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Where Technology and Science Collide: A Co-Teaching Experience Between Middle Grades Science Methods and Instructional Technology Faculty

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The purpose of this research was to investigate the viability of partnerships between instructional technology and teacher education faculty in order to promote technology integration in science methods courses. This study also focused on pre-service teachers' evolving perception of technology integration through participation in targeted technology integration workshops, led by area classroom teachers, school librarians and teacher education faculty. This mixed methods case study was conducted in a middle grades science methods course over three semesters at a large university located in the south-eastern region of the United States. Results of quantitative and qualitative data indicate that co-teaching and technology integration activities should be implemented at a high frequency if preservice teachers' perceptions and understandings are to be significantly impacted. Data also suggests that the technology integration workshop is a promising alternative structure for preservice teacher technology integration when co-teaching is not a viable option.

The explosion in technological advancement has profoundly changed how teacher education programs prepare future teachers to integrate technologies present and predicted (Wetzel, Foulger & Williams, 2008). Polly, Mims, Shepherd and Inan (2010) define technology integration "as instances in which teachers and/or learners use technology as a tool to support the learning process" (p. 863). Although there is no method identified as the best approach for helping preservice teachers develop the ability to effectively integrate technology in instruction, it has been suggested that " integration efforts should be creatively designed or structured for particular subject matter ideas in specific classroom contexts" (Mishra & Koehler, 2009, p. 3). In other words, technology integration should be explored within the context of the subject teachers are teaching. Even so, the only technology-rich curriculum traditionally available to many preservice teachers is a one-semester course (Friedman & Kajder, 2006). This was certainly the case at our institution, a large, southeastern university and its college of education where the fully-online, one-semester technology course was hosted by the instructional technology program. As is typical with this type of course, the technology tools were addressed separately from academic content and pedagogical concerns. However, several events during the spring 2010 semester triggered discussion between instructional technology and teacher education faculty over the need to model technology integration to preservice teachers enrolled in methods courses.

First, the college of education purchased Apple iPads for its faculty members, as well as two classroom sets for use in education courses. Second, the instructional technology faculty designed and delivered trainings on the use of mobile technologies to the remainder of education faculty - a setting which encouraged technology integrated activities in pre-service teacher courses. Finally, degree plan redesigns eliminated the technology course requirement from early childhood and elementary programs. As a result of these events and the discussions they generated, two instructional technology faculty and two middle grades teacher education faculty decided to work together in order to support technology integration in the middle grades science methods course.

LITERATURE REVIEW

Recent literature reflects a trend in schools and colleges of education which now choose to emphasize technology integration versus independent technology skill development (Koh & Divaharan, 2011). Studies exploring temporary partnerships between instructional technology and content methods describe units and activities targeting specific technology use within disciplines (Niess, 2007). Koh and Divaharan (2011) found that a combined focus on technological-pedagogical knowledge and pedagogical-content knowledge through technology training on interactive whiteboards within a content methods course helped preservice teachers make stronger connections between technology use and pedagogical choices. In a mathematics content methods course, preservice teachers developed and tested technology integrated math lessons using graphing calculators. Findings from this study indicated that participants moved from a perception of technology as a tool for reinforcement to a tool for development of student mathematical conceptualization (Özgün-Koca, Meager & Edwards, 2010). An analysis of grant-supported technology integration program efforts concluded that preservice teachers who observed and integrated technology during field experience and student teaching were more likely to have positive attitudes toward technology and integrate it more frequently in order to support student learning (Polly et al, 2010).

Many of the efforts behind these approaches to technology integration stem from a growing interest in preservice teacher development of TPACK: technological, pedagogical content knowledge (Pierson, 2001; Koehler & Mishra, 2009; Wetzel et. al, 2008). TPACK is a framework based on the premise that teaching expertise reflects a mental flexibility and recall of different knowledge systems which allow teachers to retrieve techniques to apply to new technology integration situations (Ertmer, Conklin & Lewandowski, 2003; Koehler & Mishra, 2009). This framework, an extension of Shulman's (1986) pedagogical content knowledge (PCK) framework, proposes three separate knowledge systems: a) technological knowledge (TK), b) pedagogical knowledge (PK) and c) content knowledge (CK). The systems intersect to form four constructs: a) pedagogical content knowledge (PCK), b) technological content knowledge (TCK), c) technological pedagogical knowledge (TPK), and d) technological pedagogical content knowledge (TPCK). It has been suggested that TCK, the knowledge of how technology can enhance and support student mastery of academic content, is particularly important for preservice teachers because this construct "supports the decision-making processes and skills necessary to choose appropriate technologies to support content learning" (Young, Young & Shaker, 2012, p. 26).

Even so, technological knowledge; knowledge of which technology tools are available and how to use these tools, is required before a preservice teacher can develop other TPACK constructs (Margerum-Leys & Marx, 2002). Literature on technological knowledge has also reported that preservice teachers are more willing to use technology tools in their teaching when they have developed a higher level of technological skill (Chai, Koh & Tsai, 2010; Hammond et al., 2009). Furthermore, Archambault and Barnett (2010) argue that although the TPACK framework is useful in visualizing areas of knowledge, separating and measuring the development of individual TPACK constructs has been a challenge, whereas only technology skill has emerged as a distinguishable domain.

Building upon this body of research, faculty involved in this present study agreed that the ability to integrate technology in instruction (TCK), and technological knowledge (TK) specifically was the construct of TPACK that we would focus on developing. This development would be addressed by teaching technology integration within a curricular context, using a co-teaching approach. The approach chosen for this partnership would also emphasize the importance of preservice teachers engaging in a community of practice through the building of collaborative relationships with area classroom teachers, school librarians, technology specialists and other education professionals through face-to-face technology integration workshops (Lave & Wenger, 1991; Wenger, 1998). Pajares (1992) found that preservice teachers enter teacher education programs with preconceived notions about teaching and knowledge acquisition. When shaking up the way these preconceived ideas impact technology use, it is strongly recommended that teacher candidates observe practicing teachers integrate technology in the classroom, whether in the field or vicariously through electronic media (Kim & Hannafin, 2008). So as to help preservice teachers develop TPACK, research also recommends that teacher educators provide opportunities for preservice and practicing teachers to interact with and discuss technology usage in the classroom (Moursund & Biefeldt, 1999; Wang, Means & Wedman, 2003). Learning through collaboration and conversation has long been advocated as beneficial, promoting reflection and knowledge transfer through the sharing of experiences (Brown, Collins, & Duguid, 1989).

PURPOSE OF STUDY

The purpose of this research study was to investigate the viability of co-teaching between instructional technology and teacher education faculty in order to promote technology integration in science methods courses. This study also focused on preservice teachers' evolving perceptions of technology integration through participation in technology integration workshops presented by local classroom teachers, school librarians and teacher education faculty. Finally, the study investigated technology integration workshops as an alternative structure for preservice teacher technology integration when co-teaching was no longer a viable option. For this study the following research questions were developed:

1. How did technology-rich activities in a content-methods course impact preservice teachers' definitions of technology integration?
2. What were preservice teachers' perceptions of the collaborative efforts between teacher education and instructional technology faculty?
3. What changes needed to be made to the collaborative partnership structure between teacher education and instructional technology faculty in subsequent semesters?

THEORETICAL FRAMEWORK

The theory of situated cognition was used to frame both the structure and perspective of this study. Situated cognition is defined as "action in which knowledge is developed and deployed" and not "separable from or ancillary to learning and cognition" (Brown et al., 1989, p. 32). Similar to Dewey's thoughts on learning in context, situated cognition involves an action, which is needed to attain and utilize knowledge. Learners must be immersed in rich contexts that combine what they are learning with real life situations (Lave & Wenger, 1991; Collins, 1988). These rich contexts allow for learners to act on their newly-gained knowledge and apply these behaviors in future environments (Schell & Black, 1997). According to Collins (1988), there are four benefits of situated cognition: 1) students learn ways they can apply their knowledge; 2) students learning in new and varied settings are more inclined to problem solve to find unique solutions; 3) students see how their knowledge impacts their setting; 4) students are encouraged to structure and use their knowledge in context with the goal of future transferability in mind.

In terms of structure, this theoretical framework enabled preservice teachers to be "situated" in the context of the learning environment by providing an authentic space where they could be immersed in the practice of what they were learning (Brown et al., 1989). In terms of perspective, the goal of this study was to move beyond a traditional focus on an individual's cognitive development, and instead explore the structures, components and relationships that contributed to the cognitive development of the group as a whole (Cobb & Bowers, 1999). In other words, this study investigated the structure of co-teaching and technology integration workshops versus the development of an individual's ability to integrate technology in a specific setting. For this study, preservice teachers interacted with a range of technologies to engage in true learning of these tools within the context of middle grades science. They were also asked to think about how to meaningfully integrate these technologies in their future learning environments. Therefore, the theory of situated cognition informed both the structure of this study, and the focus on the structure itself.

METHODOLOGY

This mixed-method, exploratory case study was conducted over three consecutive academic semesters, beginning fall of 2011 and ending in fall of 2012. Initially, the purpose of this study was to investigate the viability of co-teaching between instructional technology and teacher education faculty to promote technology integration in content methods courses. In this initial phase, preservice teachers, co-taught by two teacher education and two instructional technology faculty members were surveyed. Eventually, the study expanded to include the deployment of technology integration workshops offered outside of scheduled class time. An exploratory case study was specifically chosen to accommodate the flexibility of the technology integration program, as well as for its emphasis on collection of rich and detailed descriptive data bound by the length of each semester course (Denzin & Lincoln, 2008).

Description of Methods Course Structure and Study Setting

At our institution, preservice teachers in the middle grades program are required to take methods courses in each of four content areas. These courses are clustered by semester with Methods I (language arts and social studies) preceding Methods II (science and mathematics). Once enrolled in middle grades methods courses, preservice teachers generate lesson plans and are expected to teach lessons that *integrate technology in meaningful and relevant ways.* They are also expected to make *clear connections* between the content of the lesson and the technology. Throughout their coursework, preservice teachers are encouraged to reflect on the use of technology in their instruction and how it has impacted student learning. Teacher education faculty, in this case, methods instructors, strive to exhibit this connection through the use of technology in their own pedagogical strategies. Brown, Collins, and Duguid (1989) argue that by "enculturating" individuals, allowing them to observe and participate in authentic activities of the culture, individuals adopt the cultural practices successfully. Even with this exposure to technology, many preservice teachers continued to struggle with achieving the target level of technology integration in the middle grades setting. Reasons for this struggle, provided during individual conferences, included the lack of technology in assigned classrooms and lack of training in the use of available technology.

Preservice teachers enrolled in Methods II (science and mathematics) are required to complete a field experience under the direction of middle grades teachers in both science and mathematics. Throughout the semester, each individual is assigned to a school in which he or she observes, collaborates with, and learns from a clinical supervisor (classroom teacher). The field experience involves observation visits followed by two weeks of teaching that occur over approximately twelve weeks. During this time, the preservice teacher is in the classroom before students enter the school and he or she remains until noon each day. In preparation for the field experience, each preservice teacher completes an instructional unit in one content area and a series of two or three lesson plans for the second content area. Once completed, instructional units are graded, revised and approved by the content methods professor before being taught. The sequence of required courses in the middle grades degree plan places Methods II in the semester prior to student teaching.

Field experiences are evaluated based on content knowledge, instructional planning, instruction, classroom environment, assessment, and professionalism. A component of instructional planning and classroom instruction is the use of technology or multimedia resources to maximize student learning. Expectations are that technology will be integrated in meaningful and relevant ways that demonstrate clear connections between the content being taught and the technology used. It is important to note that the time frame for observation and completion of the instructional unit is short, hindering the capacity of clinical supervisors to provide instruction specific to the use of technology. Unfortunately, units and lesson plans developed by preservice teachers in the program reflected technology as an area of weakness, with technology functioning primarily as a passive tool for presentations in the form of PowerPoint or as a resource for student research projects.

Preservice teachers' use of instructional technology in the field experience varied depending on the clinical supervisor's own experience and comfort level in technology integration and on the availability of hardware in the classroom. In fact, many preservice teachers expressed frustrations that the clinical supervisor either did not have time to teach them how to use technologies or that the he/she lacked the knowledge necessary to use available technology at its full capacity (e.g., using an interactive whiteboard as a glorified dry erase board).Very rarely did preservice teachers venture beyond the classroom and seek advice from school librarians or technology specialists on any additional available technology.

Study Design

This study comprised three phases. Phase One, conducted at the beginning of the fall 2011 and spring 2012 semesters, began with a pre-assessment survey to determine preservice teachers' current technology skill level, their idea of what it meant to meaningfully integrate technology into a classroom, and their definition of technology integration in a K-12 setting. During Phase Two, conducted at the end of the each of the two previously mentioned semesters, the instructional technology faculty members administered a post-survey, which included all items from the pre-assessment survey and three additional open-ended questions. Phase Three began during the spring 2012 semester and continued through fall of 2012 and covered the delivery of technology integration workshops.

The mixed-method design of this study signifies that much of its approach lives within the tradition of qualitative research. A characteristic of qualitative exploratory research design is its allowance for context-dependent inquiry and inductive data analysis (Guba & Lincoln, 1988). Therefore, in order to preserve contextual accuracy, a description of activities for Phase One and Phase Three will precede the presentation of data collected during those phases. Table 1 outlines the three phases of the study, study activities and the data collected during each phase.

Table 1
Study Phases, Data Collection and Timeline

	Activities/ Data Collected	Participants	Timeline
Phase One	Pre-Assessment Survey In-Class Collaborative Technology Integration Lessons	48 Methods II Middle Grades Preservice Teachers	fall 2011 spring 2012
Phase Two	Post Survey	48 Methods II Middle Grades Preservice Teachers	fall 2011 spring 2012
Phase Three	Technology Integration Workshops Workshop Evaluations	Approximately 100 Methods I, Methods II, Early Childhood, Middle Grades and MAT Preservice Teachers	spring 2012 fall 2012

Participants. During Phases One and Two, forty-eight participants (M=22, F=26) completed a pre-assessment and post-assessment survey. All participants were enrolled in a Bachelor of Science in Education with an emphasis on Middle Grades degree program. This degree eventually leads to a teacher certification for grades 4-8.

Instrument. The pre-survey instrument used was adapted from the E-Tech Ohio Technology for Learning Survey, the Technology in My Life Survey and the TPACK Survey (BETA, 2007; McKenzie, 1999; Schmidt, Barran, Thompson, Koehler, Shin & Mishra, 2009). It contained five demographic questions and twenty-four, self-reported items. The item responses were formatted using a Likert scale (ranging from 1: Strongly Agree to 5: Strongly Disagree). This instrument was administered twice: once in the beginning and once at the end of the fall 2011 and spring 2012 semesters. The instrument consisted of three scales, including Technology Knowledge, TPACK, and Belief in Technology Integration. Questions in the Technological Knowledge category asked about specific technologies the respondent used and the frequency with which these were used. Questions in the TPACK category asked the respondent to rate attitudes and beliefs toward technological pedagogical content knowledge, resources and models. Questions in the Beliefs in Technology Integration section ask that the respondent identify opinions on different technologies, the role of technology in education, and the future of different technologies. Within the Beliefs in Technology Integration scale, four items were deleted (Total items 14-24; items deleted: 16, 17, 20 and 24).

PHASES ONE AND TWO

In-class technology integration lessons

Throughout the fall 2011 and spring 2012 semesters, instructional technology faculty co-developed and co-taught technology lessons with content methods faculty for Methods II preservice teachers. These lessons covered topics such as virtual field trips, online collaboration, mobile applications, Web 2.0 tools, information literacy, academic honesty, technological- pedagogical-content knowledge (TPACK), and lesson planning for technology integration. All of these lessons were presented in the face-to-face methods course and were directly tied to the content being covered at the time. The presentation of these lessons modeled both technology integration in the teaching of science content and collaborative partnerships between science content faculty and instructional technology faculty. The lessons fell into three basic categories: interactive classroom activities, selection of appropriate technologies, and the use of graphing and analysis software. In addition to these lessons, instructional technology faculty served as a mentor to preservice teachers during the development of the final interdisciplinary unit.

Interactive classroom activities. *Phases of the moon* is a concept that is often difficult for K-12 students to understand. Science educators must incorporate experiences that "challenge commonly held misconceptions and require students to critically reflect upon their current constructs" (Stein, Larrabee, & Barman, 2008, p. 9). The use of technology for visualization can help to eliminate misconceptions about scientific phenomena, misconceptions not easily dispelled with typical classroom resources. Instructional technology faculty supplemented a traditional approach by demonstrating how a camera could be used to provide additional visual perspectives on an already hands-on lesson.

First, the science methods faculty instructor led an activity, without technology, where students simulated phases of the moon using tennis balls and a light source. Following this activity, the instructional technology faculty member shared an alternative approach that demonstrated how a headgear webcam connected to a computer could be used to capture the visual perspective of one student who acted as the moon – sharing this perspective with others. The information visually collected by the student could then be transmitted to the rest of the class via a screen projector. The addition of the webcam would enable all participants to be engaged in the scientific exploration of this concept without the need for multiple class supplies or cumbersome apparatus such as moon phase transporters (see Figure 1). In addition, any video data collected could be saved and accessed at a later time by students who might have been absent or needed to revisit the material.

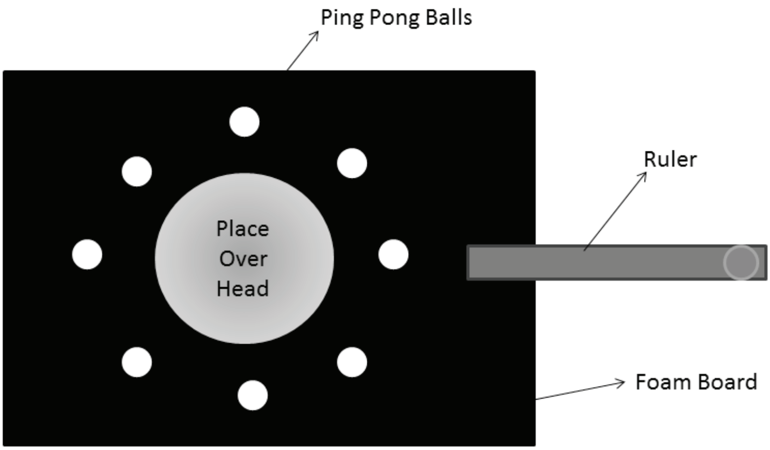

Figure 1. Moon Phase Transporter

Selection of appropriate technologies. An ability to discern between effective and ineffective use of technology is a vital component of lesson development if technology is to be used in meaningful ways (Ertmer, Conklin & Lewandowski, 2003). In order to foster this discernment, instructional technology faculty developed a lesson on the use of Web 2.0 technologies that was co-taught in the science methods course. Preservice teachers were placed into groups and assigned a specific tool Web 2.0 tool to explore. Each group evaluated the functionality of the assigned tool, considering characteristics such as age appropriateness, ease-of-use, foreseeable challenges and ability to demonstrate knowledge construction. Group findings were then presented during a class discussion, with preservice teachers brainstorming possible uses for each tool and solutions for any identified issues. Following a similar format, a group discussion was organized to analyze the accuracy and usability of iPad apps related to various concepts in science. During this activity, preservice teachers were each provided the use of an iPad with preloaded apps. They were directed to compare the content of each app to science content standards for grades 4-8, checking for errors in content and identifying any images or animations that might lead to misconceptions.

Graphing and data analysis. Long-term data collection projects focusing on either hurricanes or general weather data should reflect the ability to present data in a clear and accurate format. While the science content associated with these types of projects was presented by science methods faculty, the selection and use of technologies such as Excel and Create-A-Graph, among others, were presented by instructional technology faculty. This particular co-teaching effort aimed to introduce preservice teachers to the planning required for technology integration. It included an emphasis on providing clear instructions. After dividing into small groups, preservice teachers explored graphing and data analysis software and websites determining the technology skills K-12 students would need in order to use the assigned resource. Subsequently, each group developed a short data collection activity which integrated the assigned technology resource. Afterwards, the teams doubled up forming co-groups, teaching and completing each developed activity, providing feedback on the appropriateness of the selected tool, its role in the activity, clarity of instructions, and the resource's ability to support the scientific concept discussed.

Results of Phase One and Phase Two

Quantitative analysis. The participants' pre and post responses on the scales of Technological Knowledge and Belief and Technology Integration demonstrated statistically significant differences before and after taking the science methods course with improvement in post course completion scores. Internal consistency reliability (Cronbach's alpha) was calculated in each scale as displayed in Table 2 together with means and standard deviations for pre-test and post-test, t-test statistics and effect sizes calculated as Cohen's *d*. The low value (.51) of alpha for the *Belief in Technology Integration* scale may have been a result of a lower number of items present as described in the methodology section.

Table 2
Scale Reliabilities and Scores for Pre-test and Post-test

Scale	Cronbach's Alpha	Pre		Post				
		M	SD	M	SD	*t*	p	*d*
Tech knowledge	.77	18.83	2.76	19.88	2.85	-4.24	.001	0.37
TPACK	.93	32.44	3.68	32.50	4.82	- .11	.92	-
Belief in Tech Int.	.51	23.33	1.97	24.48	1.99	-3.44	.001	0.58

These statistically significant increases and effect sizes (small and moderate for Tech Knowledge and Belief respectively) suggest strong potential for context-embedded technology training for the development of technological skill and understanding of meaningful technology integration. Due to faculty and course schedules, co-teaching numbered a total of five lessons throughout the length of one semester. Each lesson made up one hour of a four hour class session. Therefore, the improvement attained is present despite a relatively small amount of technology training. In contrast, there was no statistical difference found between pre and post tests on the TPACK scale. This is not surprising since the interaction with preservice teachers focused on instructional activities versus fully addressing the complexities of the TPACK model.

