assessment for your interdisciplinary unit. Thus, your responses in this response to the key questions needs to provide the defense for the particular choice that you have made for inclusion in your unit project.
2. **Performance Assessment for my interdisciplinary unit**
 - Description of the assessment – Be sure to provide the important features of and directions for the assessment; provide the expected output of the assessment (e.g., students' observation notes, concept map, drawing, etc.).
 - Match of the assessment with the goals/objectives/achievement targets. Explain how this assessment provides evidence for these targets.
 - Description of validity and reliability issues for this assessment
 - Scoring guide for judging the output for this assessment

3. **Reflection on the Community of Learners:** This week you have been more focused on your own interdisciplinary unit while you investigate the use of performance assessments for gathering evidence of the students' development in meeting the goals/objectives and achievement targets. You have also reviewed another classmate's preliminary ideas. **For weeks 5-8 you will be working in a small working group** as assigned by the instructor. For this reflection, consider the following ideas:
 - How did you use your classmates in your group in responding to this assignment?
 - What ideas did you get from your classmates in the discussion that helped you frame your ideas? Discuss how the discussions with your classmates helped you understand as you were framing your individual responses to the key questions. Reference your classmates as you talk about how they assisted in your understanding.
 - What did you learn by reviewing another classmate's work?
 - What did you learn from the review of your work by another classmate?
 - What questions were left unanswered for you? What might you have done to engage the class to help you answer the questions?
 - What plans do you have for ensuring that your small group is a productive and collaborative group?

4. **Reference List:** Use APA style. Be sure to add appropriate reference citations (that are linked with this Reference List) in your work in this assignment. Keep in mind that if you reference ideas from your classmates, it would be in the reference list as a personal communication that includes the date and means of communication.

Appendix F

**SED 595 Scoring Rubric
Week 5**

Student Name:

Performance Assessments	6	3	0
Academic Contribution	Responds to all expectations in a timely manner	Responds to all expectations but some of them are not complete; submission may not have been timely	1 or more expectations left unanswered; not submitted on time
Communication	Responses communicate clearly and concisely with correct English conventions in grammar and spelling.	Responses communicate somewhat clearly and concisely with some errors in English conventions.	Responses do not communicate clearly, concisely, or with correct English conventions
Analysis & synthesis	Responses demonstrate deep synthesis and analysis of assigned readings in relation to all topics. References to the readings are clear and adequately cited	Responses include meaningful comments without support from readings OR inappropriate citation.	Responses do not demonstrate understanding of basic concepts in the assigned readings. References to the readings are not included.
Reflection	Responses reflect a deep understanding of how all of the materials affect and are affected by the context of one's own teaching AND students' learning. Makes connections with substantive and meaningful references to classmates' ideas if available.	Responses include the context of one's own teaching AND student's learning. Makes connections with substantive and meaningful references to classmates' ideas if available.	Responses omit the context of one's own teaching OR students' learning OR connections with substantive and meaningful references to classmates' ideas
Learning Community Activity	Consistently participated in the Learning Community activities throughout the week; consistently provided ideas, feedback and questions in the "discussions" to help others in understanding ideas as well as to build own knowledge. References to classmates are clearly stated and demonstrate the interaction	Participated in the Learning Community activities throughout the week; provided ideas, feedback and questions in the "discussions" focused primarily on preparing personal responses. References to classmates are sometimes stated to show the interaction	Limited participation in the Learning Community activities throughout the week; provided few ideas, feedback and questions in extending the "discussions." Not active in the group discussion. No references to classmates.

Performance Assessment	20	10	0
Assessment and scoring rubric	Assessment and scoring rubric provide clear details	Assessment and scoring rubric are included with limited details	Assessment and scoring rubric not submitted in the weekly assignment.

Total possible: 50

Feedback: