

New Technologies, New Horizons: Graduate Student Views on Creating Their Technological Pedagogical Content Knowledge (TPACK)

Hiller A. Spires

Meixun Zheng

Manning Pruden

North Carolina State University

USA

ABSTRACT

The purpose of this chapter is to present graduate students' views of their Technological Pedagogical Content Knowledge (TPACK) development. These graduate students are also teachers. Data was collected using a mixed method approach founded on the TPACK Framework and social network analysis. Koehler and Mishra (2006) claim that effective teaching with technology requires TPACK, or an ability to integrate content, pedagogy and technology flexibly during the act of teaching. As part of a graduate course on new literacies and media, participants were required to design and implement lessons that incorporated a range of technologies, produce written reflections about their experiences, and engage in online interactions with participants in the class. Qualitative results from participants' written reflections revealed four themes relative to TPACK. Additionally, a social network analysis demonstrated a positive relationship between participants' views on their TPACK development and their interaction patterns within the online learning environment. This study shows that the TPACK framework can be a useful tool, giving educators a productive way to think about technology integration as they navigate the rapid changes prompted by emerging technologies.

INTRODUCTION

The Internet is undoubtedly the most important technology of this generation. In an era where it is possible to "facebook" and "skype" friends as well as "google" just about any topic imaginable, the Internet offers both challenges and profound promise for education. There is an increasing trend in Internet usage, particularly among children and adolescents. In fact, in the United States the National Center for Educational Statistics (2009) reports that instructional classrooms with access to the Internet and web-based learning tools has increased from 51% in 1998 to 94% in 2005. On average 8-18 year olds spend a total of 10 hours and 45 minutes in a typical day using various media forms (e.g., movies, video games, music, audio) (Kaiser Family Foundation, 2010). In most cases out-of-school technology use is outpacing in-school technology use (National School Boards Association, 2007). These statistics suggest

that students are becoming increasingly dependent on the Web as a primary resource for information gathering in and out of school settings (Lawless & Schrader, 2008).

In a recent survey conducted in the US with 4000 middle grade students who were in a North Carolina statewide after-school program (Spires, Lee, Turner & Johnson, 2008), students reported high frequency usage of video and online games, music services as well as email, instant messaging, and cell phone services out of school. The main distinctions that emerged between in and out of school technology use related to the intent of the technology use and the actual devices being used. Outside of school, students were using technologies for communication and entertainment purposes. They also were more likely to use smaller handheld and gaming devices outside of school. Inside school students were using desktop computers for web-based research, word-processing and other productivity purposes. The surveys suggested that students' technology use inside school is often less creative and meaningful than their technology use outside of school. Interestingly, research suggests that while they are frequent users of technology tools, students typically lack information literacy skills and their critical thinking skills are often weak (Oblinger & Oblinger, 2005). Contemporary students may be "digital natives" (Prensky 2007), but they do not necessarily understand how their use of technologies affects their ways of learning.

As technological change transpires at a phenomenal rate, American teachers are under increasing pressure to integrate new technologies into their instruction (National Educational Technology Plan, 2010). It is important for teachers in the United States of America (USA) to use the technologies not only because students expect it, but also because educational systems have to stay abreast of the changes in online research, communication, and social media in order for students to be prepared for 21st century work and citizenship (Trilling, & Fadel, 2009). New teachers entering the field often are more adept at using technologies since they have grown up with them; although new teachers still have the challenge of using technologies in meaningful ways that enhance learning; teachers who have been in the field for some time confront the dual challenge of acquiring a disposition that accommodates ongoing change as well as "re-learning" how to teach using contemporary technologies (Darling-Hammond, 2010).

This chapter presents student voices on learning to use technologies during a graduate education course as part of a "New Literacies & Global Learning" master's degree program at North Carolina State University (2009) in the USA. Students in the course were teachers who were acquiring a master's degree while simultaneously teaching in a K-12 classroom. To frame the learning experiences for the students, the course focused on new literacies (e.g., online search and comprehension skills, use of Web 2.0 tools and participatory media) and the development of technological pedagogical content knowledge (TPACK). Specifically, the objectives of this chapter are twofold: 1) To review the current theoretical and research findings on TPACK and social network analysis; and 2) To present an analysis of how graduate students created their TPACK as they traversed the requirements of a graduate class, which included integrating new technologies in their classrooms, reflecting on their TPACK development, and interacting with their classmates in an online environment. The learning management system, "Moodle," was used to support the online interactions among the students.

THEORETICAL BACKGROUND AND RESEARCH QUESTIONS

Many educators, business leaders and policy makers, are thinking hard about the new knowledge and skills that are required for workplace productivity. Even though it is impossible to predict the future, based on current expectations from the business community, trends are emerging in terms of new employment skills that are required by school leaders. The Partnership for 21st Century Skills (P21) (2005) is one in a series of business-education groups that have targeted core content, skills, and processes that are deemed critical to twenty-first century workplaces. P21's perspective is consistent with

that of many economists and nonprofit organizations that address workforce-capacity issues (Levy & Murnane, 2004; Dede, Korte, Nelson, Valdez, & Ward, 2005). P21 (2005) has identified six key elements for 21st century education (i.e., media, communication, critical thinking, creative problem solving, interpersonal, collaboration). P21 argues that these elements enable young people to develop a wide range of skills while using information and communication technologies (ICT) in real world contexts.