Qualitative analysis. Qualitative data analysis for this study was conducted using the constant comparative method for grounded theory research (Glaser & Strauss, 1967). There were three open-ended questions at the end of the post-survey. The first question was: *What does technology integration mean to you? Over the course of the current semester, have your ideas on technology integration changed? Please be as detailed and specific as possible.*

A majority of the responses from students expressed that "technology is very beneficial" and "important." Responses emphasized that the collaboration between teacher education and instructional technology faculty was essential in demonstrating how to integrate technology in the context of the content area: "I have learned how to incorporate technology into what I'm already teaching. It doesn't feel as separate as it used to. In fact, I can't picture myself teaching without technology anymore." A misconception within the data garnered by this question was the idea of technology integration as the tool itself and not how that tool enhanced the curriculum. In meaningful technology integration, computers and technological tools should aid with either accomplishing a task, or as is more common, accomplishing a task better (Harel & Papert, 1991). In this sense, meaningful technology integration goes beyond the tool for the tool's sake. Another misconception was the idea that technology limits student creativity: "I realize that I am *forced* to integrate technology at least some of the time. I still like *being creative* with crayons, paper, clay, and paint more than technology." Also highlighted in this quotation was a sense of the preservice teacher's resistance to technology integration in general. Clear words marking this throughout the transcripts included, "forced" and "pushed."

The second question asked preservice teachers to consider the co-teaching approach itself: *This semester, you have observed a collaborative teach-*

ing partnership between (name of instructional technology faculty member) and (name of content-methods faculty member). If you were to establish a similar partnership in your future teaching, which school personnel (if multiple, please list) would you choose and why? Please be as specific and detailed as possible.

In analyzing responses, the intent to collaborate with other teaching professionals was strongly stated through belief in a school community: "we all teach the same students" and the need to reach diverse groups of students: "I would probably collaborate with a program specialist to reach all and ever [sic] learner in my class and also a technology specialist to impact and positively influence all of those learners to use technology." However, the way preservice teachers envisioned collaboration differed slightly. Some envisioned collaborative efforts with other science and math teachers: "I would have partnerships with other teachers who teach the same subject within my grade level." Others voiced a desire to collaborate with technology specialists: "I would like to be in a partnership with a technology person. I am not the most tech-savvy person." This difference in selection of collaboration partnerships mirrored the faculty teaching structure of different co-teaching activities. While some activities were taught by one faculty member (collaboration occurring when the instructional technology faculty member was present), science methods faculty combined both course sections into one, planning and co-teaching for the duration of the semester. Thus, collaboration occurred with or without the instructional technology faculty's presence.

Additionally, instructional technology faculty had hoped to promote the school librarian as an instructional partner. Unfortunately, the prevailing collaboration structure described by both groups categorized school librarians as technology specialists only. Example 1: "I would attempt to collaborate with the media specialist possibly. Most school systems put in work orders for the technology person to come service whatever device it is and it can take months to have such service." Example 2: "I would want to have a good working relationship with the media specialist. They have access to a lot of materials and could help me if I run into technology problems." Consistent with responses to question one was a teacher-centered view of the benefits of collaboration. An overwhelming majority expressed a desire to collaborate to lessen work-load, help with teaching practice or "spark ideas." Only four participants mentioned the desire for collaboration to "reach all of the students effectively" and to benefit "students who need a little extra help."

The third open-ended question asked: *What, if any, activities this semester have provided effective models of combining content, technologies* *and teaching approaches that you can apply to your future classroom? Please be as specific and detailed as possible.*

The majority of students listed general types of tools and/or specific tools, including, Brain Pop, iPads, Google apps, lesson plan websites, virtual field trips, Prezi, Word Splash, Glogster, Weebly, wikis, and Skype. Students listed mobile apps and tools that they felt they would mostly teach with rather than apps and tools that learners could use to create representations of knowledge. This reflects the teacher-centered versus learner-centered ideas present throughout responses to the first two open-ended questions. The culminating project for methods courses, an interdisciplinary unit, was mentioned throughout the responses, conveying ideas of collaboration across the curriculum and collaboration with others. One preservice teacher felt the "IDU [interdisciplinary unit] presentations are going to be an effective model of combining content, technologies, and teaching approaches." This statement evokes a basic, though introductory grasp of the concept of TPACK (Koehler & Mishra, 2009).

Despite the positive attitude towards technology-use, several participants conveyed a sense of resigned acceptance for tool availability: "iGoogle, lesson plan websites...these are great, but if you are at a school that is limited in resources, then ideas or ways to integrate technology are ineffective." This suggests that participants do not view themselves as capable of affecting change and/or confident in seeking out additional technology resources. Finally, it was emphasized within the responses that students should be introduced to SMART Board technology and be able to experience technology integration techniques in a face-to-face, hands-on format where there was "someone right there to walk me through it" so that they "applied the technology to how we would use [it] in the classroom." Many mentioned that they wanted the technology integration to be applied learning – a strong support for technology integration in content methods coursework.

PHASE THREE

Phase Three- Technology Integration Workshops

Phase Three began during the spring 2012 semester and continued through fall 2012. During fall 2011, faculty scheduling conflicts limited the list of technologies that could be addressed in class. In response, participating faculty arranged for five face-to-face technology integration workshops to be delivered outside of scheduled class time and in addition to in-class activities. Originally, the topics for these workshops were selected based on technologies discussed in the online technology integration course. These included: interactive whiteboards, K-12 online learning, Web 2.0 technologies and web design for e-portfolios. The technology checklist allowed preservice teachers to identify which technologies were available at the schools where they were conducting their field experience. Area classroom teachers and school librarians presented these workshops using real-world examples and activities. Workshop attendance, while voluntary, was encouraged through the award of extra-credit, certificates of completion, and a $20 stipend for the first twenty workshop registrants.

