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Technology Integration in Elementary Classrooms: Teaching Practices of Student Teachers

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Abstract: This study examines how and why student teachers integrated technology to enhance instruction in elementary classrooms. The participants were 31 student teachers who completed an assignment of eight weeks. Multiple data sets including observation notes of 347 lessons were obtained from three key groups for data triangulation. Results reveal that the primary technological means used to enhance teaching was to provide visuals for attention, engagement and interaction. All participants chose to integrate technology but varied substantially in their teaching practices. They applied technology for a number of reasons: student engagement, time management, motivation and meeting individual students' needs. Variables such as influence of mentor teachers, technology access, skills, pedagogical competence and personal attitudes had an impact on their application. While most of them followed their mentor's practices, some student teachers took initiative and made contributions to their mentors' professional development in technology integration. Implications on teacher preparation programs are discussed.

Introduction

Technology application is becoming part of the teaching and non-teaching practices of K-12 teachers more than ever before. Attention has also been given to research and learning theories of teacher preparation regarding the use of technology (Ottenbreit-Leftwich, et. al., 2012; Slagter van Tyron & Schwartz, 2012). California Standards for the Teaching Profession include the use of technologies to support student learning (California Department of Education, 2009). In a national survey conducted in the U.S.A. (Gray, Thomas, & Lewis, 2010), less than 50% of the teachers were found to often apply technology during instructional time but technology was utilized more in their completing administrative tasks. Teachers and pre-service teachers are challenged to integrate technology into their instruction. Kopcha (2012) provided a summary of research on the identified barriers in technology integration: access or quality of facilities, vision of school administration, teacher beliefs, time required for preparation and professional development. Professional development is a means to help teachers overcome these identified barriers in their technology application. However, the quality of professional development is

often related to connection between technology use and classroom practices (Mouza, 2009; Wells, 2007).

In the past decade, research topics on technology application in teaching and learning extend from barriers (Butler & Sellborn, 2002; Kopcha, 2012), subject specific instruction such as math and social studies (Fraser, Garofalo, & Juersivich, 2011; Henning, Peterson, & King, 2011; Keiper, Harwood, & Larson, 2000; Menard, 2010; Whitney, 2007) to practices of new teachers after program completion (Wright & Wilson, 2005). The participants of the above studies involve teachers and pre-service teachers in K-12 school setting. Pre-service teachers are in the process of developing teaching abilities through applying a variety of instructional strategies and resources. To increase quality of teacher preparation, more research is needed to examine how pre-service teachers apply technology in an instructional context.

Empirical evidence indicates that a large number of pre-service teachers have acquired technology skills, but they are yet to develop abilities to integrate technology (Liu, 2012; Maddux & Cummings, 2004; Moursund & Bielefeldt, 1999; Selinger, 2001). During field experiences or student teaching, mentor teachers play a major role in assisting pre-service teachers to integrate technology into their teaching (Kopcha, 2012; Liu, 2012). This impact of mentor teachers is confirmed in the synthesis of qualitative evidence in preparing pre-service teachers to integrate technology (Tondeur et al., 2011): 13 of the 19 selected studies highlighted teacher educators serving as a role model for pre-service teachers. One aspect that Tondeur and colleagues (2011) proposed for further research is the “influence of cultural and contextual factors on the development of pre-service teachers’ capacity to apply technology in daily classroom practices” (p. 10). Similarly, others (Kopcha, 2012; Rosenberg & Koehler, 2015) call for more research that looks into the complexity of practices and context of technology integration instead of relying on the self reports (Hew & Brush, 2007; Hixon & Buckenmeyer, 2009; Lawless & Pellegrino, 2007).

In teacher preparation, studies have been conducted on technology integration of pre-service teachers (Choy, Wong & Gao, 2009; Jaipai & Figg, 2010, 2015; Margerum-Leys & Marx, 2000). The focus of these studies is on the change of intention and action related to a technology course, acquisition of knowledge about educational technology of student teachers and mentor teachers, or application of a collaborative model to support technology integration. All of these studies were conducted on the field-based practice of pre-service teachers in an elementary school setting, and below is a brief review of each of them.

Choy, Wong, and Gao (2009) explored the change of pre-service students’ intention and action to integrate technology into their teaching before and after taking a technology course. Over 100 pre-service teachers completed a survey at different times of the program. Findings indicate that the participants increased intention of using technology in instruction with their development of pedagogical knowledge about technology integration. However, a gap existed when the pre-service teachers took actions primarily due to various external factors such as “software availability, plug-in problems, and Internet connection speed” (p. 190). As a result, the pre-service teachers were not able to fully translate their intention of integrating technology to enhance instruction and promote student centered learning.

With a much smaller number of participants but more comprehensive data collection, Margerum-Leys and Marx (2000) examined teacher knowledge of educational technology and application in a teaching context through a case study of three pairs of student teachers and mentor teachers. The researchers collected data about the classroom practices of these participants. Findings indicate that the student teachers contributed their learning acquired from university course work on technologies while the mentors played the role of pedagogical guides in the collaboration. The identified obstacles to apply educational technology include lack of time and classroom management.

The third one is also a case study (Jaipai & Figg, 2010), applying a school based collaborative model in support of elementary pre-service teachers to integrate technology in teaching. The four participants received assistance from a team comprised of two university faculty members, a school board technology consultant and a master's student, when they planned and taught technologically enhanced lessons during a 7-week period in two schools. The researchers analyzed the characteristics of application through a cross case analysis of data. Furthermore, based on the findings of longitudinal studies of pre-service and in-service teacher teaching with technology in elementary schools, Jaipai and Figg (2015) presented a framework, TPACK-in-practice with characteristics and actions demonstrated in elementary teaching practices of technology integration. The framework was developed on the basis of the Technological Pedagogical Content Knowledge (TPACK) (Koehler & Mishra, 2009; Mishra & Koehler, 2006). The TPACK-in-practice framework includes three intersections: technological content knowledge, technological pedagogical knowledge and technological pedagogical content knowledge, extending from technological skills and beliefs to external variables in a teaching context. Four stages for designing content-centric professional development workshops in technology integration are also proposed.

Based on the above literature review, this study was designed to explore the technology integration practices of pre-service teachers in an instructional context of elementary schools. Their practices are discussed in reference to the TPACK-in-practice framework (Jaipai & Figg, 2015). The emphasis is placed on investigating how their technology integration is pertinent to the three intersections of the framework. Furthermore, why the student teachers applied technology to enhance teaching is also part of the study. Specifically, the purpose of this study was to examine how and why the student teachers addressed technology integration to teach in K-5 classrooms during an assignment of eight weeks. Aspects such as the participants' access to and actual use of technology, and their explanation of technology use will be analyzed. Two research questions posed for the study are: 1) How did the student teachers integrate technology into the lessons they taught in K-5 classrooms? 2) Why did they integrate technology into their instruction?

Research Design

Mixed methods of descriptive survey research and case study of the group (Lodico, Spaulding & Voegtler, 2010) were applied in this study. Both quantitative and qualitative data were collected throughout a student teaching assignment. Multiple sets of data at different time or places and directly from or about the participants were collected and analyzed to answer the research questions.

Participants

A total of 31 student teachers in an elementary teaching credential program participated in the study. They were required to fulfill all other course requirements before they began student teaching. In addition to a generic technology course, technology was embedded in the course work they completed before student teaching took place. For example, the pre-service teachers were required to create an e-story with animation for a target subject matter. However, they did not have an opportunity to teach a lesson integrated with technology to K-5 students, not to mention reflection on teaching experience.

During student teaching, the participants completed an assignment of eight weeks in an elementary classroom adhering the school daily schedule. The student teaching placements were spread out in 15 public schools of a suburban area. All the schools were K-5 with a few that offered transitional kindergarten classes. The enrollment of these schools was between 700 and 1,100 students. The K-5 students eligible for free or reduced lunch ranged from 70% and 13% among these schools. The ethnic background of the students was diverse, and many of them were English Language Learners or had identified needs.

Each of the student teachers was assigned to work full day in the classroom to gradually assume all non-teaching and teaching responsibilities. One main task for the student teachers was to design lesson plans and teach lessons of different subjects (math, science, English language arts...) following the school district curriculum. They were observed by a university supervisor once a week and submitted a lesson plan for each observation. They also developed and taught a unit of study including at least five lesson plans. The participants reflected on their application of technology in the classroom as related to teaching effectiveness and completed a survey on access and use of technology. They received evaluations from their university supervisor and mentor teacher, aligned with the standards for the teaching profession.

Data Collection

Multiple sets of data were collected on a weekly basis from and about the participants during the 8-week period. The data extended from observation logs of the participants' actual use of technology in teaching the 347 lessons, report of access to technology in the classroom to the student teachers' reflection on their application and evaluations by their mentors. In particular, the following types of data were collected: 1) classroom observation logs of the student teachers' technology integration into teaching as well as after lesson debriefing, 2) written lesson plans with reflection, 3) summative reflection on technology integration with justification, and 4) a survey regarding access and general use of technology in a classroom. In addition, student teaching evaluations were collected to analyze their technology integration. All types of data were obtained from the three key groups: student teacher, mentor teacher and university supervisor, who were directly involved in the process. The written information provided by the student teachers or participants included lesson plans, reflection journals and their summative reflection on technology integration. A mentor teacher and supervisor were present in the lessons taught for observation. They participated in the after teaching debriefing with a student teacher

and wrote formative and summative evaluation. Additional informal information was also collected from other professionals such as school administrators and staff.

Statistical or Data Processing Methods

Data triangulation (Johnson & Christensen, 2007) regarding the student teachers and the three key groups was applied to answer the two research questions. Observation logs of technology integration in the lessons taught by the student teachers were maintained on weekly basis. The logs provided a brief summary of the technology means they used and how they applied it in teaching. Original written lesson plans were attached to the observation logs. Additionally, all student teachers wrote reflection journals after their teaching in addition to a summative reflection on technology integration. The participants also explained why they utilized technology to enhance teaching.

NVivo 10 was selected to summarize the data. Coding (Johnson & Christensen, 2007) was applied to analyze data for emergent themes (Wolcott, 1990). After repeated readings, overlap shown among codes was reduced when similar codes were clustered together. Then numerous codes were combined into a number of broad themes (*see Table 2 of the Results section below*). Additionally, all data were analyzed for generative themes using a constant comparison process in an iterative and recursive manner. When the themes within and across different types of data were studied and organized, they were used to answer the research questions and draw conclusions.

To provide more detailed background information of the data, the themes were tallied to reveal frequency of responses. Tables were used to summarize the themes with examples as appropriate, a presentation of the most frequently cited items at the top and the least at the bottom. The themes were also converted to percentage for easier view of the data summary.

Results

All sets of data were analyzed to answer the two research questions. Findings would be reported by the research questions in order. The primary data to answer the first research question were the observation logs of the participants' use of technology during their actual teaching, lesson plans of the observed lessons as well as their report of access and use of technology. For the second research question, the focal data were the student teachers' summative reflection on their teaching practices with justification and lesson-based reflection. In the meantime, all other types of data were used to enrich, further explain or clarify in answering the research questions.

Research Question 1: Types of Technology Integrated in Teaching

All of the student teachers integrated some types of technology into their teaching and non-teaching practices during the assignment. However, none of them used all technology means available in a classroom, and technology was not integrated into all of the lessons for observation. Among the observed lessons, the use of technology ranged from none to all with the majority in between. In data processing, lessons were first

grouped into technology integrated (197 lessons or 57%) and non-technology integrated (150 lessons or 43%). In the 197 technology-applied lessons, some participants integrated more than one type of technology, and all types of technology utilized were recorded for classification. Also, it is important to specify that major differences revealed in how the participants used the same technology means to engage and support their students in instruction.

Table 1 is a summary of all types of technology used when the participants taught the lessons for observation. Each of them taught approximately six lessons with 347 in total. The analysis of these lessons was also converted to percentage for a quick review of summary. Of all the observed lessons, although 43% did not involve technology integration, the participants used one or more traditional means such as whiteboard, chart paper, sentence strips, pictures, flash cards, mini whiteboard and other environmental print in the classroom to provide *visuals* in instruction. For the rest 57% of the lessons, at least one type of technology was integrated.

Type	# of use	%
Document camera (Elmo)	151	70.89
Smartboard	17	7.98
Video	15	7.04
Powerpoint	13	6.10
Audio player & microphones	11	5.16
Internet	6	2.82

Of all the lessons taught and observed, 150 (or 43%) did not show any technology integration.

Table 1: Technology Used in the Teaching of 347 Lessons

As Table 1 shows, the most frequently used technology (70.89%) was document camera or Elmo to show a variety of visuals related to a lesson. The visuals extended from learning goals, part of textbooks, graphic organizers to written summary of text/information and recorded oral discussion highlights. Sometimes, the student teachers also displayed manipulatives and realia or demonstrated experiments to engage their students in learning or discuss steps of problem solving procedures. Still other times, Elmo was switched on but was not appropriately used to present information along with progression of a lesson. Or it was only used to at the beginning, middle or end of a lesson.

Furthermore, even for the same activity with Elmo, differences were clear in procedures, time management and level of student participation. For example, Elmo was used to share student written work. Some student teachers chose the work of their students for display as an example or for making clarifications as appropriate. Other times, they called some students to Elmo one at a time to write and then explain their written work. When several students were called to the front to re-write their answers under Elmo followed by an oral explanation, time for each part of the activity must be allocated.