P21 (2005) suggests that technologies play an important role in educational change and much of the proposed change is tied to the tools and resources students use in their everyday lives. As reported earlier, students are becoming increasingly dependent on technologies to communicate, gather information, extend social experiences, and be entertained (Spire, Lee, Turner & Johnson, 2008). As students move into the workplace their interest in technologies transfers with them; however, employers often expect workers to possess even more sophisticated technological skills and know-how and an accompanying disposition receptive to change. In a recent US report, “Rising Above the Gathering Storm” (2007), members of the National Academies of Science projected that scientific and engineering occupations are expected to continue to grow more rapidly than occupations in general with a projected 70 percent greater increase by 2012. Many argue that if the U.S. is to maintain its economic leadership and compete in the new global economy, today's K–12 students must be better prepared and encouraged to enter Science, Technology, Engineering & Mathematics (STEM) careers.

The concern that the scientific and technological emphasis critical to America's economic leadership are eroding at a time when many other nations are gathering strength is widely held. In keeping with this perspective, Levy and Murnane (2004) conclude that the nation's challenge is to prepare youth for the high-wage/high-skilled jobs that are rapidly growing in number—jobs that involve the 21st skills of expert problem solving skills and complex communication. Twenty-first century skills are different than 20th century skills primarily because of the advance of information and communications technologies. Levy and Murnane (2004) have documented an important aspect of what constitutes 21st century understandings and performances:

Declining portions of the labor force are engaged in jobs that consist primarily of routine cognitive work and routine manual labor—the types of tasks that are easiest to program computers to do. Growing proportions of the nation's labor force are engaged in jobs that emphasize expert thinking or complex communication—tasks that computers cannot do. (pp. 53–54)

Dede (2007) astutely argues that proposed skills and knowledge are not robust enough to encompass what is required for the future; but rather understandings and performances will better serve U.S. students' transition into 21st century work and life. Levy and Murnane (2004) suggest that expert thinking and complex communication are essential for contemporary work, since these are the two areas in the workplace that computers cannot replace human beings. Expert problem solving involves effective pattern matching based on detailed knowledge, metacognition, and the set of skills used by the perplexed expert to determine when to end one strategy and try the next. Complex communication involves managing multiple information streams as well as the capability to interpret subtleties and construct convincing rationales. In an economy flooded with new concepts and invented language, communicating complex information effectively is an increasingly valued skill. Complex problem solving, quick and intuitive decision-making ability, and collaboration skills, are the keys to success in the workplace.

The rapid pace of change and the demand for continuous learning makes the “capacity to learn” a highly valued competency as well. One could argue that the bottom line for 21st century life and work is that

learners must be able to 1) forge understandings in ambiguous and complex problem solving landscapes, and 2) collaborate effectively within multiple information and communication streams. If students are to acquire these skills to be successful, then it is imperative that teachers know how to support and develop these skills with their students. The constant access to technology and information creates a “new learning ecology” where teachers’ professional knowledge must make a “pedagogical shift to accommodate learning that is continuous, changing, and above all exponential” (Spires, Wiebe, Young, Hollebrands, & Lee, 2009, p. 10). Two important areas for teacher development is the capacity to deftly integrate technology with academic content and to use social network interactions to support ongoing learning. Following is a discussion of the theoretical background information related to these two areas: “Technological Pedagogical Content Knowledge and Social Network Analysis for online interactions”. These two areas provide a theoretical context for our study.

Technological Pedagogical Content Knowledge (TPACK)

Mishra and Koehler (2006) assert that the successful teacher is one who can draw from content, pedagogy and technology, forming a technological pedagogical content knowledge (TPACK) framework. (See Figure 1). They have extended Shulman’s (1986) time-honored model that highlighted pedagogical content knowledge, which is the knowledge required to teach specifically within different academic content areas. Shulman’s contribution dramatically advanced the understanding of teacher knowledge and how it develops. By building on Shulman’s model, Koehler & Mishra have created a framework that can be useful as teachers and teacher educators navigate the vast changes in teaching and learning that are occurring as a result of the Internet. In essence, Koehler and Mishra claim that effective teaching with technology requires TPACK, or an ability to integrate content, pedagogy and technology flexibly during the act of teaching. They argue that teaching with technology is a “wicked problem” (Rittel & Webber, 1973), with solutions being difficult to realize because of “complex interdependencies among a large number of contextually bound variables” (Mishra & Koehler, 2006, p.9). Central to understanding Mishra & Koehler’s TPACK framework is the capacity to separate the three components (i.e., content, pedagogy, and technology) while at the same time understanding that they co-exist in a dynamic transactional relationship. For example, when a new technology is introduced it forces teachers to “reconstruct the dynamic equilibrium among all three elements” (Mishra & Koehler, 2006, p. 18). Teachers must develop capacities for continually evolving pedagogical skills that must be adapted with each new technological innovation.

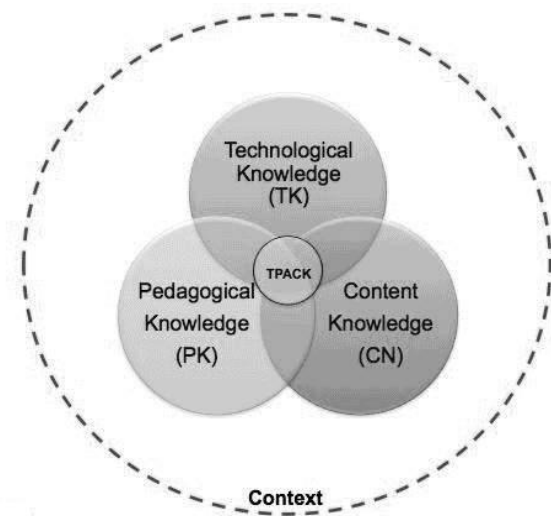


Figure 1. TPACK Model. (Adapted from “Technological pedagogical content knowledge: A framework for teacher knowledge,” by P. Mishra and M. J. Koehler, 2006, Teachers College Record, 108(6), p. 1017-1054. Copyright by the Teachers College, Columbia University. Retrieved June 2008 from <http://punya.educ.msu.edu/research/tpck/>)

Central to closing the gap between in-school and out-of-school student technology use is teachers’ dispositions and usage of technologies to support student engagement with new literacies. Learning how to use technologies is considerably different to knowing how to integrate them seamlessly during instruction, as Mishra & Koehler (2008) assert with their TPACK model. Simply having technologies and content knowledge is inadequate for applying technologies effectively and helping students learn new literacies. In-service teachers want and require their expertise and past experience to be recognized and connected to challenges of the current learning experience so that it will relate to real life issues and problems they face when integrating technologies and new literacies into their classrooms (Hughes and Scharber, 2008). According to Harris (2008), in-service teachers have to know why they are learning new skills and strategies and how they will benefit them.

Based on the TPACK framework, this study examined how graduate students’ online interactions on Moodle contributed to their TPACK development by using social network analysis (SNA).

Social Network Analysis of Online Interactions

Interaction is one of the most defining characteristics in online learning environments (Sing & Khine, 2006; Lamon, M., Reeve, & Scardmalia, 2001; Shen, Nuankhieo, Huang, Amelung, & Laffey., 2008). Social constructivism learning theory suggests that learning is a social and cognitive process mediated by frequent social interaction and discourse (Boudourides, 2003; Foko & Amory, 2008; Hendriks and Maor, 2004; Swan, 2003). In a social constructivist learning environment, effective learning happens through interactive processes of discussion, negotiation, and sharing (Vygotsky, 1978).

The purpose of social network analysis is to provide a description of the interactions among network members as fully as possible and trace how information flows within the network (Knoke & Kuklinski, 1982). One of the most important benefits of social network analysis is that it enables educators to quantify and visualize the interaction patterns of learners, and also to figure out how the social interactions of participants contribute to the new learning of learners. The social network measures used

in this study include *density* of the whole network and *centrality* degrees of individual students. “Density” refers to the extent to which all the nodes (i.e., individual graduate students in the course) in the network are connected with each other. The density of a binary network is defined as the actual total number of connections among nodes, expressed as a proportion of the maximum possible connections. The value of this measure ranges between 0 and 1.00. A higher value indicates a better established community (Scott, 1991). The most common measures of “centrality” include *Freeman’s degree* and *between-ness* (Freeman, 2006). Degree is defined as the number of other nodes (i.e. other people in the class) to which a node (i.e. another person) is connected (Scott, 1991). “Between-ness” measures the extent to which a particular node lies between the various other nodes.

In light of the new literacies that are being prompted by the use of emerging technologies, (Leu, Kinzer, Coiro, & Cammack, 2004; Coiro, Knobel, Lankshear & Leu, 2008) and the growing trends among students demonstrating their increased passion for and reliance on technologies for entertainment and communication (Lenhart & Madden, 2007), the pressure on teachers to successfully integrate technologies into the classrooms is palpable. The TPACK framework offers insights into how the complexities inherent in teaching and learning with technologies can be approached to facilitate teacher growth (Spire, Herve, & Watson, in press). Social network analysis provides a process to analyze patterns of communication and interaction in online environments. These two theoretical areas were used to frame the research study.

RESEARCH METHOD

Through a mixed-method approach (Cresswell & Plano-Clarke, 2006), this research investigated three questions:

- 1) How do graduate students (who are also teachers) perceive their TPACK development?
- 2) What are graduate students’ online interaction patterns within a Moodle environment? And
- 3) How do graduate students’ online interactions contribute to their TPACK development?

Participants

Participants included 29 students who were enrolled in the graduate course, *New Literacies and Media*, which used an inquiry project-based learning approach to integrating technologies. The participants in this study were graduate students and also classroom teachers. There were 3 males and 26 females; one African American and 28 Caucasian. Additionally, 58% of the graduate students reported having 5 years or less teaching experience; 37% of the graduate students had between six and fifteen years of teaching experience; and 5% of the graduate students had over 15 years of teaching experience. They taught in a combination of elementary, middle and high schools; content areas included English/Language Arts, Reading, Math, Social Studies, Science, and Technology.

Graduate Course Requirements

The graduate students in this study were required to create an inquiry learning project (ILP) in which they integrated technology into a content lesson and implemented the lesson in their classroom. Additionally, they reflected on their understandings of the TPACK framework, and the successes and challenges they faced as they implemented technologies into their classroom activities; and they interacted with their classmates within a Moodle online learning environment.

Data Sources and Analysis Procedures

Using a mixed method research design (Creswell & Plano-Clark, 2006), data for the study was collected from two sources: 1) Graduate students' written reflections from the Moodle forums; and 2) Graduate students' online interaction patterns determined by a social network analysis. The mixed method allowed for causal inferences to be made through quantitative data as well as complementary qualitative data (Creswell & Plano-Clark, 2006), that provided rich descriptions of the participants' reflections on their TPACK development.

Graduate Students' Written Reflections from the Moodle Forums

Data analysis focused on graduate students' responses to open-ended questions posed in weekly online forums throughout the semester. Two researchers independently read the forum responses and targeted initial topics based on the frequency with which participants mentioned certain topics. The initial topics were collapsed by similarities and the data were reread and recoded. During the second reading, a small number of new topics emerged and were coded in a third data reading session. The researchers then clustered the coded data into themes and made decisions about which themes to include in the study, based on relevance to the research question and number of responses aligned with a particular theme. The initial 7 codes evolved into 4 interpretive themes.

Graduate Students' Online Interaction Patterns Determined Through Social Network Analysis

The graduate students' online interactions were analyzed drawing on the online course log files and activity reports, and by using social network analysis (Scott, 1991). Analysis of the course log files and activity reports focused on the pattern and frequency of interaction in terms of sending and receiving comments and responses. The frequencies of interactions were counted and the results were recorded in a case-by-case matrix (i.e., the frequencies of interactions were represented for each student). For the purpose of this study, the matrix was dichotomized. Dichotomization in this context refers to the presence or absence of interactions, which is represented by 1 or 0 in the appropriate cells. Based on the new dichotomized data, the density of the whole network was measured using social network analysis software Ucinet 6.0. A directed matrix was used to specify who sent out and who received comments. To give a comprehensive understanding of the interaction patterns and frequency, the results were also visualized using NetDraw 2.0.

RESEARCH RESULTS

Qualitative results from the graduate students' written reflections and quantitative results from the social network analysis are reported separately by research question within the results section. Additionally, we demonstrated a relationship between graduate students' written reflections of their TPACK development and their interaction patterns within the online Moodle environment.

Results from Graduate Students' Written Reflections

Graduate students' online reflections were analyzed to address the research question: How do graduate students perceive their learning with technologies, and specifically their TPACK development? As mentioned earlier, 7 codes and 4 interpretive themes emerged from the online reflection data. The 4 interpretive themes were:

- 1) Newly Acquired Knowledge;
- 2) Newly Acquired Confidence;
- 3) Navigating Technology Problems; and
- 4) Motivated and Excited by Student Responses to Technologies.

Newly Acquired Knowledge: "It's not the technology that matters--it's how it is used."

Since technology tools are evolving at such a rapid pace, teachers are searching for ways to think productively about how to integrate technologies in meaningful ways. Graduate students in this study were no exception. Throughout the course as they reflected in the Moodle forum, the graduate students were encouraged about their new found knowledge regarding the TPACK framework; specifically they were relieved to have a way to think about technologies in reference to their content and pedagogy—two areas with which they already felt comfortable. See Table 1 for a sample description of how the graduate students applied TPACK by making choices about technologies, pedagogies, and content as they created their lessons.

Several graduate students expressed their new understandings by contrasting the educational value of the technologies versus the “fun factor.” One graduate student expressed it this way:

The TPACK model is a great tool for teachers when integrating technology. It's not enough to decide to use technology in the classroom. I fear I have too often used a tool just to use it, rather than examine whether or not the tool will engage my students in their learning or get in the way of their learning. I have to be sure that students are engaged in learning and not just having fun with a new technology.

Another graduate student expressed that before she understood the TPACK framework application, she often used technologies in a superficial way:

In the past, I fear some of the projects I've given students were designed to be more of a fun or creative project with a brief nod towards the Standard Course of Study. Also, I have often chosen the technology tool because it was new, innovative and/or fun; unfortunately, the tool wasn't always appropriate to the content or skill I was teaching and I tried too hard to make it fit.

Still other graduate students were aware of the power of the technology tools when used appropriately to help school students be innovative with their thinking: “If the knowledge that [school] students acquire by creating a Glogster project or a ToonDoo artifact can help them express their ideas more thoroughly and more innovatively, then integrating the technology was truly worthwhile.” One graduate student claimed, “I think the concept of TPACK is revolutionary. It provides a concrete guideline for educators to obtain accountability for their teaching practices and methods to promote student learning.” Another graduate student succinctly illustrated how her TPACK knowledge evolved over the course of the class:

In the beginning of the class as I was introduced to the complexities of social networking, gaming, and cool tools (e.g., Tux paint, Animoto, Trailfire, and Toondoo) I felt excited, overwhelmed, and perplexed. Initially I wondered how these tools could be purposeful in the classroom; as a result of applying the TPACK framework and actually using the tools with my content, I get it now.

Most TPACK theorists agree that using the TPACK framework to frame the development of graduate students' knowledge does not require a rigid adherence to one approach to technology integration (Harris, Mishra, & Koehler, 2009). Rather the development as well as the demonstration of graduate students' TPACK knowledge requires flexibility and fluency. During the course, graduate students began to develop some flexibility and fluency as they applied the TPACK framework to their instructional lessons.

Table 1. Sample description of how graduate students applied TPACK by making choices about technology, pedagogy, and content as they designed lessons.

Technology Tool	Content	Pedagogy	Graduate Student Reflections
iMovie	Story Retelling-- <i>The Three Little Pigs</i> by Jeanette Sanderson	The teacher had students create three pictures depicting the story sequence. Students then shared their three pictures and provided an oral retelling, which was recorded using iMovie. The movies served as inspiration to write their own version of <i>The Three Little Pigs</i> , which served as the script for a puppet show.	“As graduate students, we saw first-hand the increased level of engagement from students when technology is incorporated into a lesson because of every student’s desire to record their retelling. Students are eager to create another story.”
Wordle	Writing-- Word Choice & Frequency	The teacher demonstrated how to copy and paste a story into Wordle; students then pasted their written story in Wordle. Students reviewed all the words highlighted which represented their descriptive word choice frequency of word usage.	“We were actually surprised at how excited the students got about picking out their describing words in the Wordle. They were visually excited about the Wordle, but were also excited because it was individualized and something they had never worked with.
VoiceThread	Unit on Central Africa	The teacher had students create a culminating project using VoiceThread. The project incorporated all they learned about the people of Central Africa. The VoiceTread allowed for the students to thoughtfully organize and represent the content learned.	“I saw firsthand how the middle school students came more alive and involved with their classmates and with the content itself. They were able to carry on a lengthy discussion of different issues that involve the lives of Central Africans, such as war, plague, famine, and drought.”
Glogster	Reading-- <i>The Gift of the Magi</i> by O. Henry	The teacher instructed students to create a Glog for O. Henry’s <i>The Gift of the Magi</i> that represented their literary analysis of the story. The Glog contained five quotes from the story, five images, three literary terms found in the story (i.e., irony, imagery, metaphor), and a sentence suggesting the theme of the story. Students’ final product was uploaded to the class webpage.	“Even the hesitant students who were initially frustrated eventually completed the assignment. The activity was much more engaging than using markers and paper; it likewise allowed the students a chance to practice their online literacy skills.”

Toondoo	Reading-- Fictional Text	The teacher used Toondoo to enhance students' ability to understand character analysis. The students focused on the following aspects of the characters in the story: appearance, actions, personality, and interaction with other characters.	"Students gained deeper understanding of the characters in the story than if they had only read the book."
Technology Tool Reference iMovie: http://www.apple.com/ilife/imovie/ Wordle: http://www.wordle.net/ Voice Tread: http://voicethread.com/ Glogster: http://www.glogster.com/ Toondoo: http://www.toondoo.com/			

Newly Acquired Instructional Confidence: "My fear level has diminished greatly!"

Coding results of graduate students' reflections showed that as a result of participating in the course, they had a new attitude towards the "technology" element in the TPACK framework. They no longer had a skeptical attitude towards the values and importance of technology integration. One graduate student revealed her change in attitude by sharing, "I am hesitant to use technology because I am nervous it will not be meaningful. But I am now willing to take the risk until I get it right." Another graduate student added,

I was very skeptical about technology's place in the classroom. Now I can see how it can be used effectively in the classroom. Technology tools are great because they are fun for students and they get students engaged in learning. They also provide students with experience and practice in new literacy skills.

This change in graduate students' perceived value of instructional technologies in turn led to the shift in how they now recognized that technologies should not be extra, which was evident in several graduate students' forum posts. One graduate student stated, "Integrating technology into curriculum is not a choice any more. It is requirement." Another graduate student highlighted her change of attitude when she explained,

Initially, I viewed the use of technology as a separate entity within the confines of the classroom. After reading Daniel Pink's 'A Whole New Mind,' I understand that the integration and exposure to different mediums of technology is the key to participating in the conceptual age. The necessity of integrating technology in the classroom is overwhelmingly vital for teaching students how to be global learners.

Obviously, graduate students have come to understand that they cannot "use technology for the sake of using it". Instead, they realized that technologies in the classroom must be integrated in such a way that the students are the ones that are taking the lead, as stated in one of the teacher's final paper.

In addition to the graduate students' shift in their perceived values of technologies and the urgent demand for them to integrate technology as an integral part of teaching, most of the graduate students in this study also acknowledged that their confidence level in applying new technologies to further student learning

had greatly increased due to their TPACK development throughout the semester. One graduate student stated,

At the beginning of this class, I was overwhelmed. However, I feel I have grown so much in my confidence. I now feel confident in discussing these new media literacies with my students and learning from their experiences to drive future instruction.

Another graduate student used an analogy to express her TPACK:

Like a puzzle, I need to figure out the perfect placement of each piece of TPACK to make it work together. On numerous occasions I have tried but have not found the correct placement. Now I feel my puzzle is starting to come together. I feel much more confident combining the various components of the TPACK analogy and using them in unison.

Another graduate student voiced an increased confidence level in technologies integration. In her initial TPACK reflection she stated that she “felt a little ‘in the dark’ and overwhelmed.” At the end of the course, she stated, “I don’t feel as overwhelmed because I now have more experience and know that I can integrate technology successfully!”