At the end of spring 2012, one of the participating instructional technology faculty members moved to a different state. The loss of this individual, and its impact on scheduling, removed the option of face-to-face co-teaching activities. During this time, the workshops became extremely popular and a decision was made to make these available college-wide. As a result, the remaining faculty members applied and received an internal seed grant to fund eight face-to-face technology integration workshops for the fall 2012 semester. The topics selected for these workshops were based on technologies preservice teachers previously identified as available in their field experience assignments. These included: interactive whiteboards, Edmodo, web 2.0 technologies and mobile applications. Again, workshop attendance was voluntary and encouraged through extra-credit, certificates of completion, and a $20 stipend for the first twenty workshop registrants.

For each workshop, participants were recruited from Methods II for one week. At the end of this limited registration period, participation was made available to all preservice teachers enrolled at the institution, advertised through the College of Education listserv and social media. Workshops were scheduled for an evening block of 2.5 hours and rotated weeknights so as to maximize access for all interested participants. All workshops were delivered in a learning resource center which contained a class set of iPads, interactive whiteboards, computer labs, a fully equipped instructor's station, projector, and wireless internet. Just like the workshops from the previous semester, area classroom teachers and school librarians presented training using real-world examples and activities. All presenters encouraged participants to develop lessons during workshop time, collecting resources and receiving feedback.

Results of Phase Three

At the conclusion of each workshop, participants filled out a nine-question online evaluation form. Evaluations were collected from over 100 participants. All participants were preservice teachers from one of the following degree programs: early childhood, middle grades and Master of Arts in teaching. Respondents were asked how the workshop impacted their ideas on the use of the addressed technology in the K-12 classroom. Responses collected could be placed into three categories: participants gained strategies and ideas for lesson development, participants considered the activities to be engaging and interactive, and participants felt that these workshops helped to improve both their teaching and technology skills.

The majority of participants identified ways in which they gained additional strategies and ideas to use in lesson development. "Amazing workshop!" stated one student, "This was very informative, and I learned things that I know will impact my teaching strategies in the classroom." Participants voiced their belief that strategies presented would help with "differentiation for all students" and could be used with "all the students…even those with IEP." Participants seemed particularly impressed by the wealth of knowledge that area teachers and librarians brought to the workshop experience. They identified these instructors as "very knowledgeable" and "enthusiastic." One participant stated of a middle school science teacher that "His enthusiasm made me want to use [iPad apps] in my classroom!" In conversation, several workshop participants expressed that the workshops were more meaningful when presented by someone who was actively using the technology with middle school students.

Participants liked the "hands on participation" and that they were able to "try out" the technologies as they were presented. One student shared, "It opened my eyes to the different resources available for me. It seems that it will be helpful in maintaining the attention of my young students while relaying the information." Another pointed out that he/she had learned "a great and safe way to engage students through technology." Overall, the participants agreed that the workshops added to their skill set, enhancing both "teaching abilities" and general knowledge of technology in order to "incorporate more technology" in the classroom. Those who described themselves as not being "computer savvy" or having "very little knowledge" about technology expressed that the workshops demonstrated "how easy it is to use these tools in the classroom" and that "you do not have to be an expert."

Participants were also asked to provide feedback that would allow future workshops to be more beneficial. Few suggestions were offered for improvement. However, these comments were taken into consideration during the scheduling and development of subsequent workshops. Several participants suggested that the length of the workshop was too long (2.5 hours), and requested that the workshop "be broken into a few sessions." However, the most common and valuable feedback given dealt with the timing of topics presented. Some topics were found to be more useful early in the semester. While others, such as the interactive whiteboard, were preferred after teaching topics were assigned for the field placements. The initial concern was that students needed to know how to use the board before developing instructional units. However, there were several responses that suggested this workshop come later in the course. One participant stated that, "It was hard to get into the [interactive whiteboard] without having my unit topic." This insight allowed for future workshops to provide technology learning opportunities at times when they were of most value to the preservice teacher.

DISCUSSION AND CONCLUSIONS

This study was conducted in response to the need for technology integration and the construct of TK to be incorporated within the context of subject matter, specifically middle grades science. As the programs, one-by-one, transitioned away from the solo technology course taught in isolation from content, it was imperative that faculty consider options that would more effectively prepare preservice teachers for their first year of teaching. Hofer and Grandgenett (2012) call attention to the expectation that preservice teachers develop a proficiency in technology integration before program completion. Therefore, it is incumbent upon schools and colleges of education to ensure that all programs provide preservice teachers with opportunities to develop these skills.

Through three overlapping phases of implementation, faculty from both instructional technology and science content methods co-taught and co-developed lessons and organized workshops that collectively addressed ways to make clear connections between science content and technology. Phase One and Phase Two focused on co-teaching and preservice teachers' evolving perception of technology integration as they participated in the associated activities. Phase Three expanded on this approach with the addition of technology integration workshops as an alternative structure for promoting preservice teacher technology integration when co-teaching was no longer a viable option. The workshops also enabled classroom teachers and librarians from local schools to share their knowledge and experience of technology integration.

Definitions of Technology Integration

Research on TPACK development has found that before a teacher is able to consider the pedagogical implications of a technology tool, technological knowledge and comfort with the tools themselves must already be in place (Graham, Burgoyne, Cantrell, Smith, St. Clair, & Harris, 2009; Koh & Divaharan, 2011). This study suggests a strong potential for content-embedded technology training for the development of technological skill in preparation for understanding of meaningful technology integration. Responses from preservice teachers affirmed that both the co-teaching model and the workshops provided a hands-on format that enhanced their skill, comfort level and experience with using technology.

However, when asked how the technology-rich activities in a content-methods course impacted their definitions of technology integration, the majority of preservice teachers simply described technology integration as important and beneficial. They were still unable to voice a connection between the technology taught in the methods classes and technology integration in their assigned field experience location. In fact, many still defined technology integration as the basic use of a technology tool rather than addressing the pedagogical choices behind integration for meaningful learning. Some responses actually revealed a sense of frustration, indicating a resistance to technology integration when they felt that it was being forced upon them.