Evidence of teacher and student interaction shows that both parties benefited from the above sample sharing activity on Elmo in various aspects. The teacher had an opportunity to understand the students' thinking process in problem solving, assess learning, and use the assessment information to redirect instruction. For the students, they

should be motivated to complete work efficiently, develop presentation skills, justify their answers, and receive feedback from others about their work. On the other hand, there were some issues a student teacher had to face in organizing the activity such as time efficiency and level of student participation. Time could easily be lost in waiting for one student to walk to/from Elmo and rewrite/copy their work. Another issue would be related to getting all other students involved when one was writing on Elmo. These issues were not about the technology hardware but rather time, behavior management and student participation.

The second most frequently used technology at 7.98% of the lessons was Smartboard, an advanced version of Elmo. Smartboard, an integration of visuals, video and audio, connected to a computer/laptop and whiteboard, was only available in a few classrooms, and the student teachers experimented with part of Smartboard functions similar to Elmo. Sometimes, the participants used Smartboard rather minimally to display a title, key vocabulary or learning goal in a lesson.

Videos were another way of technology integration (7.04%) on the list, and the clips were shown on a video player connected to a monitor or were played directly on laptop or desktop. The video clips were either obtained from an online resource such as Youtube, a paid online program or digital video disks. However, major differences existed in how the video clips were used. Some allowed little transition before and after the video play in a lesson and run through a video with no interruption. Others asked questions before or after playing a video to hold/redirect their students' attention or review information at the end of a video show. During video play, discussion was also generated between pauses to make a connection to the lesson objectives. Moreover, variance was shown in the means through which to play a video: LCD projector, TV monitor or laptop. It was challenging for everyone in a group to see well when a video was played on a laptop. Some student teachers had to use a laptop as alternative when they and their mentor applied parallel teaching with a split of the class of students into two groups.

The next item on the list is rather software-based, the application of PowerPoint at 6.1%. Differences were clearly visible in the file design (visuals only, visuals and animation, or visuals and sound effects combined) and slide structure (text, picture, colors/highlights and graphic organizer). Even more differences presented in how the files were used in teaching. Some decided to quickly go through a collection of pictures, some paused between slides to generate oral discussion, and others showed a jeopardy game with questions on each slide for review. Still others sequentially organized all key information of a complete lesson with objectives, pictures of objects, posed questions, charts, text and samples in addition to exercises for students and lesson review. After witnessing the success of some lessons taught by their student teacher, some mentors requested a copy of e-files for their own future use. To use this application or software, a desktop, laptop or ipad was chosen.

The participants' use of online resources with direct Internet connection during a lesson was scarce. In two cases, an e-map from the Internet was used in a lesson of geography, and a social networking website was shown to discuss the students' written responses to the posted questions. However, most of the student teachers selected materials such as pictures, text and charts from online sources and showed the

information on Elmo/Smartboard or displayed a hard copy on chart paper in the classroom.

Other than the above means, the participants also used non-visual technology or audio facilities to support learning in the teaching of a small number of the lessons. An audio player was to play sounds (e.g., farm animals) or background music, and songs were played for choral sing along related to the target content. Audio was also used to set up routine or for the purpose of making transition between activities. In addition, other means was selected to address the special needs of individual students. For instance, microphones were utilized to help the hearing impaired students.

It is interesting to note that the participants responded differently to lack of desirable facilities. Most of them chose to use what was available in the classroom just like their mentors. When they encountered barriers with technology, some had to step away from their initial plan of integrating technology and used traditional means as alternative to show visuals. For example, when lighting quality of projection was problematic or an upgrade was unavailable, chart paper/poster was selected as replacement. In contrast, some others took action to address issues by seeking assistance from their mentors and technology support staff or bringing in additional resources such as laptop or ipad to implement their plan of integrating technology. When they took the step, they helped their mentors improve the use of technology in the classroom through equipment set up/upgrade or producing new e-information for their mentors to use in the future. Encouraged by a mentor and the principal, one student teacher even provided a training session to the interested teachers at the school on the use of technology to enhance the teaching of a science unit.

Research Question 2: Reasons to Integrate Technology

Why did the participants decide to use technology? They provided summative responses and wrote reflection on the lessons they taught to explain their choices and action taken. Some of them contributed to more than one theme in their responses. Table 2 is a summary of the reasons to integrate technology given by the group.

Reasons	Example	Count / %
Student engagement and motivation	- "I made a lot more connections to the texts and found it more entertaining when content was presented with technology." - "This made both teaching and learning fun as all students were engaged, curious, and eager to discuss."	15 / 31.91%
Get organized in lesson planning & teaching to improve time efficiency	- "...save time as compared to writing the same information on a whiteboard." - "When using the white board, I have to constantly step out of the way so the students can see. Using the Elmo allows all the students a clear view of the information."	9 / 19.1%
Behavior management with rewards & routines	- "Students were excited to receive points and would participate in discussions in hopes of gaining points on ClassDojo." - "The audio player was used to help create the routine and establish an atmosphere of learning."	8 / 17.0%

Meet individual needs of students	- “All students, especially English Language Learners need visuals to help them learn.” - Use technology for a student who broke her arm and two students wearing hearing aids.	7 / 14.8%
Influence of mentor teachers	- “My mentor teacher used it fairly extensively in his 2 nd grade classroom, so I followed suit in my own teaching and found it very useful in my lesson planning and implementation. “ - “I decided to use the ELMO as instructed by my MT. She uses it extensively and has mentioned that in the near future she will have access to a Smartboard which would further the ease of modeling instructional material.”	7 / 14.8%

Table 2: Summary of the Reasons to Use Technology by the Participants

As Table 2 presents, the top one reason on the list stated by 15 (31.91%) participants was to engage the K-5 students through attracting or holding their attention and making a lesson interactive and entertaining. One participant commented: “I made a lot more connections to the texts and found it more entertaining when content was presented with technology.” Another student teacher shared her students’ excitement by describing their responses to the use of technology in teaching:

The students in the Kindergarten class were engaged as soon as they entered the classroom after recess. They said things like, “Wow! Are we going to see a movie!” ... A somewhat dry content of comparison between apples and pumpkins became a very exciting subject for the students.

On the other hand, the comments made by a different participant focused on the interactive aspect through asking questions to make the students think.

While watching the videos, I paused at strategic points to pose questions and engage students in brief discussions. After watching all three video clips, I posed the big question and the vast majority of students could express specific reasons, which dealt with safety and survival.

The second most frequently cited reason to enhance teaching was related to getting organized in planning and teaching (9 or 19.15%). The student teachers specified time management or organization in their use of technology. They were able to make it more efficient when they prepared e-information for effective display, or they saved instructional time when they minimized writing on whiteboard during teaching. Another way they increased efficiency was to get familiar with operation of equipment: “I’ve learned how to quickly switch projection between the ELMO and the computer so that we don’t waste class time on technical issues.” Without the required technical skills, the effect would be different as it was in the case below.

I’m still getting used to teaching with the Elmo (zooming in and out of text, getting the lighting right, etc.). So I feel that it affects my teaching at times because I get distracted trying to figure out how to use it and lose my train of thought. Fortunately, it doesn’t happen often but it’s helped me realize that successfully using any piece of technology for instruction requires investing time (non-instructional time) getting familiar with the equipment.

The third reason is related to behavior management or routines when students were encouraged to stay on task and be active participants in learning (8 or 17.02%). The student teachers were able to use technology to reward students with points for participation. Moreover, technology application was perceived as a means to set up or

enforce classroom routines and procedures. For example, an audio player was to “help create the routine and establish an atmosphere of learning” in a first grade classroom. The comment was echoed by another student teacher: “Consistent use of the technology made it a routine for the classroom. The students become used to it as a method of learning.” Also, effective use of technology would allow a student teacher to sweep the classroom for behavior management and progress monitoring during a lesson.

I have found that the first grade class loves to socialize as well as get up move. When writing with your back to the class they tend to socialize more. With the Elmo, I can place myself in front of the class while also facing them. This makes it really easy to survey the class during instruction and assess if the class is able to understand the different teaching points I am trying to get across.

The fourth reason regarding technology integration was to address the needs of individual students (7 or 14.89%). One type was to create a meaningful context with visuals and sounds for English language development. Some other needs were associated with physical disabilities such as hearing impairment or hand injury, which could be temporary or long term.

Last but not the least, although only seven of the participants made specific comments on the influence of their mentors, practically all student teachers were more or less affected by their mentor teachers and other staff. One student teacher tried an application in teaching as result of a staff meeting.

I decided to use the Popplet app, because during a staff meeting, one of the teachers modeled how she used it to make a thinking map with her students. She also mentioned how students were excited about using this app to create thinking maps. It was a great way to show vivid realistic pictures of the different parts of plants.

In addition to the influence of other staff, the above participant also shared that she received assistance from a family member in using the application. She brought in an ipad to teach the lesson for better student engagement. Several other student teachers also used laptops (unavailable in the classroom) to show video clips or pictures in their teaching of a group or whole class.

On the other hand, five student teachers had to reduce their initially planned level of technology integration due to lack of support from their mentors, set up of facilities or quality of equipment. Two were unable to integrate technology as they had hoped because trying a new technology went beyond the comfort zone of their mentors. In other instances, they were not able to use the facilities in the classroom because of hardware set up or quality. For instance, it was challenging to address classroom management when one had to use the technology station in the classroom with his/her back to the class. Similarly, Elmo was not used because the lighting of projection was of low quality.

The participants’ report of technology integration was reflected in the evaluation of their mentors. The average rating of the student teachers’ technology use on a 1-4 point scale (with 4=Exceptional Beginning Practice and 1=Inconsistent Beginning Practice) was over 3.5. Some mentors made specific comments to elaborate their rating. One praised a student teacher for using “Power Points and videos to develop schemata around the theme of patriotism and perseverance”. Another wrote: “She used technology in the classroom on several of the lessons she taught. The students loved it” because she made learning exciting. A third mentor complimented her student teacher for taking

initiative to help her “set up the technology system of laptop, Elmo, speakers and Internet connection and search online resources to enrich teaching”. However, the majority of the mentors did not provide any specific comments about their student teachers’ technology application in the written evaluations.

Discussion

The discussion of the participants’ practices in technology integration unfolded in alignment with the three intersections of the TPACK-in-practice framework (Jaipal & Figg, 2010). Each of the intersections served a focal point of discussion with reference made across as needed. The first component was TCK-in-practice (technological content knowledge, e.g., knowledge of tools, skills, and personal attitude) followed by TPK-in-practice (technological pedagogical knowledge, e.g., classroom management, differentiated support and assessment) and TPCK-in-practice (technological pedagogical content knowledge, e.g., different models of teaching to meet learning goals such as direct instruction and question-based instruction). The participants’ growth in one aspect could be connected to their overall development. Additionally, the purpose of using technology was to enhance instructional experiences (Jaipal & Figg, 2010). In this study, enhanced instruction referred to appropriate engagement of students, motivation, active interaction between a teacher and students, and appropriate pacing and time management to reach learning goals. All of the above aspects were also highlighted in the participants’ reflection on technology integration.

TCK-in-practice (Technological Content Knowledge)

Findings reveal that all of the student teachers applied some types of technology into their instruction and demonstrated knowledge about content appropriate technology related to the TCK-in-practice. The evidence was not only revealed in the participants’ work, self reports and reflection but was also confirmed in observations by the second or third party. Their use of technology was directly influenced or restricted by available resources in the classroom or external factors (Butler & Sellborn, 2002; Choy, Wong, & Gao 2009; Kopcha, 2012). In other words, the participants tended to apply the technology, software or hardware, already available in the classroom, which was also often used by their mentor teachers. Among different types of technology, the predominant top choice was to provide visuals via Elmo to engage and support K-5 students in learning, and traditionally presented visuals were also used in the teaching of all other lessons without application of technology.

It was essential for the student teachers to possess technology skills in order to enhance their teaching with smooth transition between activities or lessons for time efficiency. In addition to technology skills, appropriate equipment set up or upgrade was also important for the participants to use technology effectively. In the context of field experience or student teaching, mentor teachers played a major role (Kopcha, 2012) either because of their level of technology integration or because of their support and readiness for student teachers to explore new applications. Findings show that most of the student teachers decided to use a certain type of technology after observing successful

practices of their mentor teacher. Furthermore, when a mentor was not competent enough to provide the expected support in technology integration, the personal attitude of a student teacher would lead to either maintaining the status quo or taking initiative to explore alternative ways to reach their goal. Some participants were able to apply additional technology to their teaching, and the action, supported by their mentor, turned into an opportunity for a pair to develop new skills. This allowed them both to explore and improve technologically and pedagogically together instead of having a student teacher contribute in technology and a mentor contribute in pedagogy (Margerum-Leys & Marx, 2000). Consequently, the experience was beneficial for them to develop professionally as equal partners.

Results indicate that classroom access to technology was the main factor in technology integration for the group. In other words, the technology means that the participants primarily utilized were already equipped or available in the classroom. These means included Elmo, LCD projector, desktop, Smartboard, audio player or microphone. Their technology use was affected by a variety of external factors such as availability, plug-in problems and Internet connection (Choy, Wong & Gao, 2009; Kopcha, 2012). However, for some participants, the external factors alone did not stop them from exploring other ways to integrate technology. Their personal attitude or beliefs (Inan & Lowther, 2010; Kopcha, 2012) made a difference in their professional development as student teachers. They took initiative to help their mentors expand the horizon of technology application with additional software or facilities, getting the existing equipment connected or updated, and obtaining online information to enrich teaching and learning. Another contribution made by some participants was to bring in extra resources. The implication of this finding for teacher preparation is that pre-service teachers should be encouraged and guided to find alternatives such as portable electronic devices outside of the classroom to make full use of their existing skills and strengths in technology integration. Identifying issues and exploring ways to address the issues are essential for a classroom teacher to be successful. Information of portable electronic resources that pre-service teachers can tap into for use in a classroom would be helpful to enrich learning and teaching experience. Also, while mentors can be role models, student teachers should not mimic but find their own teaching style during student teaching. By playing an active part in technology integration, student teachers have an opportunity to grow independence and develop capacity to collaborate with others in the moment and the future.