Developing constructive attitudes and fostering a sense of responsibility is vital for graduate students to successfully use technologies in their classrooms and to face the challenges in the new educational era. It was evident from the data analysis that the different course activities and the scaffolding they received fostered a new attitude about TPACK.

Navigating Technology Problems: “Technology can be very frustrating but that doesn’t mean we shouldn’t use it!”

Many educators are aware of the problems facing the integration of technologies in the classroom. Several of the graduate students in this study voiced the challenges and difficulties that have prevented or hindered their use of technologies in the classroom. As one graduate student stated, “Time constraints, too few resources, and limitations and restrictions made integrating technology frustrating.” The coding results represented that indeed time, too few resources, and restrictions are the three problems faced most often when integrating technologies in the classroom.

Time restraints were identified the most frequently within the coding. As one graduate student revealed, “Time seems to be my major limiting factor; time to explore the tools, time to create meaningful activities and the time to teach my students.” Another teacher added,

I often feel that I simply do not have enough time to really dig into technology integration to do it justice. Technology changes and morphs so quickly, I hardly feel that I can keep up with learning the content, let alone integration of new concepts using technologies in meaningful ways.

There are only so many hours within a school day and time spent incorporating technologies is often the first to be set aside. Since using technologies does initially take time to integrate within the classroom, many graduate students (prior to their TPACK development) voiced that it was easier to just give up. However, throughout their TPACK development they discovered the importance of incorporating technologies into classroom activities. One graduate student stated, “I saw how incorporating technology with content and pedagogy really does make the material more accessible and gives students an added

educational benefit/advantage.” This is an example of how time sowed in the beginning produces time in the long run.

The lack of resources was the second problem identified by graduate students throughout the coding. The U.S. economy and school budgets are often unable to financially provide classrooms with the latest technologies. One graduate student revealed, “I know when I have taught before technology was not always available. We had a computer lab once a week.” The technological lag in many ways is the main contributor to the educational-technological gap. This gap was a source for frustration for many of the graduate students and was often another cause for the graduate students to abandon technologies integration into teaching and learning. One graduate student stated, “There are numerous issues that may hinder one from being at the center of the TPACK model. Stressful assessments, low budgets, and limited technological resources can account for the many educators who lag behind the TPACK journey.” Once technologies became a content commitment rather than a classroom commodity, graduate students’ perceptions changed even in the face of little resources. One graduate student voiced her new attitude towards technologies integration after her TPACK development:

I love the idea about technology being a ‘wicked problem’ and that there aren’t quick easy answers that will work for everyone; that teachers will need to look at their specific circumstances and creatively work towards a solution that will probably not ever be completely resolved. I love the idea that it’s a constant work in progress, much like a piece of art.

The third problem graduate students addressed was the restrictions often placed on technologies within the classroom. Bans and blocked sites as well as government restrictions present an ongoing problem for technologies use in the classroom. One graduate student stated, “I have always been intimidated by trying to get all my students to use technology before because there is typically some type of complication that arises in the midst of it.” Restrictions often times are created to protect students from inappropriate content and technological predators. In keeping a school safe however, a large technological gap is the price teachers often pay. One graduate student voiced her TPACK discoveries with regard to restrictions and limitations as follows:

TPACK forced me out of my comfort zone. Working with technology can be tricky and frustrating! I learned that I like to take risks with technology and that it feels good to know I’m providing my students with cool tools they can use in other curricula as well.

Another graduate student added,

My attitude has changed in that I am less weary of trying new things with my students. I am less intimidated by the idea of classroom instruction on the Internet. When used appropriately, student engagement, increased comprehension and mastery of new literacies can occur. Most importantly, I’ve learned that if I expect my students to be open and malleable, I too must be willing to take chances.

These chances are not taken at the expense of student safety but as a way to teach school students how to become critical consumers of multimedia text.

Motivated and Excited by School Students Responses to Technologies: “I was thrilled to see my students so engaged.”

Motivation and excitement are two components that are necessary for technologies integration into classroom activities, to overcome the many challenges and become a fixed facet of instructional curriculum. The motivation to bridge the technological gap in classrooms must begin internally with the teacher. We cannot wait for technologies to become a curriculum requirement in order for teachers to incorporate them. The integration must start with the teacher. The graduate students throughout their TPACK development became increasingly more motivated to include technologies in their teaching and learning activities, in spite of the constant challenges. It was clear that many graduate students' perspectives were changed and they become motivated to incorporate technologies in their own classes. As one student stated,

I want to incorporate technology today that will help my students prepare for their futures tomorrow, whether that is through demonstrating lifelong learning as I attempt to use new technology tools, through teaching them how to read critically online, or through using technology in ways that match how they will need to use it in the workplace.

Integrating technologies during the course provided a chance for the graduate students to have many questions answered, experience camaraderie, and to see the big picture of technologies integration. These combined with a pedagogical foundation and content knowledge helped to dispel fears and produce motivation. One graduate student expressed her new perspective by saying, "My students will be facing a world which does not exist at the moment and it is up to me and other teachers to prepare them for that world." These graduate students' motivation was not influenced by the "cool factor" of technologies, but rather by their responsibility to students.