On the other hand, this same disconnect and feeling of resistance was not present in workshop evaluations. Within the workshop settings preservice teachers were much more apt to view technology rich activities as both valid and essential for student learning. This may be because workshop participants viewed teacher and library presenters as authentic members of their community of practice. Wenger (1998) explains: "communities of practice reproduce their membership in the same way that they come about in the first place. They share their competence with new generations through a version of the same process by which they develop" (p. 102). It is possible that preservice teachers who participated in the workshops more easily envisioned themselves as members of a temporary community of practice, learning from other members, in this case, teachers and librarians who could directly address fears, concerns, questions and ideas on technology integration through a real world point of view.

Collaborative Partnerships

Teacher attrition, specifically in the first few years, is oftentimes tied to the isolation and the loneliness that new teachers feel (Allensworth, Ponisciak & Mazzeo, 2009). One of the major goals of the collaborative partnership between instructional technology and teacher education was to demonstrate teacher collaboration through an immersive experience. As suggested by the theoretical framework of this study, "things assumed to be natural categories...require reconceptualization as cultural, social products" (Lave & Wenger, 1991, p.203). Therefore, preservice teachers directly experienced the collaborative structure present in co-teaching situations, encouraging them to re-conceptualize the view of the teacher as an isolated individual; and envision themselves in future collaborative relationships with other educators, specifically school librarians and technology specialists.

While some responses demonstrated an interest in forming these types of partnerships, the motivation was generally teacher-centered with a concept of the school librarian/technology specialist as someone who assists in servicing hardware for the classroom and troubleshooting technology problems. Many of those surveyed expressed interest in the formation of partnerships with other teachers who specialized in the same content area while still others emphasized the need for collaboration to "spark ideas" or to decrease workload. Although instructional technology faculty advocated for school librarians as potential collaboration partners, the qualitative data collected during phases one and two indicated that preservice teachers did not categorize school librarians as having instructional roles. Lance (2010) points out that "far too many people who now work as administrators and teachers never experienced the sort of school library program the profession advocates today" (p. 81). He warns "teacher-librarians are ultimately responsible for whether or not their educator colleagues understand and embrace the role of teacher-librarian" (p. 82).

School librarians who served as workshop presenters were more successful in clearly articulating their roles as instructional partners and co-teachers. Qualitative data collected during phase three clearly indicated preservice teachers' perception of school librarians as master teachers. Similar projects that encourage structured interactions between preservice teachers and school librarians for the purpose of planning for instruction echo the findings of this study. Roux (2008) concluded that exposing preservice teachers to these types of projects led to a clear picture of the school librarian as a valuable partner in student information literacy development.

The Collaborative Partnership Structure

The collaborative partnership between faculty in content methods and instructional technology was modified throughout the project. While changes made to the technology workshops were made due to survey results, unforeseen factors inadvertently reduced the amount of time and flexibility available for instructional technology faculty to continue with the initial co-teaching model. One faculty member left the university, remaining in the project as a mentor/consultant only. The second faculty member continued to assist in the collaboration, but had no release time from her normal duties and responsibilities to address gaps in personnel. Although her time was increasingly limited as the project progressed, she continued to consult with science methods faculty and to facilitate workshops. The quantitative and qualitative data collected during phases one through three strongly suggest that a combination of technology integration within content methods coursework and technology integration workshops led by practitioners holds promise as a strong approach for introducing preservice teachers to TPACK. Faculty schedules and responsibilities may need to be adjusted so that co-teaching across programs becomes a feasible option.

IMPLICATIONS FOR FUTURE RESEARCH

The role of technology integration in teacher education programs is evolving to meet the demands of a new generation of learners, bolstered by an ever increasing wealth of technology resources. When preparing preservice teachers for their first year in the classroom, it is imperative that teacher education programs invest in developing a true understanding of technological resources, not just as tools to use in the classroom, but as pedagogical resources that can enhance meaningful learning. This study focused on the teaching of technology integration within a curricular context allowing students to learn through practice in content methods courses and field experiences. As the study evolved to incorporate workshops on special topics aligned with the methods course, so have the implications of this study. Further research is needed to determine how the different components of the current study structure impact overall TPACK development. The role of practicing teachers and school librarians in the development of preservice teacher TPACK is also underrepresented in literature and rightfully warrants a closer look. Ideally, the co-teaching faculty from instructional technology and content methods will continue to collaborate, sponsoring workshops that are designed around the demands of preservice teachers. Practicing teachers and school librarians will continue to serve as instructors for the workshops, bringing with them a connection to the real world of middle grades science education.

References

Allenworth, E., Ponisciak, S., & Mazzeo, C. University of Chicago Urban Education Institute, (2009). *The schools teachers leave*. Chicago: Consortium on Chicago School Research.

BETA 08-09 teacher survey. Retrieved October 22, 2007, from *Etech Ohio Technology for Learning* Web site: http://www.etech.ohio.gov/jcore/doclib/DocView.jsp?step=view&file=948CF396-9BCA-47B0-A32A-049884B19CB7

Brown, J., Collins, A. & Duguid, P. (1989). Situated cognition and the culture of learning, *Educational Researcher, 18*, 32-42.

Chai, C., Koh, J. & Tsai, C. (2010). Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). *Educational Knowledge & Society, 13*(4), 63-73.

Cobb, P., & Bowers, J.S. (1999). Cognitive and situated learning perspectives in theory and practice. *Educational Researcher, 28*(2), 4-15.

Collins, A. (1988). Cognitive Apprenticeship and Instructional technology. (Technical Report No. 6899). BBN Labs Inc., Cambridge, MA.