Unfortunately, some student teachers were not able to use a desirable device because of classroom set up or incompatibility. For example, a participant had hoped to show a video clip to a small group of students at a table in the back of the classroom but was unable to do so with the monitor equipped at the front. Opportunities to enhance teaching would be lost when hardware was not set up properly for maximal use. Such issues could be prevented if input and feedback of classroom teachers were elicited and considered. It would be helpful for schools or school districts to maintain effective communication with classroom teachers so that issues can be tracked for adjustments to be made in a timely manner.

All of the student teachers considered technology integration important to enhance the quality of teaching. The technology facilities or software they decided to use were primarily to engage their students in the senses of sight, hearing or sight and hearing

combined. There seems to be a need for pre-service teachers to explore other technological means beyond visuals. In the teacher preparation programs, course work that helps pre-service teachers develop skills in competently using tools, software and resources to provide support beyond visuals would better prepare them to meet a variety of students' needs in the future.

TPK-in-practice (Technological Pedagogical Knowledge)

Classroom management, an element of TPK-in-Practice, was apparently reflected in the practices of the participants. Results indicate that an obstacle in the use of technology was related to classroom management or dealing with misbehavior (Bauer & Kenton, 2005; Lim & Khine, 2006; Margerum-Leys & Marx, 2000; Wachira & Keengwe, 2010). However, most of the participants in this study integrated technology for the purpose of keeping the children on task and encouraging appropriate behavior. A number of them were able to achieve this goal in their teaching with a package of technology skills, familiarity with equipment, and alignment between selected technology and target subject matter. Pre-service teachers should be most appropriately prepared for successful practice in the classroom when they were well trained in all of these aspects.

How to provide differentiated instruction was a key aspect in designing lessons for a student teacher and a mentor. Based on their lesson planning, they were able to divide up the physical space in the classroom for each to support a group or half of students with application of technology. To achieve success, effective communication for a pair or team would be critical to implement their plan, maximizing the use of available technology in teaching. A good way to minimize distractions for the two groups would be to keep the farthest distance in between and with the back of one group of students to the technology used for the other group. Thus, distractions in visuals and sounds from the other group would appropriately be reduced for both groups to stay on task.

Moreover, integration of technology could serve as a means for conducting assessment. The participants evaluated student learning in applying technology during instruction. They were able to accomplish this in several aspects. One way was to have a student solve a problem or do an assignment on Elmo while all others were doing the same task at their seat. This allowed a teacher to monitor student progress and generate discussion with sample work projected on screen. Other students also had an opportunity to evaluate the work completed by a peer. Another way to assess student learning was to display sample work completed by a student or a group on Elmo for evaluation and discussion in class. To increase time efficiency, it appeared unnecessary to spend extra time for students rewrite under Elmo and walk between their seat and Elmo. To reduce distractions, traffic in the classroom should be minimized. A third way to assess student learning was to apply an e-jeopardy game for review. All questions were displayed one slide at a time for each student to respond. More active participation would be obtained when all students were asked to write in their notebook or on mini whiteboard as compared to an oral response from only one student. A student teacher was able to provide feedback and make clarifications based on the students' response to the questions on each slide.

How the student teachers conducted assessment varied in lesson flow, means for students to demonstrate learning and level of student participation. What is the best way

to assess student learning of different subjects during a lesson with technology application? That would be an important topic to explore in strengthening technology integration for pre-service teachers. The topic is also closely related the next component, TPACK-in-practice when instructional models are considered.

TPCK-in-practice (Technological Pedagogical Content Knowledge)

The participants' use of the same type of technology also diverged significantly to meet content learning goals in TPACK-in-practice. The primary models of instruction revealed in the observed lessons were direct instruction (e.g., a lesson on alphabet letters or division) and question-based (e.g., a lesson on Native Americans with posed open-ended questions) for students to process information and develop target concepts. For the direct instruction model, a learning goal stated in a complete sentence was projected on screen. The students' understanding of the learning goal was unknown when they were only asked to read it chorally. Discussion of the learning goal related to previous lessons and asking the students questions about the goal would allow a teacher to assess understanding. In this context, the use of visuals per se does not directly lead to effective instruction, helping students reach learning goals. The critical element was when and how to make full use of the displayed visuals via technology to facilitate and assess student learning, and then use the information to redirect instruction.