The graduate students' motivation was also fueled by student responses to technologies integration. Many graduate students claimed to see an increase in their students' productivity, interest in the content, and ownership of their work. However, the graduate students began to see how bridging school students' out-of-school literacies with the curriculum, enhanced rather than decreased learning productivity. Many graduate students echoed this graduate student's statement that "Students realize the importance of technology and their world is beginning to revolve around it more and more." As the graduate students began to incorporate technologies into their own classroom, their students began to respond in very similar ways as revealed in the following graduate student's statement:

I observed how beneficial it was toward my students' learning. The inclusion of VoiceThread was important for developing higher level thinking skills in my students. This Web 2.0 tool seemed to engage my students better than the textbook has in the past, and they really enjoyed listening to the story being read to them, as well as being able to comment on different questions.

Another graduate student stated, "I learned that my students have NO FEAR when it comes to technology. They greet each new resource with cheers and excitement. The newer the technology is, the higher the excitement. I need to be this way!" Many graduate students also agreed that they must welcome their new educational challenges with excitement; they had seen how responsive their own students had become from their incorporation of technologies. As one graduate student stated, "The wheels are turning and I am dreaming of a myriad of ways that I can put into practice all that I have learned this semester."

The graduate students' commitment to integrate technologies into their teaching and learning did not stop in their classrooms. Many of the graduate students revealed their desire to pass this learning onto fellow graduate students and other schools. One graduate student stated, "My goal is to influence other teachers

to combine their technological, pedagogical and content knowledge into lessons. I plan to share my lesson ideas, which are formed with the TPACK framework in mind, with my fellow educators". Throughout the study of these graduate students' TPACK development, the coding revealed that TPACK was the catalyst for their new motivation and excitement for technologies in school classrooms. Their own students' responses were the final nudge forward into the exploration of digital technologies and the sharing of knowledge with their learning and teaching communities. The goal stated by this graduate student sums up the desired result of a TPACK development:

I am not going to be just the cool technology teacher who lets the students do fun things. I am going to be the cool technology teacher that knows her stuff, meets the content needs of the classroom teachers, engages her students in fun, yet meaningful ways, and prepares each student who leaves her classroom to meet the ever demanding global needs of the 21st century.

Results of Social Network Analysis of Students' Online Interaction Patterns

The graduate students' online interactions were analyzed to address the research question: How does online interaction contribute to graduate students' TPACK development? In order to answer this question, a social network analysis on the graduate students' interactions within Moodle was conducted. Data for the analysis was acquired from computer log files and activity reports that are part of the Moodle course management system.

According to the requirement of the course, each graduate student was required to respond to at least one other graduate student's original posts in each forum. The frequency of the interactions was recorded in a matrix. It is important to note that, for the density measure in this study, the matrix was dichotomized (cutoff value=0) using the social network software Ucinet 6.0. The results of the social network analysis indicated that the online learning community had a density level of 0.3842, which, based on previous research, is considered high (Lipponen, Rahikainen, Lallimo, & Hakkarainen, 2003).

In order to give a clearer picture of the entire network, the interaction pattern was visualized using social network software Netdraw 2.0 (see Figure 2). The dark lines indicate reciprocal interactions, which mean that the targeted pair of graduate students commented on each other's posts. The light gray lines indicate unidirectional interactions among all of the graduate students, with the arrows indicating the direction of interaction. From Figure 2, we observed that "Robin", "Jasmine", and "Jenny" were in a more central position of the network. This position of centrality indicates that these 3 graduate students were the most active participants in the social network; specifically, they had a greater number of reciprocal as well as unidirectional interactions within the online community.

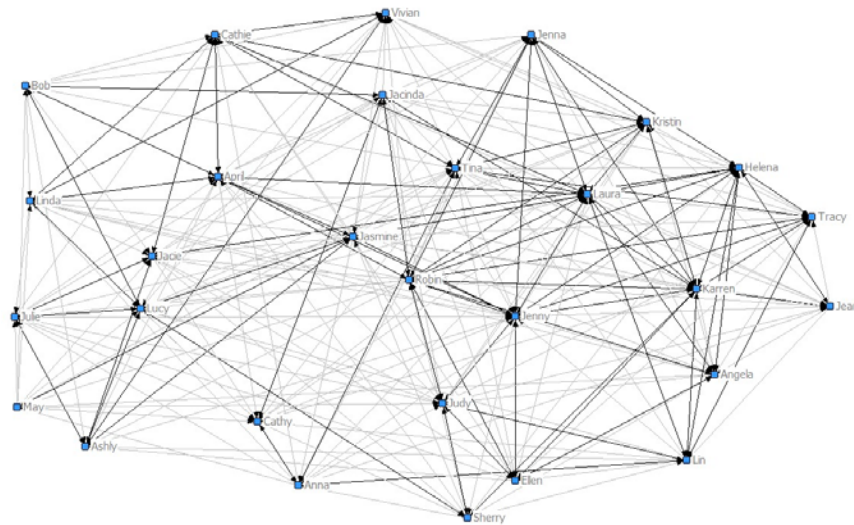


Figure 2. Visualization of students' interactions

Relationship between TPACK Development and Online Interaction Patterns

It is evident from the social network analysis data that the graduate students were able to form a cohesive online learning community through interactions with each other within the Moodle environment. This online network and connection in turn contributed to the students' TPACK development. These findings were also supported by our coding results of graduate students' online reflections. One graduate student stated in her final paper, "I have been able to network and seek help from fellow graduate students. I benefited extensively from the collaborative, idea-sharing atmosphere." Another graduate student added, "This course really became more of a congenial community where we shared our knowledge and helped each other learn." Yet another graduate student went further by saying,

At the beginning of this class, I felt a bit intimidated by incorporating technology into my lessons; I knew I would need support and guidance through the process. However, I feel I have grown so much in my confidence. I have also been given much to consider through the readings and the online discussion forums.