Collins, A., Brown, J.S., & Newman, S.E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. Resnick (Ed.), *Knowledge, learning and instruction: Essays in honor of Robert Glaser* (453-494). Hillsdale, NJ: Erlbaum.

Denzin, N. K., & Lincoln, Y. S. (Eds.) (2008). *Collecting and interpreting qualitative materials*. Thousand Oaks, CA: Sage Publishing.

Ertmer, P., Conklin, D. & Lewandowski, J. (2003) Increasing preservice teachers' capacity for technology integration through use of electronic models. *Teacher Education Quarterly*, *30*(1), 95-112.

Friedman, A. & Kajder, S. (2006). Perceptions of beginning teacher education students regarding educational technology. *Journal of Computing in Teacher Education, 22*(4), 147-151.

Glaser, B., & Strauss, A. L. (1967). *The discovery of grounded theory.* Chicago: Aldine.

Graham, C. R., Burgoyne, N., Cantrell, P., Smith, L., St. Clair, L. & Harris, R. (2009). TPACK development in science teaching: Measuring the TPACK confidence of inservice science teachers. *TechTrends, 53*(5), 70-79.

Guba, E. & Lincoln, Y. (1988). Do inquiry paradigms imply inquiry methodologies? In D. M Fettermen (Ed.), *Qualitative approaches to evaluation in education: The silent scientific revolution.* (pp. 89-115). New York: Praeger.

Hammond, M., Fragkouli, E., Suandi, I., Crosson, S., Ingram, J, Johnston-Wilder, S., Kingston, Y., Pope, M. & Wray, D. (2009). What happens as student teachers who made very good use of ICT during pre-service training enter their first year of teaching? *Teacher Development, 13*(2), 93-106.

Harel, I. & Papert, S. (Ed.) (1991). *Constructionism*. Norwood, NJ: Ablex Publishing Corporation.

Hofer, M. & Grandgenett, N. (2012). TPACK development in teacher education: A longitudinal study of preservice teachers in a secondary M.A.E.d. program. *Journal of Research on Technology in Education, 45*(1), 83-106.

Kim, H. & Hannafin, M. (2008). Grounded design of web-enhanced case-based activity. *Education Technology Research and Development*, 56(2), 161-179.

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

Koh, J. & Divaharan, S. (2011). Developing pre-service teachers' technology integration expertise through the TPACK-developing instructional model. *Journal of Educational Computing Research, 44*(1), 35-58.

Lance, K. C. (2010). The mind of a researcher. *Teacher Librarian, 37*(4), 81-82.

Lave, J. & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. New York: Cambridge University Press.

Margerum-Leys, J. & Marx, R. (2002). Teacher knowledge of educational technology: A case study of student/mentor teacher pairs. *Journal of Educational Computing Research, 26*(4), 427-462.

McKenzie, J. (1999). The technology in my life survey. Retrieved October 22, 2007, from *The Educational Technology Journal* Web site: http://fno.org/techlife.html

Moursund, D., & Bielefeldt, T. (1999). *Information technology in teacher education*. Eugene, OR: International Society for Technology in Education.

Niess, M. L. (2007). Developing teacher's TPCK for teaching mathematics with spreadsheets.

Technology and Teacher Education Annual, 18(4), 2238-2245.

Özgün-Koca, S. A., Meagher, M., & Edwards, M. T. (2010). Preservice teachers' emerging

TPACK in a technology-rich methods class. *Mathematics Educator, 19*(2), 10–20. Retrieved from http://proxy.library.oregonstate.edu/login?url=http://search.

ebscohost.com/login.asp?direct=true&db=ehh&AN=50448899&site=ehost-live

Pajares, M.F. (1992). Teachers' beliefs and educational research: Cleaning up a messy construct. *Review of Educational Research*, 62(3), 307-332.

Partnership for 21st Century Skills. (2012). Retrieved from http://www.p21.org/overview

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

Polly, D., Mims, C., Shepherd, C. & Inan, F. (2010). Evidence of impact: Transforming teacher education with preparing tomorrow's teachers to teach with technology (PT3) grants. *Teaching and Teacher Education, 26*, 863-870.

Roux, Y. (2008). Interview with a vampire, I mean librarian: When pre-service teachers meet practicing school librarians. *Knowledge Quest, 37*(2), 58-62.

Schell, J. W., & Black, R. S. (1997). Situated learning: An inductive case study of a collaborative learning experience. Journal of Industrial Teacher Education, 34, 5-28.

Schmidt, D., Baran, E., Thompson, A., Koehler, M.J., Shin, T, & Mishra, P. (2009, April). *Technological Pedagogical Content Knowledge (TPACK): The Development and Validation of an Assessment Instrument for Preservice Teachers*. Paper presented at the 2009 Annual Meeting of the American Educational Research Association. April 13-17, San Diego, California.

Stein, M., Larrabee, T.G., & Barman, C.R. (2008). A study of common beliefs and misconceptions in physical science. *Journal of Elementary Science Education, 20*(2), 1-11.

Wang, F., Means, T. & Wedmen, J. (2003). Flying the KITE (knowledge innovation for technology in education) through a case-based reasoning knowledge repository. *On the Horizon*, 11(2). 19-31.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity.* New York: Cambridge University Press.

Wetzel, K., Foulger, T. & Williams, M. (2008). The evolution of the required educational technology course. *Journal of Computing in Teacher Education*, *25*(2), 67-71.

Young, J. R., Young, J. L & Shaker, Z. (2012). Describing the pre-service teacher: Technological pedagogical content knowledge (TPACK) literature using confidence intervals. *TechTrends, 56*(5), 25-33.