Difference was also obvious in how the participants applied technology to address lesson flow or sequence. Most of them used technology at the beginning, middle or end of a lesson. Some others had Elmo on throughout a lesson, but few were able to make effective transition between activities in a lesson. Therefore, pre-service teachers would benefit more when they are trained to appropriately use technology to maximize student learning (Liu, 2012; Maddux & Cummings, 2004; Moursund & Bielefeldt, 1999; Selinger, 2001). The aspects to consider for professional development should include features of a target subject, student engagement, lesson flow and transition related to the use of identified technology to increase efficiency and effectiveness in instruction.

In summary, technology application does not automatically yield high quality instruction. In addition to familiarity with technology, the student teachers needed to learn how to most effectively utilize technology in lesson planning and actual teaching. When technology was applied to show information not directly related to learning target or relevant information displayed was not appropriately processed, visuals, sounds, or visuals/sounds alone or combined did not serve the purpose of helping the students reach learning goals. Abrupt transition between activities also posed a challenge in instruction when the students were lost and had to ask many questions for clarifications despite use of technology.

For elementary pre-service teachers, they should lay a good foundation to integrate technology in planning and teaching lessons when taking methodology courses. The primary types of technology can be selected in response to the most commonly available resources in classrooms of the local school districts. For example, almost all of the classrooms, regardless of the students' socioeconomic status, had access to a desktop/laptop, LCD projector and Elmo. Application of these means aligned with subject matter in course work would better prepare pre-service teachers to integrate technology into instruction. Also, pre-service teachers should be encouraged to take

initiative based on their strengths in technology, content or pedagogy to address issues by making sufficient use of resources in and outside of classroom. Such experience would create an opportunity for equal partnership and professional collaboration to better prepare them for independence and leadership as future classroom teachers.

To improve the quality of student teaching, teamwork is a critical component for partnership between pre-service and in-service sectors as well as a pair of student teacher and mentor. School districts and teacher preparation programs would both benefit when they have an opportunity to collaborate on technology integration for professional development of pre-service and in-service teachers. Some student teachers with advanced skills in technology can make contributions to professional development at assigned elementary schools as it was the case with several of the participants. Schools should be more enthusiastic in hosting student teachers when their staff can benefit from mutual learning and partnership in the school-university collaboration.

Limitations

Due to its scope, this study focused on examining the practices of student teachers. Although multiple sets of data were collected about the student teachers from all key groups, it would strengthen the study when actual technology use of the paired mentor teachers was also investigated. That would provide an opportunity to better understand the mentors' practices in comparison to their student teachers in the same classroom. In addition, the student teachers were placed at different schools. Besides access to technology facilities, the impact of school vision on technology could also be discussed through the action taken by the mentors.

The quality of teaching related to technology integration was examined through informal assessment of attention, participation, and competence demonstrated by the K-5 students in completing tasks aligned with learning goals in the observed lessons. The informal assessment was conducted by a student teacher as well as a mentor teacher and university supervisor. If other types of informal and formal assessments of student learning outcomes were available for more comprehensive analysis, that would also serve to enrich the data collection.

Conclusion

Technology integration is practiced by student teachers in the elementary classrooms with a goal of improving instruction. However, more research is needed to explore how student teachers can effectively integrate technology in their daily instructional practices. The critical issue does not appear to be *what* technology to select but *how* to apply the selected means to maximize learning outcomes within given instructional time. Multiple internal and external variables can affect how they select and utilize technology means for their teaching. While physical facilities are more associated with school budget, teacher candidates' personal interests and technological skills can directly influence their choices and action. They should be encouraged and guided to make sufficient use of all resources available in and outside of the classroom to enhance and improve instruction.

Student teachers learn to integrate technology into instruction with direct assistance of their mentor teachers. The practice of mentors no doubt has an impact on the professional development of their student teachers. In the meantime, student teachers can also make a contribution when they are advanced in technology skills, have new ideas to improve teaching and are highly motivated to integrate technology, if their mentors are open to improvement. This would allow student teachers to take initiative and feel proud of their ownership and contribution in a true partnership.

Since student teaching is field based, collaboration between a credential program and local school districts would be powerful in professional development. The teamwork may create an opportunity for a pair of teacher and student teacher to better meet the needs of students in a given classroom by making good use of the technological and pedagogical skills they possess. They can collaboratively explore the most effective and efficient ways to motivate, actively engage and assess their students in reaching goals across the curriculum.

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