It became evident that the graduate students benefited from the scaffolding they received from their classmates in the online community.

One of the reasons some graduate students were more active in the online community than others, may have been due to their level of comfort with technologies in general. For example, the graduate students who reported higher levels of technologies experience at the beginning of the course were also the graduate students who were more active in the online discussions. "Robin", for instance, was in the most central position of the network, was a graduate student in the instructional technologies program as well as a teacher, who had much experience with technologies. He also stated in one of his written reflections in reference to his TPACK, that he was "the calm in the midst of the storm" when it came to technologies integration. In an online learning community, like in a face-to-face learning environment, more experienced participants tend to help less experienced participants make new meaning, create new knowledge, and develop professional skills during frequent online discourse. This type of distributed

expertise among class members is essential in order for everyone to receive the necessary scaffolding for skill development.

Several other graduate students held a more central position in the network based on their prior experience with technologies. Based on the research data, however, all graduate students regardless of their initial level of technologies experience participated actively in the online environments. Their participation went well beyond the course requirement of at least one response to a classmate for each forum. It can be concluded then, that graduate students with different initial technologies integration levels were able to fully participate in online interaction and discussion by actively sharing ideas, information and experience, and negotiating their views of learning with technologies, and specifically, the TPACK framework. Based on Vygotsky's (1978) view that learning is a social phenomenon, such frequent social interactions can also serve as scaffolding of students' new TPACK knowledge construction.

FUTURE RESEARCH DIRECTIONS

There are several directions that future research could address. Firstly, this study was based on a single semester-long online graduate course. Further research that has a longer study timeframe and larger sample size would be helpful for a deeper understanding of how graduate students use the TPACK framework to evolve their practices with technologies integration. Secondly, it is important to note that the social networking analysis addressed online interaction patterns of the participants but it did not address the quality of those interactions. Future research could focus on providing a content analysis of graduate student responses to assess levels of quality, including construction of new knowledge. Thirdly, research could also be undertaken to assess students' performance and learning outcomes in an online environment, compared with students' in a face-to-face or hybrid learning environments. Fourthly, studies focusing on the impact of the online facilitator as well as other contextual and student factors could also significantly contribute to the body of knowledge in the field of online teaching and learning. Clearly, there is much research to be conducted in this area so that we can have a clearer picture of communication patterns as the learning that takes place online.

CONCLUSION

The theoretical and practical implications of this study contribute to our understanding of the value of TPACK and the value of student voices to help shape the future educational landscape. It is important for graduate students to articulate the types of learning and "meaning making" that they experience with technologies. Ultimately, teachers will always face challenges in engaging students with content through technologies. Using TPACK as a framework to help guide thinking and instructional choices appears to be a powerful tool for teachers and students. Throughout their TPACK development the graduate students within the class began to see that many of the challenges as opportunities to grow as an educator and as an individual. As one graduate student stated, "Only by blending time-honored practices and strategically and reflectively incorporating technology can my students reach new horizons and learn what they need for future success." The goal is for teachers to be lifelong learners and to adapt to changes so they can support their students to be engaged, 21st century learners who will grow up to be globally engaged citizens and workers.

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KEY TERMS & DEFINITIONS

TPACK: Technological Pedagogical Content Knowledge (TPACK). Koehler and Mishra (2006) claim that effective teaching with technology requires TPACK, or an ability to integrate content, pedagogy and technology flexibly during the act of teaching

PCK: Pedagogical Content Knowledge (PCK). Shulman (1986) highlighted pedagogical content knowledge, which is the knowledge required to teach specifically within different academic content areas. Shulman's contribution dramatically advanced the understanding of teacher knowledge and how it develops.

New Literacies: New literacies emerge from the theoretical and practical intersection of literacy, evolving technologies, and media. The New Literacies Collaborative (NLC) is a multidisciplinary team of scholars and educators who promote teaching, learning, research, professional development, and global connections around new literacies (see newlit.org).

Inquiry Learning Project (ILP): A graduate level assignment in which students posed an inquiry question related to integrating technology into their content area.

Social Network Analysis: Social network analysis focuses on the patterns of interactions among individuals in the network. Common measures in social network analysis include density, centralization and centrality degree.

Density: In social network analysis, the density of a network is defined as the actual total number of ties among nodes, expressed as a proportion of the maximum possible ties.

Dichotomized Matrix: In social network analysis it refers to the presence or absence of interactions, which is represented by 1 or 0 in the appropriate cells of the network.

Mixed Methods: Use of both qualitative and quantitative methods to study educational phenomena. The two methods may be used simultaneously or at different stages of the same study.